Unravelling the technique of double-sided painted silk banners through the characterisation of five Kenning examples of Glasgow Museums Collection

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Submitted in fulfilment of the requirement for the degree of

Doctor of Philosophy

School of Culture and Creative Arts

College of Arts

University of Glasgow

August 2022

To my mum,

the true doctor in my life.

In memory of

Françoise Renée Hatchondo Roux.

Abstract

This thesis presents technical art historical research on five Kenning banners of Glasgow Museums Collection, manufactured by the London-based companies of George Kenning, and George Kenning & Son between the years 1883 and 1917. Trade union and society banners are important and representative objects of British socio-political culture. However, their often-unknown historical context and limited understanding of the materials and methods used in their making complicate their interpretation and conservation, preventing several existent banners from being easily available for study and display.

The historical contextualisation of the five Kenning banners of Glasgow Museums Collection allows for the temporal situation and distinction of the banners, the societies that had them commissioned, and the companies that manufactured them. It also shows how they have developed from a long tradition of painting on silk dating back to Cennino Cennini's fourteenth-century manuscript, with further descriptions found in seventeenth and eighteenth-century European sources, as well as nineteenth and early twentieth-century American manuals for sign painters. These sources reveal the basis for their manufacturing technique, which has not yet been studied in the context of British trade union and society banners.

The technical examination conducted on the five Kenning examples of Glasgow Museums Collection characterises the materials employed in the banners' production from the two companies. The results are used to produce historically informed reconstructions, which aids in the understanding of the original manufacturing technique. In doing so, this study gives continuity to the previous research on British trade union and society banners and offers a holistic approach to continue with their study in the future.

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Acknowledgements

This work was supported by *Consejo Nacional de Ciencia y Tecnología* CONACYT (the Mexican National Council for Science and Technology), scholarship reference 327134/472757; *Banco de México*, trustee of the National Federal Government in the trust *Fondo para el Desarrollo de Recursos Humanos* FIDERH (Fund for the Development of Human Resources), student loan No. 1711110612; the College of Arts Graduate School of the University of Glasgow through the Research Support Award 2018/19; the University of Glasgow Crisis Grant 2020 and Hardship Fund 2021; and Glasgow City Council, Scottish Welfare Fund Self Isolation Grant Reference Number: LWA8320888.

My deepest thanks to the University of Glasgow and their staff, particularly to Christina Young for making this project possible, Debra Strickland from her support from day one, Karen Thompson for her meticulous and persistent review of this thesis and Margaret Smith for having generously shared their research on painted banners with me. A special thanks to Mark Richter for his guidance and Paul Garside for his valuable insights and review of the scientific data.

My deepest thanks go also to Glasgow Museums and their staff, for having facilitated access to their five Kenning banners, allowed me their inspection and sample at their premises, and helped me with their provenance research. A special thanks to Helen Hughes for having shared her passion for banners with me from the very beginning!

Huge thanks to the staff at the libraries, archives, and museums I visited for my research, especially to Louise Pichel of The Museum of Freemasonry London, Anne Cameron of the Archives and Special Collections University of Strathclyde Glasgow, Jenny van Enckevort and Kloe Rumsey of the People's History Museum Manchester. This research would not have been possible without their kind assistance.

Special thanks to the banner specialists Vivian Lochhead and Nicholas Mansfield for having generously shared their time, knowledge, and experiences with me.

I am very grateful to my family, especially my mum Carmen, my granny "*Mamá Güera*", my auntie Cristina and my sister Paulina for their unconditional love! A particular thanks to my uncle Guillermo for his generous support.

I am also very grateful to my Scottish family: my *maw* Carol, my *paw* Tom, my brothers and besties Darren and Connor, and my *wee* brother Ross. Thanks for truly making me feel at *hame*!

And last but not least, thanks to my amazing friends who have accompanied me and helped me throughout. Especially to Steveo, Alex, Noah, Niall, Jon, Trisha and Craig, McTaggart and family, Sam, Greig and Kate, Pete, Northway, Barry, Donald, Jimmy, Matt, Cecilia, Tess, Yolanda, and my flatmate James. A special thanks to my PhD sister Rosa, the nicest finding of this endeavour, and David, for the ultracareful proofreading of this thesis.

Author's Declaration

I declare that, except where explicit reference is made to the contribution of others, this thesis is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

Daniel Sánchez Villavicencio.

Abbreviations

ATR	Attenuated total reflection
EDX	Energy dispersive X-ray analysis
c.	*Circa*
CTC	Centre for Textile Conservation
CTCTAH	Centre for Textile Conservation and Technical Art History
FTIR	Fourier transform infrared reflectography
GC	Gas chromatography
GK	George Kenning Company
GK&S	George Kenning & Son Company
GU	*The Glasgow Upholsterers Society* banner
MG	*The Grain Millers of Glasgow* banner
MS	Mass spectroscopy
NUVB	The National Union of Vehicle Builders
OM	Optical microscopy
SEM	Scanning electron microscopy
SM	*The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* banner
TS	*The Glasgow Typographical Society* banner

TUC	Trade Union Congress
UKSC	United Kingdom Society of Coachmakers
UV	Ultraviolet
VB	*The National Union of Vehicle Builders, Glasgow Branch* banner
XRF	Portable X-ray Fluorescence Spectrometry

Introduction

1.1 Context

Society and union banners are an emblematic part of modern British social history and a characteristic type of painted textile. Arising from the Victorian era, these society and union banners were commissioned in Britain by a wide range of social and labour organisations (Dew, 2016, p. 4; Dunn, 1998, p. 9; Wray, 2009, p. 151). They were used to symbolise the group and society identities and to proclaim messages on social, political, or industrial issues. Organisations for whom banners were produced included members of friendly and fraternal societies, trade societies/unions/guilds, temperance groups, co-operative societies, churches, chapels, and Sunday schools (Edwards, 1997, p. 15); as well as workplaces, clubs, campaigning and protesting organisations, councils/boroughs, and political and military organisations (Dew, 2016, p. 4).

During the period 1830s-1924 from the Chartist movement to the first Labour Prime minister, and significantly between the 1880s and 1914 (Weinbren, 2006a, p. 172), banners provided a regular spectacle in Victorian and Edwardian Britain for numerous demonstrations by trade societies and unions, in the sense of public display, such as the May Day celebrations and specific protests (Donnelly, 1973). The largest processions were held in conjunction with the three Great Electoral Reform Campaigns of 1831-32, 1866-67 and 1883-84, along with the Great London Dock Strike of 1889 (Donnelly, 1973) and the 1896 May Day celebrations in London. In the case of the 1896 May Day celebrations in London, for example, an estimated £20,000 worth of banners at the time were carried out as part of the event (Gorman, 1974, p. 21) in a year when the peak of trade union registry stood at 1358 unions (Smethurst, 2009, p. ix). Banners became the quintessential icon of the trade union movement due to their ceremonial display (Donnelly, 1973). Their effective design helped convey their message in the most powerful manner, validating the importance of their role in British labour history (Mansfield, 2004, p. 92) and thus they are considered important examples when analysing politics and the working-class presence of nineteenth-century England (Edwards, 1997; Mansfield, 2004, 2008; Weinbren, 2006a), Ireland (Loftus, 1978; O'Leary, 1994; Jarman, 1999, 1998, 1997), Scotland (MacDougall, 1985; Clark, 2001; Nixon, Pentland, and Roberts, 2012), and Wales (Lord, 1998).

The study of banners began with the publication of the seminal work *Banner Bright: An illustrated history of the banners of the British trade union movement* (Gorman, 1973), drawing attention to the importance of trade union/society banners and the need to preserve them for future generations.

Gorman conducted the first survey on British banners between 1967 and 1973, identifying trade union/society banners as a numerous and specific group, delimiting the research field from the first half of the nineteenth to the first half of the twentieth centuries (Gorman, 1973, p. 26). He estimated that 10,000 trade union banners were made from the time of the first Reform Bill in 1832 until the beginning of the Second World War, finding that the largest surviving group belonged to miners' organisations with over 250 examples. Next in terms of numbers are the banners of the "new unionism", term given to the organised unskilled labour from the periods 1889-1910 and 1910-1926, then the "old craft unions" (Gorman, 1973, pp. 22-24), from which two banners of the Tin-Plate Workers Society of Liverpool and Merseyside are disputed as the oldest surviving British banners dating 1821 (Gorman, 1973, p. 68; Lennard, 1989, p. 3; PHM, 2021).

Gorman's research sparked increased interest in trade union/society banners, leading to two major exhibitions in 1973; the first of its kind at the Whitechapel Gallery of London, and the second at the former Glasgow Art Gallery and Museum (Donnelly, 1973; Mansfield and Uhl, 2002, p. 43), today's Kelvingrove Art Gallery and Museum.

Continued interest triggered a second survey on British banners, responding to the perceived lack of proper facilities for the conservation, storage, and display of the surviving banner collections throughout Britain. Named the National Banner Survey, it started in 1995 as an initiative of the former National Museum of Labour History, today's People's History Museum, linking fourteen British institutions with significant banner collections to improve their care, increase investment and public access, and promote their use for academic research. The survey, implemented between March 1998 and May 1999, collated a total of 2,370 banners including: 693 from trade societies/unions/guilds, 216 from friendly societies, 263 from religious organisations, 265 from women's organisations, 130 from political parties/groups, and 802 from other organisations not including the military (Mansfield et al., 1999, pp. 2-3,9). This survey remains to date as the largest effort in registering and categorising British banners, all included in the National Banner Database under custody of the People's History Museum. The major research gaps identified were the scarcity of contextual research on banners and their organisations as well as the limited study of the banner makers.

Banners are considered as one of the most abundant types of painted textiles in British museum collections (Thompson, Smith, and Lennard, 2017, p. 69), differentiated from traditional easel paintings due to their function-related form, which required convenience for storage, portability and sometimes urgency in their making (Cannon and Villers, 2000, p. viii-ix). They are defined as textiles bearing slogans or images, often of large dimension, designed to be hung from a horizontal pole. They differ from flags which are typically attached by one of their sides, permanently or temporarily, to a fixed shaft, pole or rope while being displayed (Dew, 2016, p. 3; Thompson et al., 2017, p. 69). Although flags and banners are often used outdoors, the latter were purposely designed to being carried aloft during demonstrations and processions, adding the marching function to their name (Rogerson and Lennard, 2005, p. 12). In addition, banners are usually designed with a double-sided layout, intended to be seen from all angles while being paraded (Dew, 2016, p. 65; Thompson, Smith, and Lennard, 2017, p. 69).

1.2 Aims, scope and methodology

This research aims to contextualise and characterise the materials and techniques of five double-sided painted banners with historical significance from the Glasgow Museums Collection, manufactured by the companies of George Kenning and George Kenning & Son, and originally belonging to Glaswegian workers' organisations who identified as both friendly societies and trade unions over the course of their existence. The dataset additionally considers relevant information extracted from the National Banner Database on their entries on George Kenning and George Kenning & Son, as well as the inspection of five supplementary examples from the People's History Museum Manchester and Edinburgh Museums Collections used for comparison when pertinent.

The five Kenning banners from the Glasgow Museums Collection were selected for their research potential, firstly for having been bestowed by their original and locally based owners after they merged onto larger national trade unions, and secondly, for having all been manufactured by one of the most important banner-maker companies in Britain. These two conditions allowed for contextual research of the banners, their use, meaning, and of the societies that commissioned them. They also allowed the opportunity to compare these five examples with a further five by the same manufacturer made over the period between 1873 and 1917, which are respectively the manufacturing years of the oldest and most recent banner inspected. This enabled comparison of banners from two of the companies under the name of Kenning: 'George Kenning' and 'George Kenning & Son'. Therefore, this research is valuable for the characterisation and distinction of their particular manufacturing technique, as well as a contribution to the study of British society/union banners and to the study of painting materials between the nineteenth and twentieth centuries. The five Kenning banners from Glasgow Museums Collection have importance for not having been included in the National Banner Survey due to staff shortage issues at the time (Mansfield, 2021), but still being considered "qualitative evidence in tracing the lineage and development of radical politics and the labour and protest movement within Glasgow" with "significance at national and international levels due to the city's economic status and the strength of the reform and protest movements" (Glasgow Museums, 2002, p. 158-159).

This object-based research centres on the five Kenning banners of Glasgow Museums Collection and focuses on establishing the history of each banner through archival and art technological source research, scientific analysis, and historically informed reconstructions of their materials. The objective of the reconstructions is to gain a better insight into the manufacturing technique in the context of banner production. The investigation addresses the main research question: is there an identifiable technique followed by the companies of George Kenning and George Kenning & Son for the manufacture of the five painted banners in the Glasgow Museums Collection?

A review of the primary written sources on the history of materials and techniques has been conducted, that has informed the identification of the technical processes used by the artists and craftsmen in the period the banners were made. This critical evaluation of primary sources is considered crucial for the application of experimental studies, setting the context in which the interpretation of the results must be placed (Muñoz-Viñas, 1998, p.114).

The experimental object-based research aims to answer five specific questions about the banners: When were they made? Where were they made? By whom were they made? What materials are they made of? How were they made? These questions set the main guidelines for the study of the manufacturing technique seen in the five selected banners, adapted from the study of the painting technique in traditional easel paintings (Plesters, 1976, p. 101).

This technical art history methodology also considers Boon and Townsend's proposal for researching an artist or a period in depth, using several methods of analysis to find similarities: between objects, between statements in the historical sources, and between the results from historically accurate (or more often historically informed) reconstructions (Boon and Townsend, 2012, pp. 342-343).

Although identification of pigments, fillers, additives and binding media in cultural heritage has become more reproducible and accurate, the understanding of the working properties as single materials, composites and laminate systems is still a complex task. Therefore, reconstructions are considered as important tools for technical art history (Bucklow et al., 2012, p. 24-26). By making reconstructions with historically accurate (or more often informed) materials it is possible to ascertain the reasons why paints were prepared in a certain way, how they behaved during application, what made the manufacturers choose them and what could have been their original appearance, gaining an insight into their practice and production (Carlyle and Witlox, 2007, p. 1). The historically informed reconstructions of banners, along with comparisons of other relevant examples, complemented the results of the technical analysis and the thorough inspection of the Glasgow Museums Collection banners, helping to understand their technique in a holistic way.

1.3 Structure

The thesis is presented in eight chapters and four appendices.

Chapter one describes the significance and aims of the research, gives an overview of the methodology of the research and of the structure of the thesis.

Chapter two introduces the five Kenning banners of Glasgow Museums Collection, gives an overview of their symbolism, and the historical contextualisation of the trade societies that commissioned them and of the companies that manufactured them. Based on archival research, this chapter sets the timeframe of the research. It is divided in two sections, beginning with the description of each of the banners and the source of their design, the identification of the Glasgow-based trade societies/unions that had them commissioned and the trailing of their provenance up to their bestowing to Glasgow Museums Collection. It focuses on the dates of commission, delivery, or first use of the banners to help in dating their manufacture, as well as the indication of any significant uses relevant to their cultural significance. It also discusses the limitations of the trade union archives. The second section examines the different companies under the surname Kenning and identifies the two firms responsible for the manufacture of the five Kenning banners of Glasgow Museums Collection, George Kenning, and George Kenning & Son, providing the timeline and setting of the banners' production that is crucial when interpreting the technical analysis of the five banners, as the identification of materials can only be done in context.

Chapter three is a literature review on the historical manufacture of double-sided painted silk banners. It is divided into three sections. Section one evaluates the art technological sources specifically relating to the making of this type of banner in the Western World, going back to the origin of the genre up to the time of production of the latest banner selected for this study. Section two evaluates the primary sources relating to the production of the two largest banner-making companies in Britain, George Tutill's and George Kenning's, to establish a comparison that identifies their similarities and differences. Section three reviews the current state of the material characterisation of nineteenth and twentieth-centuries British double-sided painted silk banners, considered as the basis for the technical component of this research.

Chapter four describes the methodology for the technical examination of the five Kenning banners from the Glasgow Museums Collection, the analytical techniques chosen and their limitations. Technical examination included the use of ultraviolet-induced fluorescence (UV), optical microscopy (OM), fluorescent staining, portable X-ray fluorescence spectrometry (XRF), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy with energy-dispersive X-ray spectrometry (SEM-EDX), and gas chromatography-mass spectrometry (GC-MS). It also describes the making of historically informed reconstructions of the identified banner technique as well as their main outcomes, which helped in the interpretation of the fluorescent staining results and in understanding the empirical side of painted banner manufacture.

Chapter five presents an additional literature review and preliminary tests on fluorescent staining which were conducted before applying this analytical technique to the banner cross-sections. These sections are presented separately in the chapter. The potential of fluorescent staining for the identification and localisation of proteinaceous and lipidic binders in double-sided painted silk banners was tested in samples from each of the stains and targeted materials (e.g., animal skin glue, silk, and linseed oil), mock-ups and banner reconstructions. This addressed one of the main gaps in the understanding of British painted banners technique to date: the identification of the presence or absence of a size layer and the possibility of determining its composition.

Chapter six presents the results and interpretation of the scientific data collected through UV, OM, fluorescent staining, portable XRF, FTIR, SEM-EDX, and GC-MS.

Chapter seven presents a discussion of the research, evaluating the outcomes of the historical, scientifical and empirical results obtained throughout this study. This chapter addresses the main research question and attempts to explain the manufacturing technique used by the companies of George Kenning and George Kenning & Son in the five Glasgow Museums Collection banners.

Chapter eight presents the significant conclusions of this research, identifies remaining gaps in knowledge concerning the characterisation of double-sided painted silk banners, and proposes continuing research directions for the future.

The four appendices include further information to accompany chapters four, six and seven. Appendix I contains the written and photographic documentation of each of the five Kenning banners of Glasgow Museums Collection. Appendix II contains the location, description and photographic registry of every sample obtained. Appendix III contains the scientific results in full, and appendix IV contains the description of materials and method of the two banner reconstructions prepared.

This research represents the first attempt to systematically compare the banner-making techniques of two companies, George Kenning and George Kenning & Son, to assess the extent of their differences and similarities, providing the basis for future research of attributed works by either of the two companies and of other similar commercially manufactured British banners between the period 1873 and 1917.

2 Historical contextualisation of Glasgow Museums Collection's Kenning banners

2.1 Introduction

This chapter defines the importance and historical contextualisation of the five Kenning banners of Glasgow Museums Collection, identifying the trade societies that commissioned them and the companies that manufactured them. Based in archival evidence, this information sets up the background of the banners' production, crucial for the correct interpretation of the data gathered throughout the research. The chapter describes the banners provenance and their cultural significance, which adds to the justification of the present research.

In a broader sense, it is accepted that every object that has an artistic or historical importance is entitled to be preserved as a legacy of the past to the present and the future (Philippot, 1996, p. 260). The importance of the five Kenning banners of Glasgow Museums Collection is thus given by their intrinsic values, which according to the International Council for Museums and Sites (ICOMOS) provides an historical monument, as the banners will be considered in this thesis, with cultural significance (ICOMOS, 2013).

The concept of cultural significance was defined in a document firstly disseminated by ICOMOS in 1979 and revised and updated in 1999, 2004 and 2013, *The Burra Charter* (ICOMOS, 2013). According to that charter, cultural significance is defined as the sum of the aesthetic, historic, scientific, and social values found in a historic monument, "which help an understanding of the past or enrich the present, and which will be of value for future generations" (ICOMOS, 2013). Of all these values, the charter highlights the historic as the most important, for it "encompasses the history of aesthetics, science and society, and therefore to a larger extent underlies all".

A historic monument is defined as a work in which evidence is found of a particular civilisation, a significant development, or a historic event and for that it must be safeguarded (ICOMOS, 1964). They are considered living witnesses of the past and as such, they must be hand “to the next generations in the full richness of its authenticity” (ICOMOS, 1964).

Although the concept of historic monument was initially addressed to architecture in what is considered the basis for the protection of cultural heritage, *The Venice Charter* by the ICOMOS (Gordon, 2014, p.95), unlike the concept of work of art it is applicable in a larger extent to the diversity of tangible and intangible expressions of cultural heritage, if they have acquired cultural significance over the pass of time (Gordon, 2013, p. 95). Thus, the banners of this research are considered historic monuments, part of cultural heritage and therefore important to be studied and preserved for generations to come.

2.2 The imagery and design of British trade society/union banners

The rich imagery seen in British trade society/union banners and emblems drew from various styles and influences, firstly noticed by Leeson, who similarly to Gorman produced a seminal work on the subject (Leeson, 1971). The predominant influences detected in the design of trade society/union banners between the first half of the nineteenth and the first half of the twentieth centuries have been identified in the use of: heraldic and guilds, the Classical and Renaissance style, the symbolism of Freemasonry and other friendly and fraternal societies, as well as Christian imagery and biblical references (Bowden, 2010, p. 1; Dunn, 1998, p. 8; Edwards, 1997, p. 17; Ravenhill-Johnson and James, 2013, p. 15).

Such influences remained part of the Victorian culture in which their artists and makers were immersed, as “banner-art is no counterculture. Its duty was to communicate with the generality, it employed the media of the commons…No banner can move far from the common discourse”’ (Gorman, 1973, p. 13). As proposed by Bellamy, banner imagery would also make use of elements taken from the Victorian ‘high art’ in an attempt to express and legitimise the dignity and skill of labour (Bellamy, 1991, p. 16). This would, reinforce the identity of the workers and their role and contribution to the society, in the forms of expression of the dominant culture of the time, as discussed by Ravenhill-Johnson (Ravenhill-Johnson and James, 2013, p. 6).

Trade societies/unions firstly turned to their own symbols and insignia to identify themselves and to produce their emblems and banners. They used their coats of arms or designs which appeared to be armorial bearings and included their mottoes. Such motifs were either taken directly or adapted from the accredited arms of the craft guilds, like the Livery Companies of London, or designed by making free use of heraldic art (Gorman, 1973, p. 27). It is reported that by the mid nineteenth century it was a common practice for the crafts to employ the tools of the trade and the products made with them as a basis for banner designs, having the advantage of immediate recognition and associating the union with the particular craft (Gorman, 1973, p. 30). They were also a reflection of the pride of the craftsmen for their work and their genuine concern for the trade, legitimising the existence of their organisation.

Of the influences mentioned, classical imagery appears to be the predominant one predominates in trade and friendly societies emblems and banners, as their designs were often structured around architectural arrangements that were common to Greek and Roman styles (Bowden, 2010, p. 5). Such classical style had been undergoing a popular revival in Victorian Britain from the 1820s, permeating the arts in many ways including architecture, painting, and sculpture (Ravenhill-Johnson and James, 2013, p. 15). It became an available resource for the makers of trade society/union emblems and banners (Dunn, 1998, p. 8).

Other resources from the Renaissance, available to banner artists and engravers of the societies' emblems, were the Books of Emblems like the *Emblemata* by Andrea Alciato (1522) discussed by Ravenhill-Johnson (Ravenhill-Johnson and James, 2013, p. 25) and *Iconología* by Cesare Ripa (1593) discussed by Emery (Emery, 1998, p. 26). These books influenced the form and arrangement of the trade society/union emblems and banners in a central motif flanked by associated symbols, adapting the model of a small allegorical picture (the icon), a motto (the lemma) and an explanatory verse (the epigram) to their design, which verbally would describe something with an alternative, usually moral, meaning (Ravenhill-Johnson and James, 2013, pp. 25-26). In that manner, trade union imagery also followed the tradition of picture parables inspired by Aesop's

Book of Fables and the Bible, representing recurrent images of ‘The Bundle of Sticks’ or ‘The Good Samaritan’ (Weinbren, 2006b), in accordance with the Victorian preoccupation of moralising (Gorman, 1973, p. 39; Carlyle, 2001, p. 2).

However, it has been proven that Freemasonry also influenced the imagery of trade unions and friendly societies to a great extent (Bowden, 2010, pp. 1-5; Dennis, 2005, pp. 50-56; Ravenhill-Johnson and James, 2013, pp. 26-32), mostly because their membership reached the royal family itself and thus were maintained legal during the period of the Combination Acts (1799-1824) when trade unions were not (Ravenhill-Johnson and James, 2013, pp. 84). Masonic symbols would acquire a different meaning depending on the society, adapting them to their needs in their own way (Dennis, 2005, p. 50). Correspondingly, Freemasons borrowed their symbols and imagery from various traditions, including mythological, Biblical, humanistic from the Renaissance, astrological, natural and from the tools of their trade.

It is proposed that trade societies/unions adopted the language of classicism and Freemasonry to reassure the upper classes they shared the same culture and moral beliefs, that they were part of a brotherhood and that they worked for the good of society (Ravenhill-Johnson and James, 2013, p. 33). Their banners and certificates were the means in which the working classes appropriated the ‘high art’ and ‘language’ of capitalism to claim a social and cultural equality and empower themselves. This language is portrayed in the five Kenning banners from Glasgow Museums Collection, as it is described in the following sections.

Other themes frequently depicted in the imagery of banners were scenes related to welfare benefits, which were provided by the trade unions and friendly societies to their members (Wray, 2009, pp. 158-159). These scenes acknowledged the dangers of industry including death, sickness, and accident, and were often represented by the inclusion of women as widowers (Gorman, 1973, p. 43), reminding of the reciprocity of the organisations with their members and of its their continuing value within a changing society (Weinbren, 2006a, p. 177). Examples of these are seen in one of the banners of Glasgow Museums Collection.

The design of trade union and friendly societies banners, at least from the 1830s onwards (Nick Mansfield, 2004, p. 83), followed in general a standard pattern, which is seen in the five Kenning banners of Glasgow Museums collection: a curved ribbon at the top with the name of the organisation, a central scene referring to the organisation, elaborated decorations surrounding both, and a bottom ribbon containing a motto. The long, usually curved ribbon at the top of the banner textiles would carry the name of the organisation, and in some cases their particular branch or 'lodge', a term used by the miners' and other organisations (Wray, 2009, p. 162). The letters were usually Roman typeface, frequently shaded with a contrasting colour to obtain a three-dimensional effect. Both the ribbon and the central scene would be surrounded by an elaborate scrollwork resembling curling foliage, often accompanied with flowers, tasselled cords and even *putti* and *cornucopia*. (Emery, 1998, pp. 17-18). The elaborate scroll work and foliage, repeatedly included in that type of banners, has been also seen as a consequence of the Victorian taste for ornament and the Renaissance style revival (Dennis, 2005, p. 56; Edwards, 1997, p. 16). However, it is not always clear which side of the banner was considered the front and which side was considered the back, as it has been reported to change depending on the purpose and moment, start or finish, of the procession (Rode, 2003). Thus, the two sides of the banners of this research are named side A and side B depending on their textile construction (see Appendix I, Banners documentation for details).

2.3 The five Kenning banners of Glasgow Museums Collection

2.3.1 The banner of The Glasgow Typographical Society

The banner depicts the name of the society at the top 'GLASGOW TYPOGRAPHICAL SOCIETY' in black capital letters within a sinuous scroll of silver (now tarnished) and red banding, plus the text 'INSTITUTED 1917' at the bottom, inscribed within a similar scroll, all over a dark-blue textile background (Figure 2.1). Both sides have the same texts. The central painting of side A represents two images related to the typographers' trade divided into two halves: the upper half shows a well-lit room with three glass windows, three green pendant lamps, three raised tables and seven workers in white aprons, whilst the lower half still set in a similar-looking room, includes three pieces of machinery equally related to their trade and operated by other five workers in white aprons (Figure 2.1, a). The central painting of side B portrays two standing young men in classical style togas facing each other whilst clasping a laurel wreath with their right hands; the man on the left is in a yellow and red attire and the man on the right wears blue and magenta garments. They are standing in front of a fiery pedestal below an open book that reads 'I AM THE LIGHT OF THE WORLD' and includes an all-seeing eye topped by the legend 'LET THERE BE LIGHT'. The scene is flanked by a pink painted scroll reading 'UNION IS STRENGTH' and a golden scroll reading 'KNOWLEDGE IS POWER' (Figure 2.1, b). Both sides A and B have intricated central painting frames decorated with flowery garlands of roses, thistles, and shamrocks.

a)

Figure 2.1 Banner of *The Glasgow Typographical Society*, a) side A. (Image © CSG CIC Glasgow Museums Collection).

b)

Figure 2.1 Banner of *The Glasgow Typographical Society*, b) side B. (Image © CSG CIC Glasgow Museums Collection).

The design of the banner is based on the emblem of the Scottish Typographical Association made by Mr J. D. Carmichael in Edinburgh (Scottish Typographical Association, 1903; 111), particularly its lower third (Figure 2.2). The first description of the emblem was published in January 1883 as part of the forty-fourth reports of the association (Scottish Typographical Association, 1883). By instruction of the Executive Council, the Association Secretary provided a sketch of the form and details of their emblem to Mr J. D. Carmichael, who in turn delivered his preliminary version to the Association in December 1882. Unfortunately, neither of those sketches were located. The finished emblem was sold in their Branches and the description related to *The Glasgow Typographical Society* banner went as follows:

> '…The base contains two portions, in one of which is a composing room, and in the other a machine room, showing a Web Printing Machine, a Wharfedale, and an old Hand Press. Immediately above the two departments, two male figures (wearing the toga uniform) are

> presented, standing in front of an altar, on which appears the sacred elemental fire; they have each hold of a garland with their right hand. Overhead are the words, "Union is Strength", and underneath "Knowledge is Power". On either side floral devices are shown, in which the thistle, rose and shamrock are conspicuous. Above this part there is an "All-seeing Eye", surmounted by the words "Let there be Light", and rays seem to dart down upon an open book, on the pages of which appear, "I am the Light of the World".' (Scottish Typographical Association, 1883; 15).

Given the restricted space of the banner in comparison to the printed emblem, the selection of imagery to be portrayed seemed to include the elements that were considered a priority to *The Glasgow Typographical Society*: their ideals and motto on side A, and the base and technical evolution of their trade on side B, all within the idea of the British Empire represented with the national flower of each of their three nations at the time: England, Scotland and Ireland.

Figure 2.2. Emblem of The Scottish Typographical Association, M.D. Carmichael, 1883. (Image © Scottish Typographical Association, 1903). Area inscribed in the yellow rectangle is that represented in the banner.

2.3.1.1 Brief historical account

The Glasgow Typographical Society was formed in 1817 by the letter-press printers of Glasgow, with the aim of representing the master printers and other workers in the industry of printing. As described in the publication *A hundred years of progress: the record of the Scottish Typographical Association, 1853 to 1952* (Gillespie, 1953), it was according to Gillespie one of the earliest trade unions in Britain, campaigning for workers employment rights and pay (Gillespie, 1963). The Glasgow Typographical Society's surviving records were consulted at their current repository, the Special Collections of the University of Strathclyde, Glasgow.

The Glasgow Typographical Society was mainly concerned with the relief of unemployment through the tramping system and the need to retain scrutiny on wages, influencing them as far as the law allowed (Marsh and Smethurst, 2006, pp. 91-92). Membership was open to journeymen only, on payment of a 5s entrance fee and a contribution of 6d a month. It played a leading part in the formation of the General Typographical Association of Scotland in 1836, the Association's Central Board being appointed by and from the Glasgow Branch. With the end of the General Association in 1844 and its merger into the National Typographical Association, the Glasgow Society maintained its independent existence and continued to work for a re-formed Scottish Association. By 1852 four other societies would join the Glasgow one, Dumfries, Kilmarnock, Paisley and Edinburgh (Marsh and Smethurst, 2006, pp. 91-92).

The Glasgow Typographical Society thus became the Glasgow branch of the Scottish Typographical Association when the latter was formed on 1 January 1853 (Marsh and Smethurst, 2006, pp. 91-92). Its precursor was the National Typographical Association, initiated after a meeting held in England in late 1844 (Scottish Typographical Association, 1903; 13). The Glasgow branch kept referring itself as 'The Glasgow Typographical Society' at least until 1946, year of the last surviving record at the University of Strathclyde archive (University of Strathclyde, T-GTS1/1/13). From that year onwards they referred to as the Glasgow Branch of the Scottish Typographical Association, whose available records go up to 1956 (The National Archives of the UK, n.d.).

In 1974 the Scottish Typographical Association was renamed as the Scottish Graphical Association, which would later amalgamate with the Society of Graphical and Allied Trades (SOGAT) to form the Society of Graphical and Allied Trades 1975 (SOGAT'75), according to the information published by the Modern Records Centre of the University of Warwick (Warwick, 2014). The union would finally merge with the trade union Amicus in 2004 (Marsh and Smethurst, 2006, p. 4).

2.3.1.2 Banner provenance

The first mention of The Glasgow Typographical Society banner was in the minute book dating from 18th of April 1874 to 10th of August 1888, where the request of the banner was informed to the attendees of a special meeting held on the 26th of September 1883. The entry reads the following description:

> 'The President having read the circular calling the meeting, which stated that the object was to make further arrangements with reference to the proposed Trades Demonstration on the 6th October (University of Strathclyde, T-GST1/1/4).

The Secretary stated there that the 'Committee had given instructions to Mr George Kenning to provide a new Banner at a cost of £16-10/- […] They were doing what they could to render the Demonstration a success, and trusted that the members of the Society would turn in large numbers on the occasion.' (University of Strathclyde, T-GST1/1/4).

The demonstration in turn was organised for the laying of the foundation stone of the new Municipal Buildings of Glasgow, as stated in the previous entry of 8th of September 1883, normally held on the first Saturday of the month (University of Strathclyde, T-GTS1/1/4 a). On such meeting, it was stated that the Society would take part in the Trades' Demonstration [of the 6th of October], regardless of the £40-£50 that would cost them (University of Strathclyde, T-GTS1/1/4), which was not elaborated in the minute entry. Thus, the actual request of the banner should have taken place on the following Monday 10th of September at the earliest, allowing a maximum time length of 27 days from that date until the date of the demonstration. This short interval of time for the manufacture of the banner shows the efficiency and speed with which Kenning's company was distinguished ((George Kenning and Son. Summer Number [Supplement], 1901).

Two more mentions of the use of the banner were found in The Glasgow Typographical Society minutes, both relating to trades demonstrations. The first one referred to the attendance cost for the demonstration organised for the Franchise Bill on the 6th of September 1884 (University of Strathclyde, T-GTS1/1/4 b). The second one referred to the Demonstration on behalf of the Tramway Employees organised by the Trades Council on the 12th of September 1889, stating the following information:

> 'The Secretary intimated that Sir William Collins had very handsomely granted the use of one of his machines for the purpose of printing leaflets on the lorry, and that he had given authority to Collins Chapel to see that the affair was carried out successfully, and to submit the account for the same men to carry the banner were also arranged for, and also the appointment of Marshalls for the conduct of the procession.' (University of Strathclyde, T-GTS1/1/5)

The banner was gifted to the People's Palace Museum by the Glasgow Typographical Society, which at the time had their address at 222 Clyde Street, Glasgow in 1973, as recorded in the museum cards (People's Palace IRGMA CARDS 1973). On the record filled out by Elspeth King on the 15th of January 1981, the current inventory number is inscribed: PP.1973.14. The banner is currently stored at Pod 12 of Glasgow Museums Resource Centre.

2.3.2 The banner of The Glasgow Upholsterers Society

The banner depicts the name of the society at the top of side A 'GLASGOW UPHOSLTERERS SOCIETY' in black capital letters within a sinuous scroll of silver and red banding. The scroll is decorated with floral motifs that stretch towards the bottom of the banner on its left and right sides (Figure 2.3, a). A central painting, inscribed within a rectangular frame, depicts Glasgow's coat of arms with its motto in a pink scroll reading 'LET GLASGOW FLOURISH' at the centre, flanked by two saints ichnographically identified as St Paul on the left and St Andrew on the right. The figures stand on top of what could be a wooden coffin, given the relation of upholsterers with undertakers, as meant by the old English word for them of upholders (Houston, 2006, p. 16). At the bottom centre, an oval with a golden frame holds the clasped hands, symbol of mutual help and responsibility (Dennis, 2005, p. 53). At the bottom of side A of the banner, another three-turn scrollwork holds the date of institution of the society 'INSTITUTED 1864', all over a dark-blue textile background.

Side B of the banner shows the same distribution and decoration but the words at the top indicate instead the legend 'SONS OF ST PAUL', patron of the upholsterers (Houston, 2006, p. 16) and at the bottom the society's motto "Be Steady" (WCML catalogue, 2018) with additional wording referring to their moral values and trade unionist ideas reading: "SHELTER FOR THE NEEDY, UNITE AND BE STEADY" (Figure 2.3, b). The central painting portrays the society's badge, which is formed by three tents and the Lamb of God holding the resurrection cross or St John the Baptist's cross (*Ecce Agnus Dei*) (Figure 2.4). The three tents are the coat of arms for the Company of Upholders (Upholsterers) of London and represent the mystery of the transfiguration as told in Matthew 17:4 "Peter said to Jesus, "Lord, it is good for us to be here. If You wish, I will put up three tents, one for You, one for Moses, and one for Elijah." The scene is framed within painted purple curtains with yellow fringes and holders and set in a mountainous landscape as that described in the Bible. The three tents are topped with a red onion-shaped canopy and each of them has a red saltire flag waving. Although the meaning of such flags is not clear, two possible interpretations can be made: the flag, also known as St Patrick's saltire, has been associated with Ireland since the 1780s, added to the Union Flag still in use by the United Kingdom after the 1800 act that joined the Kingdom of Ireland with the Kingdom of Great Britain (Hayes-McCoy, 1979, p. 38). The other interpretation could relate the flags to the International Code of nautical signals, which was firstly published in 1857. In there, the red saltire means assistance (Board of Trade, 1923), which could relate to the society's ethos of assisting the needed. Unfortunately, the lack of primary sources from the society makes it difficult to substantiate.

According to the description published for the Franchise Bill demonstration held in Glasgow on the September 1884, the society's banner:

> "It had the city arms in the centre, with the figures of St Andrew and St Paul on each side, and over the top of all was the name of the

society, while underneath were two hands clasped and the words 'Instituted 1864'. On the reverse side of the flag there were the trade coats of arms, with the words above and below 'Sons of St Paul' and 'Shelter for needy unite and be steady' (*Glasgow Herald*, 8th September 1884).

a)

b)

Figure 2.3 Banner of *The Glasgow Upholsterers Society*, a) side A, b) side B. (Image © CSG CIC Glasgow Museums Collection).

Figure 2.4 Photograph of painted emblem of the Upholders' Society, undated. (Image © Working Class Movement Library, Salford).

2.3.2.1 Brief historical account

The first trade society of upholsterers from Glasgow was established in 1853 under the name Glasgow Journeymen Upholsterers Trade Society. Said to have been formed by workers in the trade who had a general loss of fortune following strikes and trade depression, it ceased to function in 1860 (Marsh and Ryan, 1987, p. 356). It is known from surviving branch records that their members were in touch with other local unions of upholsterers in Edinburgh, Dublin, London, Liverpool, and Manchester. Mentioned in *A catalogue of some Labour records in Scotland and some records outside Scotland* by Ian MacDougall (1978), the rules belonging to a different but somewhat related society, the Glasgow Upholsterers Friendly Society, dating 1831 and 1832 were located at the Scottish

Record Office, now National Records of Scotland. However, such manuscripts could not be located.

The Glasgow and District Upholsterers Society, which was the full name of the society whose banner is now part of Glasgow Museums Collection, was the second attempt of upholstery workers in Glasgow to form a union. As stated in their banner, their date of institution was 1864, four years after the Glasgow Journeymen Upholsterers Trade Society. Also mentioned by MacDougall, their surviving records containing the manuscript minutes from the 11th of January 1864 to 1891, although missing those between June 1875 and December 1887, were stored at The Mitchell Library in Glasgow under the National Union of Furniture Operatives Collection (MacDougall, 1978, p.268). Unfortunately, the minutes seem to have subsequently been lost (Thompson, 2018).

In 1891, the Glasgow and District Upholsterers Society became the Glasgow Branch of the Amalgamated Union of Upholsterers (AUU) with 126 members, with a membership recorded at 271 and 336 for the years 1891 and 1896 respectively (Marsh and Ryan, 1987, p. 356). In 1898 Glasgow and the West of Scotland were the centres of what Marsh and Ryan called the great Scottish lockout, the most protracted dispute in the history of the AUU. The Society continued to be recorded in Board of Trade Reports as an independent organisation until 1900, being described therein both as the Glasgow Union of Upholsterers and the Scottish Upholstery Trade Union (Glasgow). When the Society became the Glasgow branch of the AUU, one of its members, James Bowie, became the first general treasurer of that union" (Marsh and Ryan, 1987, p. 356).

The Amalgamated Union of Upholsterers (AUU) thus included societies from Liverpool, Manchester, Glasgow, Edinburgh, Belfast, and Dublin. During their first couple of years, the AUU was involved in strikes in Dublin, Greenock, Manchester, and London. Their main efforts were focused on controlling the number of apprentices to each journeyman, on raising the wages and overtime rates, as well as the allocation of government contracts, which were being given to sweat shop firms. The AUU amalgamated in 1947 with the National Amalgamated Furnishing Trades Association in order to form the National Union of Furniture Trade Operatives (Marsh and Ryan, 1987, p. 353).

The National Union of Furniture Trade Operatives (NUFTO), which is the name holding the remaining records of the society at the Mitchell Library, added in 1969 the United French Polishers Society. In September 1971, having 60,754 members, NUFTO amalgamated with the Amalgamated Society of Woodcutting Machinists with 23,100 members forming the Furniture, Timber and Allied Trades Union (Marsh and Ryan, 1987, p. 332). They finally merged into GMB in 1993, a general trade union with over 600,000 members active to date (GMB, 2020).

2.3.2.2 Banner provenance

Three of the five Kenning banners of Glasgow Museums Collection were included in MacDougall's illustrated volume on Scottish labour history, exemplifying two important moments in the first and second halves of the nineteenth century. The banner of the Glasgow Typographical Society, although dating later in the nineteenth century, illustrated how Scottish trade unions were active during the years when trade unionism was unlawful, having been requested by a society established in 1817 (MacDougall, 1985, p. 58). For the second half of the nineteenth century, MacDougall stated that trade unionism expanded considerably in Scotland towards the third quarter of that century, with many unions either being newly formed or re-formed, as happened with the Glasgow Upholsterers Society whose banner is also included (MacDougall, 1985, p. 89). The third included banner, that of The Grain Millers of Glasgow, is used by McDougall to illustrate the struggle of the unskilled unionism during the industrial depression of the 1870s and '80s stating that:

> "Craft unions survived, despite some casualties, the industrial depression of the 1870s and '80s that had contributed greatly to the revival of socialism. Nor was unionism of the unskilled destroyed by the severity of the depression, though many of the organisations formed in the 'boom' period in the late 1860s and early '70s were swept away. By the later 1880s, however, there began a great revival of unskilled workers' unionism –the 'New Unionism'." (MacDougall, 1985, p. 135)

As stated in the previous quote, craft unions, historical continuation of the craft guilds, survived the industrial depression. An example of that is the banner of the Upholsterers. Although no records survive of the commissioning of the banner, the detailed description and indication of its first use for the demonstration in turn of the Franchise Bill on the 6th of September 1884, confirmed the likely year of its manufacture and delivery (The Glasgow Herald, 8 September 1884). It also hinted the reason for its request: to be used in the third most important demonstration related to the Electoral Reform, which established a uniform franchise throughput the country and brought the franchise in the counties into line with the 1867 householders and lodger franchise for boroughs (UK Parliament, 2022).

An historical photograph of a May Day demonstration in Glasgow dating 1938 survives in the Glasgow Museums Collection, showing the Glasgow Upholsterers Society banner being marched behind that of the National Union of Vehicle Builders (Figure 2.5).

Figure 2.5 Black and white photographic negative of May Day, 1938, passing Charlotte Street in London Road. (Image © GMA.1420.84.68). The Glasgow Upholsterers banner is inscribed within the yellow rectangle. The banner on the front is of the NUVB Glasgow Branch.

The banner was gifted in 1967 to the People's Palace by Mr J. Young, member of the National Union of Furnishing Trades Operatives with address at 66 Berkeley Street, Glasgow (People's Palace IRGMA CARDS 1973). The entry was carried out by Elspeth King on the 4th of October 1978, maintaining the inventory number given in 1973 that still holds to date: PP.1973. The inventory also indicated that some provisional stitches were added by a conservator with initials A. P. whose name was disclosed. The banner is currently located at Pod 12 of Glasgow Museums Resource Centre.

2.3.3 The banner of The Grain Millers of Glasgow

The banner depicts the name of the society at the top of both sides A and B ‘THE GRAIN MILLERS OF GLASGOW’ in black capital letters within a sinuous scroll of silver and red banding. The banner portrays an original design that has been described as “unusual for the period and has a graphic quality ahead of its time” by Gorman (Gorman, 1973, p. 82). Over a dark-blue background given by the banner textile, a curved scroll of silver and red banding undulates over a mixed shaped central painting that occupies most of the textile, bordered with golden sprigs of wheat growing from the bottom centre, which turn into silvered thistles, roses, and shamrocks towards the top of the frame on both sides, representing the three united Kingdoms of Scotland, England, and Ireland. The year ‘1884’ in golden letters is placed underneath the central paintings also on both sides A and B, all over a dark-blue textile background (Figure 2.6).

Side A of the banner portrays the evolution of milling by contrasting the two ancient millstones with the modern roller-mill (Figure 2.6, a). Additionally, these elements relate to a specific area of the City of Glasgow, known as the burgh of Partick at the time. The central painting has an undulated pink scroll above the three figures with the society’s motto reading ‘THE GOLDEN GRAIN. GOD’S GIFT. WE GRIND.’.

Side B of the banner represents the three periods of milling and how they were powered; on the left there is an octagonal brick-built windmill, typically associated with Scotland (Cookson, 2018), and on the right, a traditional water corn-mill (Figure 2.6, b). Both would have used millstones for making the flour. In the centre is the latest stage of milling with a steam powered mill, which could still have used millstones before the roller-mills took over towards the end of the nineteenth century.

a)

b)

Figure 2.6 Banner of *The Grain Millers of Glasgow*, a) side A, b) side B. (Image © CSG CIC Glasgow Museums Collection).

The centre design of side B could have been inspired by the building of The Scotstoun Mills of Partick. The Scotstoun Mills were acquired in 1833 by John White, member of the Grain Millers of Glasgow, who erected a new building in 1877 where the previous Waulk Mill stood since 1701 (The Glasgow Database, GC 679 WHI). He kept the name of his hometown Scotstoun, until the building had to be rebuilt following an explosion in 1909, renaming it as John White & Sons Mills. In the commemorative catalogue of his renewed business, a photograph from 1897 shows the previous steam mill resembling that on the banner (Figure 2.7). The design of the banner is described in the 1883 article as “the [grain milling] art in its progress from the earliest times down to the most recent roller mill” (*The Miller*, 5 November 1883), which is what is represented in their banner.

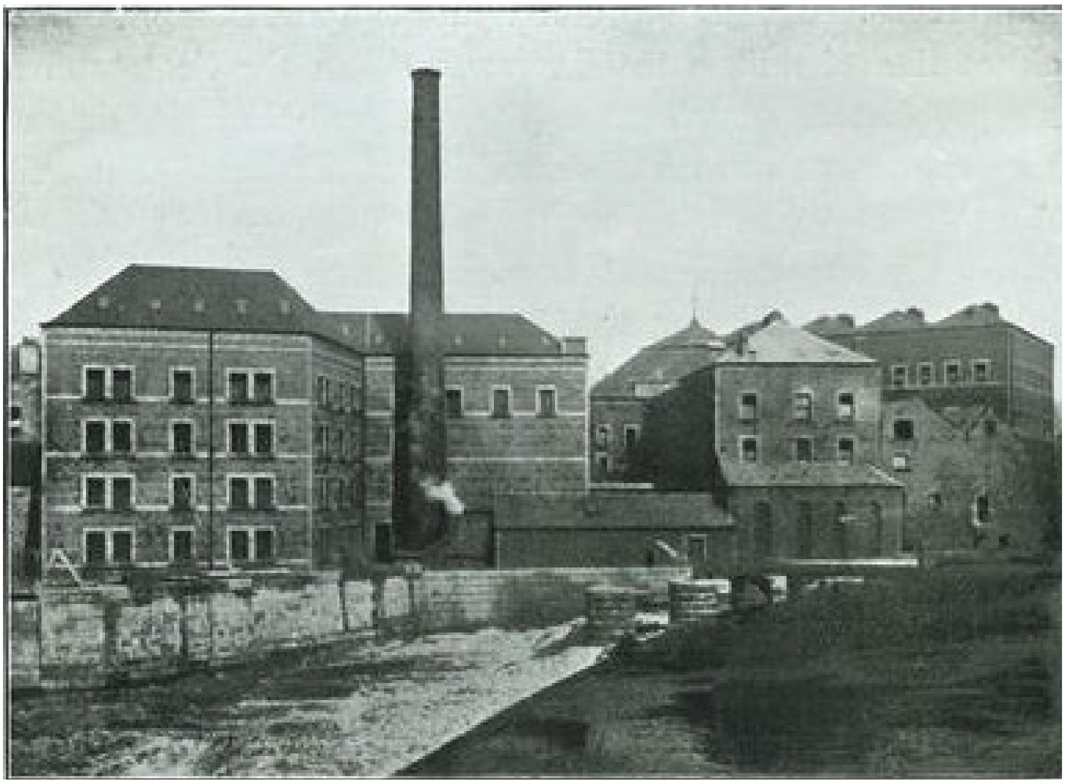


Figure 2.7 Photograph of the Scotstoun Mills included in the Souvenir of New Flour Mills John White & Sons, 1911. (Image © GC. 679 NHI, Mitchell Collection).

It is evident that the Grain Millers of Glasgow wanted to include references to the burgh of Partick in their banner, as a section of the official coat of arms granted in 1872, got incorporated on the rear (Figure 2.8) (Glasgow Mitchell Library, Reference 477590). The two millstones are portrayed likewise alongside a central element, substituting the central wheat sheaf with the latest piece of machinery of their trade: a belt driven roller-mill. Altogether, the banner's design emphasised the modern approach of the Grain Millers of Glasgow and the role of that area of the city in achieving it.

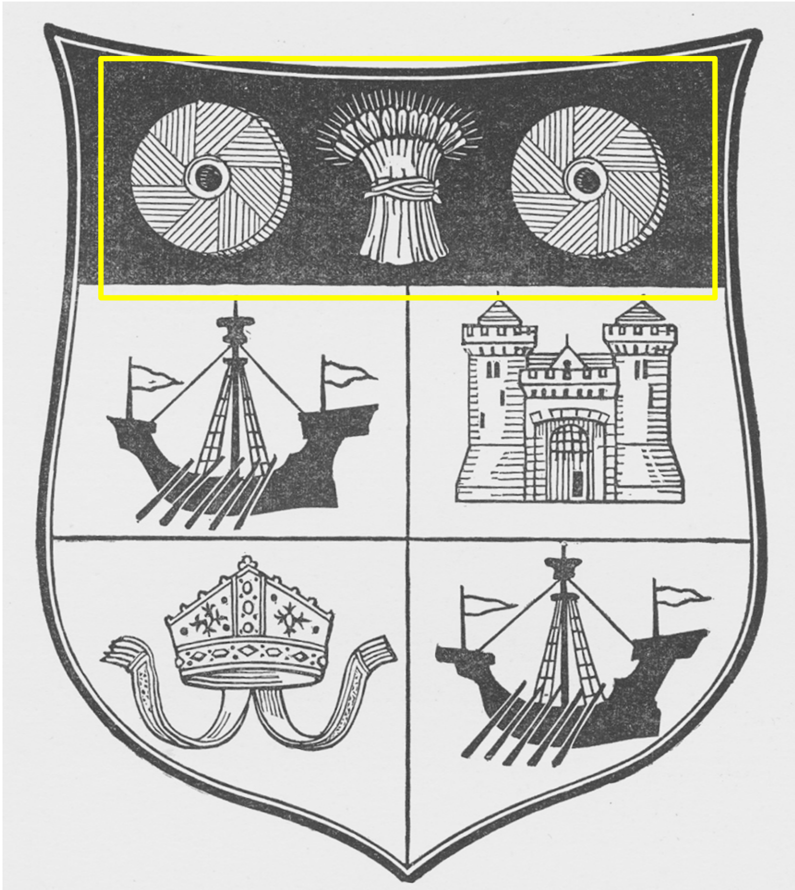


Figure 2.8 Official coat of arms of the burgh of Partick. The area indicated by the yellow rectangle is the one included on the Grain Millers banner side A. (Image © Mitchell Library Collection).

The inclusion of that specific roller-mill could have also had an underpinning purpose, as to even state a sense of pride for Scotland. Due to the precise depiction of the object, not only it was possible to locate the exact same device, but also the information about its maker, a Scottish-born inventor named William Dixon Gray (Figure 2.9). Gray became in 1876 the chief engineer of the American company Edward P. Allis based in Milwaukee, Wisconsin (*The Northwestern Miller*, 6 December 1899). There he produced his first belt-driven roller mills around June 1878, for the Kern's Mill of the equally American company J.B.A. of the same city. The name of the company is actually included in the banner, showing the importance that such detail had for the society that requested it (Figure 2.10). The invention was given letters patent to John Whittier Throop in the City of London, a communication from abroad by W. D. Gray of Milwaukee, dated 12th of February 1879 and sealed the 18th of April, with No. 551 (Mitchell Library Historical Patent Collection, Glasgow).

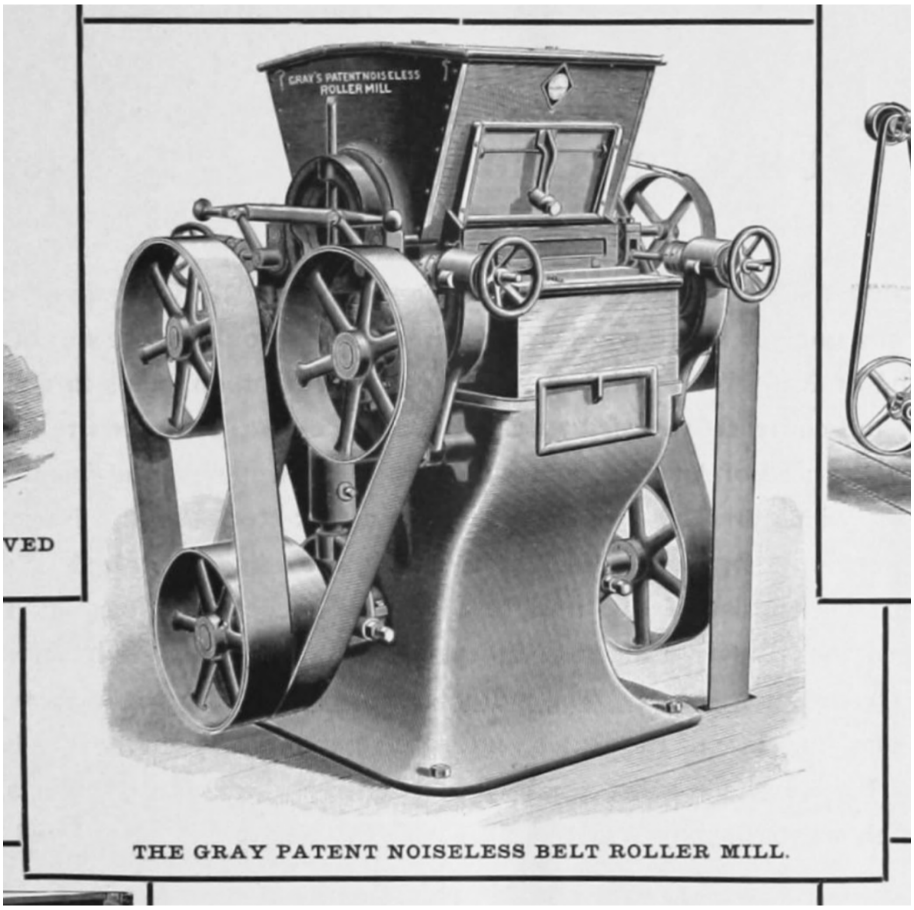


Figure 2.9 Screenshot of the Gray patent noiseless belt roller mill advertised in the catalogue The kind of mills we build by Edward P. Allis & Co, 1889. (Image © The Internet Archive).

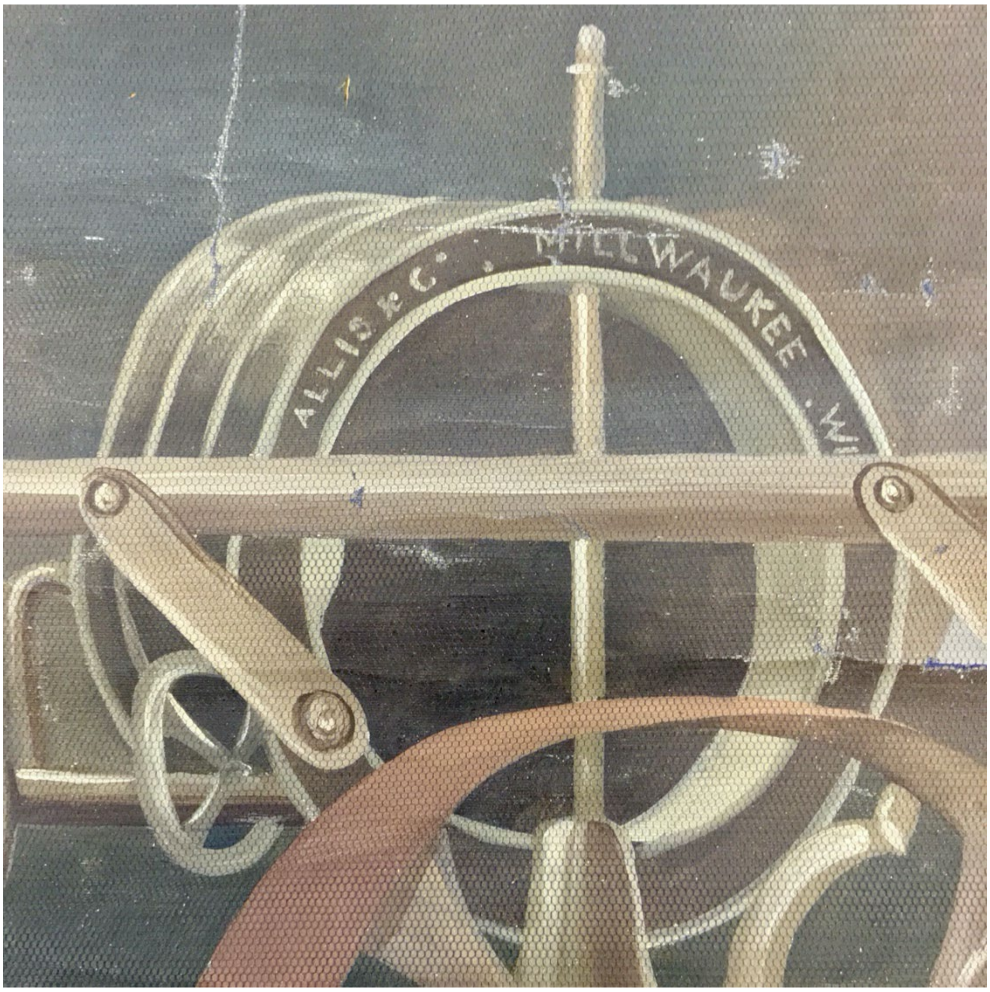


Figure 2.10 Detail of the roller-mill portrayed in the banner reading ALLIS & C. MILLWAUKEE. WI. (Image © D.S.V.).

This established a connection between the American-based inventor and the Grain Millers of Glasgow, which continued with their attendance at the International Millers' Convention of 1881, held in Cincinnati, Ohio (*The Northwestern Miller*, 20 December 1899). Many orders for Gray's patented belt driven roller-mills were taken at the event, including two by other members of the Grain Millers of Glasgow: Andrew and William Glen of Cheapside Mills (Jones, G. (2001) *The Millers,* p. 69). Evidently, John Ure also placed orders for his mills, as by 1883 he "…adopted the same methods of flour making, and by similar machinery, as is used in Minneapolis…" (*The Miller*, 5 November 1883). With that decision, the Grain Millers of Glasgow equalled the quality of the flour coming from the leading American city using local manufacture. Hence, the choice of including in their banner the revolutionary design of Gray, praising his Scottish heritage and the impact of his invention on the developing of the trade in America, Britain and Scotland.

2.3.3.1 Brief historical account

Not much is known about the Society of Grain Millers themselves, although information published in the exhibition's catalogue and other sources, indicated that they were part of the Transport and General Workers' Union (TGWU) by the twentieth century (Gorman, 1973, p. 82). According to MacDougall, the 'Society of Grain Millers', which seemed to be their full name, became part of the Workers' Union in 1917, amalgamating in turn which with the TGWU in 1922 (MacDougall, 1978).

However, The Grain Millers of Glasgow were active as early as 1860, as they celebrated their 23rd annual festival on the 5th of March 1883 (*The Miller*, 5 March 1883). A list of members of The Grain Millers of Glasgow published in that article represented some of flour mills in the city at the time: Mr James Marshall of Ibrox Mills; Mr James Snodgrass of Washington Mills; Mr James Glen of Cheapside Mills; Mr John Ure Primrose of Centre Street Mills; Messrs John and Matthew White of the Scotstoun Mills; and Mr David Murdoch of Crown and John Ure & Sons Mills.

In another article published on the 25th of February 1884, the Glasgow Millers defined and defended their trade as follows:

> "The millers were the connecting link between the farmers and bakers. From the old wheat fields of England, Scotland, and Ireland, and from the new water and vaster fields of America, Australia and India, the tiller of the soil gathered the golden harvest which passed through various channels into the hands of the miller. Their calling was essentially an honourable one (…) and with a continuance of that enterprise the palmy days of the Glasgow milling trade could and would be brought back…" (The Glasgow Herald, 25 February 1884).

After The Grain Millers of Glasgow became part of the Workers Union and amalgamated with the TGWU, this national union merged with Amicus on the 1st of May 2007 to create the current Unite the union (Unite the Union, 2022).

2.3.3.2 The Grain Millers of Glasgow banner provenance

In an article dating 5th of November 1883, there is a detailed account of The Grain Millers of Glasgow participating in the ceremony of the laying of the foundation stone of Glasgow City Chambers (*The Miller*, 5 November 1883). The event happened on the 6th of October of that year and a trades' parade was organised as part of the massive celebration, attended by an estimate of 50,000 people (The Glasgow Database, GCf381GLA). The Millers were part of the group IV on the official program of the celebration, given to the 'Miscellaneous Trades' (The Glasgow Database, GC No.23 p.171). The society of Grain Millers of Glasgow put on an impressive display of models and decorated trolleys to depict the history of milling through the years, including the latest piece of equipment that would be implemented in the Glaswegian mills as early as 1881: the roller-mill (*The Miller*, 5 November 1883). However, they lacked a banner of its own, as indicated by the reporter: "while the others had their special emblems [banners], the millers had their models of flour dressing machines, milling stones, and other adjuncts connected with their art". The author used the word emblem to refer to banners and not printed emblems as he then describes the emblems of the other unions being marched in the procession.

By the following year, the society would have needed its own banner to represent them in the massive demonstration supporting the third electoral reform to be approved in 1884: the Franchise Bill, where the Millers were listed in one of the trades' groups (Glasgow Herald, 8 September 1884). It is likely that the date included on their banner coincided with that of its manufacture, similarly to the banner of the Upholsterers.

The banner of *The Grain Millers of Glasgow* was loaned to Glasgow Museums in 1973 for the historical display *Banner Bright: An Exhibition of Trade Union Banners from 1821* (Exhibition Catalogue, 1973.). It was lent by its owner at the time, the Transport and General Workers Union (TGWU) and remained at the former Glasgow Art Gallery and Museum, today's Kelvingrove Art Gallery and Museum, from the 22nd of August to the 24th of September.

Records of the banner's provenance in the museum archives show it entered the People's Palace Collection of Glasgow Museums on the 25th of March 1988, having previously been kept at the Congress House building of the Trade Union Congress (TUC) in London (Social History Correspondence, Glasgow Museums Resource Centre Archive.). The banner was donated by their librarian at the time, Ms Chris Coates, who found it during the refurbishment of their Russell

Street building. However, there was no indication of how the Scottish banner came into possession of the TUC. Gorman stated that the banner, which was included in his London exhibition at Whitechapel Gallery in 1973, was kept at Transport House, the name given to the headquarters of the TGWU, but also of the Labour Party and the TUC at a time, located on Smith Square and Dean Bradley Street in the city of London. The TUC would later move to the new building on Russel Street named Congress House, where they have their headquarters to date. A possible interpretation is that the banner may have ended up in Congress House as if it was the TUC's property.

The banner was restored at some point between 1973, date of its exhibition and 1988, date of its gifting to the People's Palace Museum. Two undated colour slide photographs of the banner taken at the first location of the National Museum of Labour History at Limehouse Townhall in London, show the banner without the current invasive treatment detected in the inspection years after the 1973 exhibition (see Appendix I Banners documentation for details) (Figure 2.11 a, b). The National Museum of Labour History would subsequently move to the former Mechanics Institute in Manchester in 1990, along with its photographic records, which are now kept at the People's History Museum, its new name since 2001, now located in the former hydraulic pumping station of Bridge Street, Manchester. Stylistically, the restoration seemed to be carried out by the Royal School of Needlework (RSN), which conducted many similar treatments on banners during the eighties (Lennard, 2019). However, the file of its restoration was unable to be located as the banner would have entered the school under the name of the person who brought it, not the institution, as was specified by the chief executive of the RSN, Dr Susan Key-Williams (Key-Williams, 2019).

a)

b)

Figure 2.11 Banner at the first National Museum of Labour History c.1980s. (Image © People's History Museum, Gorman Collection).

2.3.4 The banner of The National Union of Vehicle Builders, Glasgow Branch (former United Kingdom Society of Coachmakers)

The banner depicts the name of the society at the top of both sides A and B 'NATIONAL UNION OF VEHICLE BUILDERS' in gilded capital letters within a sinuous scroll of red background and yellow ochre turns, all over a dark-blue textile background (Figure 2.12). Immediately underneath there is the society's badge, also on both sides A and B, accompanied with a smaller scroll of green background and yellow turns stating 'GLASGOW BRANCH' in black capital letters. The central paintings are arranged under the badge with a different image on each side, as well as four smaller roundels set at the four corners of the remaining textile.

Side A of the banner has a red motorcar with black hood and Vogue Tyre brand tyres at the centre, whilst four other types of vehicles are set clockwise as follows: a Hackney coach, a two-story yellow tramcar, a subway carriage, and a Roman carriage. The frame and surroundings are decorated with vegetable motifs and painted tassels, with the society's motto inscribed at the bottom in a green and silver scroll: "TRIUMPHANT WE BRAVELY DEFEND" (Figure 2.12 a).

Side B of the banner shows a Hackney coach in the centre, which was of particular significance to the Society due to its popularity at the time of its invention that even got a particular taxation from the government (NUVB, 1934, pp. 16-19). On the four roundels surrounding it, there can be seen two images related to hard work and cooperation, a beehive on the top right and clasped hands between a laurel wreath on the top left. The first symbolises community and collaborative industry leading to prosperity, and the second reciprocal friendship (Dennis, 2005, p. 53). The bottom roundels show two of the benefits the society decided to present on their banner: succour to the afflicted and bereaved, on the lower right, and support in old age, on the lower left. Underneath a green and silver scroll holds the date of establishment in black lettering reading 'ESTABLISHED 1834' (Figure 2.12 b).

a)

b)

Figure 2.12 Banner of *The National Union of Vehicle Builders, Glasgow Branch (former United Kingdom Society of Coachmakers)*, a) side A, b) side B. (Image © CSG CIC Glasgow Museums Collection).

The badge of the United Kingdom Society of Coachmakers was designed after the first amalgamation of 1834 (NUVB, 1972) (Figure 2.13). Disposed as a heraldic coat-of-arms, then left-hand emblem is that of the old Guild of Coachmakers and the right-hand emblem is the Royal Standard, both supported by two horses rampant. Over the crest, the figure of Phoebus is portrayed driving his chariot over the clouds, which corresponds with the Latin motto of the society *Surgit Post Nubilae Phoebus:* The sun rises after the clouds. The badge also contains four clasped hands symbolising friendship and the other motto of the society: Triumphant we bravely defend” (NUVB, 1972). The Glasgow Museums Collection banner includes the two emblems, horses and chariot ridden by Phoebus but not hands clasped nor Latin inscription.

Figure 2.13 Official badge of the National Union of Vehicle Builders and of the former United Kingdom Society of Coachmakers. (Image © NUVB, 1972)

Five emblems or certificates of the society were issued between 1834 and 1934, depicting the changes that vehicles had along those years (NUVB, 1972). As stated in that society’s publication, it was a practice to issue each member with such emblems and have it framed upon the living-room wall, and this was evidenced on the banner of Glasgow Museums Collection where the emblem is painted hanging on the scenes' walls (Figure 2.14 a, b).

Figure 2.14 Detail of the framed Society's emblem painted inside the benefits scenes on side B: a) left side scene, b) right side scene. (Image © D.S.V.).

The earliest emblem was a lithograph portraying six different coachmakers working in the construction of a coach, a bodybuilder, a painter, a smith, and a draughtsman. On the four corners of the emblem the four benefits gained by belonging to the society were portrayed: relief on travel, aid for the sick, succour for the aged and relief for dependants upon death (NUVB, 1972). The same theme was maintained through the second emblem issued around 1870 and the third issued around 1886, the latter adding to the imagery of the emblem a railway carriage and a tramcar. The fourth emblem, issued at the beginning of the twentieth century, added in turn a motorcar and kept only two of the benefits: support in old age, and succour to the afflicted and bereaved. This is the emblem on which the banner of Glasgow Museums Collection is based on (Figure 2.15). The fifth emblem deleted all the benefits from its design, adding the new name NUVB as well as an omnibus, a car, an underground carriage and an aeroplane.

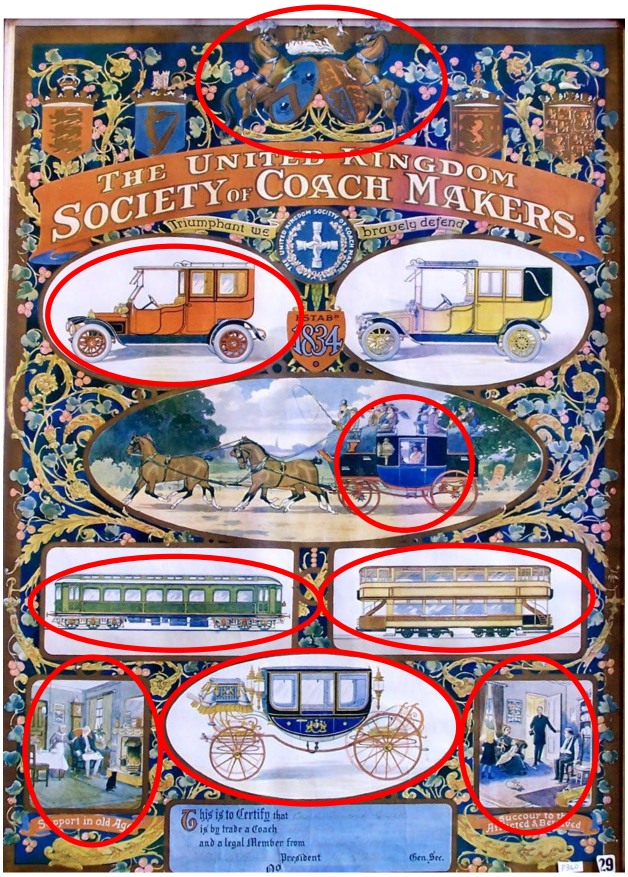


Figure 2.15 Emblem of the United Kingdom Society of Coachmakers c.1898. (Image © Working Class Movement Library, Salford). Figures inscribed in red circles are included in the banner.

2.3.4.1 Brief historical account

The ‘National Union of Vehicle Builders’ (NUVB) was the name given to the former ‘United Kingdom Society of Coachmakers’ (UKSC), after their amalgamation in 1919 with the ‘London and Provincial Coachmaker’s Society’, the ‘Operative Coachmakers and Wheelwrights’ Federal Labour Union’, the ‘London Coachsmiths and Vicemen’s Trade Society’, and the ‘United Kingdom Society of Coachmakers’ (Lyddon, 1987; 227). However, the NUVB traced back their origins to the establishment of the UKSC, which happened after the co-operation of the Liverpool’s and Manchester’s Coachmakers societies during the coach-makers’ strike on the first week of December 1834 (National Union of Vehicle Builders, 1934; 11-12). By keeping their former organisation’s year of establishment, the NUVB would proudly proclaim as one of the oldest trade unions in existence, having branches and districts in various parts of the country (National Union of Vehicle Builders, 1959; 29).

The NUVB would latterly absorb the Amalgamated Wheelwrights, Smiths and Kindred Trades Union in 1925, and the Wheelwrights and Coachmakers' Operative Union in 1948, until they finally transferred their engagements to the much modern Transport and General Workers' Union (TGWU) in 1972 (MacDougall, 1978; 345). On the 1st of March 2007 the TGWU merged with the union Amicus to form the second largest union in the UK (Unite the union, 2022).

According to the National Archives' Discovery website, the archive of the NUVB was split into 2 parts towards the 1970's, when the union had already turned into the TGWU (The National Archives of the UK, n.d.). The oldest documents of the union and its predecessors, predominantly those from the UKSC, are kept at the Modern Records Centre of the University of Warwick. Those belonging to the Glasgow branch of the organisation were kept at the Special Collections Archive of the Mitchell Library in Glasgow (The National Archives of the UK, n.d. a).

Although the known records go back to the first quarter of 1851, it was impossible for the members to fix an actual date of opening for the Glasgow Branch of the UKSC, as they seemed to be active much earlier (NUVB, 1951, p.9). Excerpts from the records of the Chester Branch showed that Glasgow Branch members were relieved since 1840 onwards from tramp (a working system in which the worker sought work elsewhere and was paid by its society if none was found), and according to Chartist pamphlets the Glasgow Coachmakers took part on the Mass Demonstrations held in 1837. Another unfortunate event that led to the destruction of their records was the fire of the Albion Halls in 1909, place where they had kept them from inauguration, along with their banners and trade symbols, some of them carried in the Chartist demonstrations (NUVB, 1951, p.9).

By the closing years of the nineteenth and the early years of the twentieth centuries there was considerable evidence of the growing militancy spirit in the Branch, related to the changing of the trade from traditional coaches to motorised vehicles. By that point, the 51-hour week which they were fighting for since 1880 was secured in several workshops, from 1900 until the year 1913 (NUVB, 1951, p.9).

The amalgamation of 1919 coined the new and more appropriate title of the National Union of Vehicle Builders, leaving the "Old Timers", as they were referred at the time, statutes of the UKSC and accepting for the first time in their membership semi-skilled workers as a further opportunity of recruitment. The Glasgow membership grew immediately attaching areas of Ayrshire and Stirlingshire into the branch, with a membership of over 1,200 and working conditions correspondingly improved (NUVB, 1951, p.20).

The NUVB Glasgow Branch would henceforth be very actively involved in protests against repressive movements of the twentieth century: campaigning on behalf of the Spanish Republicans in 1955-58, asking for the withdrawal of Russian troops from Hungary in 1956, requesting the withdrawal of British troops from Egypt in 1956, the withdrawal of Americans from Chinese Formosa islands in 1955, all stated in their surviving correspondence archived at the Mitchell Library (CLASS:TU F331.881847 NAT).

2.3.4.2 Banner provenance

Recorded in the Minute Book of the United Kingdom Society of Coachmakers, Glasgow Branch from the 15th of July 1913 to the 21st of September 1918, the society first referred to the making of their new banner in an entry of the Committee Meeting on the 3rd of March 1914, Mr Symington presiding:

> 'Banner: It was decided to put advert. in Daily Citizen for price etc. of Banner, and also to recommend to the Branch the asking of affiliation with May Day Committee and that the next meeting to be held in Neilston's Temperance Hotel Ingram St. at 7.45 PM on Monday 9th March.' (T.U. F331.881847 NAT (Vol 2))

On a second entry dating 27th of March 1914, Mr Symington in the chair shared the seeing of a banner as follows:

> 'Banner: Secy. intimated to Branch Committee that he had made arrangements for seeing a banner at 3 o'clock the following day Saturday the 28th March, in the hall in Watson St.' (T.U. F331.881847 NAT (Vol 2))

Although not stated on the last entry, it can be inferred that the said banner had been of Kenning's manufacture, as the following statement on the 16th of April

1914 referred to the purchase of their new banner chose that company for the manufacture:

> ‘Banner: The meeting instructed the Committee to purchase New Banner from Messrs Kenning and Son’s at a price of 20 (Twenty) Guineas. Moved by A. Lillie “That the necessary Balance of money be taken from Incidental” P. Watt Sec. Amendment by Mr Hutton “That we ask Springburn Branch to contribute towards the Banner Fund” Sec. by A. Liddell the motion was carried by a large Majority” (T.U. F331.881847 NAT (Vol 2))

The request of their new banner was followed in detail, as other five entries referred to it, showing the importance that such items supposed to the societies that had them requested. On the 21st of April 1914. Mr Paterson V.P. in the chair shared that the President of the Branch had received instructions regarding the ordering of the banner, which was later confirmed on the 28th of April, date on which the banner was ordered to be made (T.U. F331.881847 NAT (Vol 2)).

The manufacturing and delivery of their banner lasted from then till the 30th of June, as that date the Committee held a meeting to agree its delivery by the last week of July, which got delayed. A possibility for its delaying could have been the start of WWI, officially recorded on the 28th of July 1914, as the society’s Secretary was instructed to ask the company another probable date for the banner delivery in a meeting held on the 6th of August (T.U. F331.881847 NAT (Vol 2)). Another possible interpretation is that the banner simply took longer to be made.

The banner was finally delivered on the 2nd of September 1914, as Mr Symington presiding stated the following:

> ‘Banner: After inspection of New Banner, Secy. was instructed to write to Kenning & Son commending workmanship of same.’ (T.U. F331.881847 NAT (Vol 2))

The new banner was displayed in the hall of their headquarters at 9 Watson Street, Glasgow, on the 22nd of September of 1914, and the society invited the members of the Springburn branch to come and join such display.

The banner was so precious to them that they discussed its insurance in one of the items of a meeting held on the 29th of September 1914:

> 'Insurance of Banner: Mr P. Watt moved seconded by Mr V. Earl that the Banner be insured and that the Secy. be instructed to write the Co-operative Insurance Society to give their terms.' (T.U. F331.881847 NAT (Vol 2))

No other item was found to have been requested to be insured by the society and such practice was not seen in the minutes of the Typographers, hence the adjective of precious in the previous paragraph. Nevertheless, there was no discussion regarding the cost of making the banner found in the society's records.

The first recorded use of their new banner for a demonstration took place for the celebrations of May Day on 1917, referring to arrangements for the banner bearer etc. Other important participations of the society where the banner got used were recorded in their minutes, like another May Day demonstration happened on the year of their amalgamation, 1919, and in 1921 (T.U. F331.881847 NAT (Vol 2)) (Figures 2.16 and 2.17).

Figure 2.16 Black and white photographic negative of May Day, 1920s, United Kingdom Society of Coachmakers and their banner. (Image © GMA.1420.84.69)

Figure 2.17 May Day, 1926, Demonstration in Glasgow (Image © Mitchell Library Archive)

The banner would be used so frequently that by January 1928 the Committee would mention its “bad condition” and requested an estimate to have it “touched up “(NUVB GB minutes 10/3/33).

The first alteration was located on the Committee Meeting Minutes held on Tuesday the 9th of May 1933. J. Hill Pres. Presiding stated:

> ‘The Branch Banner: The cmtte. agreed on the question being raised on the Branch Banner, that the name on banner be altered to read the N.U.V.B. and that the whole banner be touched up. Enquiries had been made on the cost, and same would be approx. £7.’ (NUVB GB minutes 10/3/33)

This first alteration would paint over the original name of the society, The United Kingdom Society of Coachmakers, the new one of the NUVB. However, the remaining Glasgow Branch and society’s mottoes would remain untouched for not having changed. The newly named banner would be firstly used on the demonstration of the 25th of March 1934, “the biggest ever” due to the Centenary of the society, organised against the New Unemployment Bill (NUVB GB, December 1933- November 1935).

The second alteration, which is actually signed in the banner as “Renovated 1942” (Figure 2.18), was offered by one of the society’s members, Mr W. Robertson on the Tuesday 7 October 1941 and accepted by the Committee (NUVB

GB minutes 7/10/41). Two more entries refer to the process on the 14th of October and finally on the 7th of April 1942, date when the Secretary "reported that the branch Banner had now been touched up by W. Roberston". (NUVB GB minutes, 7/4/42).

Figure 2.18 Detail of the "Renovated 1942" on side B of The National Union of Vehicle Builders, Glasgow Branch banner. (Image © D.S.V.).

The banner is registered on the People's Palace IRGMA cards of 1973 without indication of acquisition method. The banner was included in the 1973 Banner Bright exhibition at the now Kelvingrove Art Gallery and Museum (Banner Bright Exhibition Catalogue, 1973), and the entry on the People's Palace card mentions that it kept coming apart during the time it was lent (People's Palace IRGMA CARDS 1973). The inventory number given to the object is still the one that holds to date: PP.1973.16, indicating that it entered the People's Palace Collection on the year 1973. The banner is currently stored at Pod 12 of Glasgow Museums Resource Centre.

2.3.5 The banner of The Scottish Tin Plate Braziers and Sheet Metal Workers' Society

The banner depicts the name of the society at the top of both sides A and B 'SCOTTISH TIN PLATE BRAZIERS AND SHEET METAL WORKERS' SOCIETY' in gilded capital letters within a sinuous scroll of red background and silvered decorated turns, all over a dark-blue textile background. The banner is profusely decorated at the top on both sides, with foliage and floral elements in coloured-glazed silver in yellow, red, and purple. Side A of the banner portrays a central painting with a female figure in pseudo-Classical theatrical attire, which has been identified as the Greek/Roman goddess Athena/Minerva by the iconography displayed: holding a distaff in her right hand as the goddess of craft and wisdom (Ravenhill-Johnson, 2013, p. 100-101). On the background of the character, an industrial city landscape and a naval port are seen, with a sail ship with the rampant lion of Scotland on the right side. Surrounding the central scene there are four smaller roundels with characteristic products made by the society identified clockwise as a naval lamp, a black enamelled (also known as Japanned) coal scuttle, a street gas lamp, and a rail warning light. Underneath the scene, the motto of the society is inscribed in a scroll with the words 'LABOUR IS THE SOURCE OF ALL WEALTH' (Figure 2.19, a).

The central painting on side B shows the workshop depicted in the emblem of the society, with eight workers on white aprons arranged around sheet metal objects in process of being manufactured. Clockwise surrounding the central painting are four roundels portraying other typical products of the society: enamelled crockery, a cooker with pots and pans, a dry gas meter, and an enamelled bathtub. Underneath, the institution date of the society is inscribed within a scroll with the wording 'INSTITUTED 1833' (Figure 2.19, b).

a)

b)

Figure 2.19 Banner of *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society*, a) side A, b) side B. (Image © CSG CIC Glasgow Museums Collection).

The design of their banner was based on the emblem of another kindred society, *The National Amalgamated Tin Plate Workers of Great Britain* designed by the emblem artist Alexander Gow in 1894 (Figure 2.20). The National Amalgamated Association of Tin Plate Workers of Great Britain started on 3 January 1876, where the Wolverhampton Tin Plate Workers Society and the Birmingham Tin

Plate Workers Society formed the Amalgamated Tin Plate Workers Society of Birmingham, Wolverhampton and District. In April 1889 the United Tin Plate Workers Association and the Gas Meter Makers Association of Edinburgh and Leith joined the new association, bringing the total membership to some 1,400, and changing their name to the National Amalgamated Tin Plate Workers of Great Britain (Marsh and Ryan, 1984, pp. 117-118). The amalgamation of these societies explains the variety of products represented on the emblem and on the banner, particularly the gas meter and the assortment of Japanned items typical of Birmingham manufactures.

The entry on the design of their emblem was located on *The National Amalgamated Tin Plate Workers of Great Britain* minute book of 1894, describing the following anecdote:

> "During the year Mr A. Gow, Lithographer, London, had wrote A. Ricket and E. Fookes, and sent specimens of Emblems his firm had got up for different Trade Organizations, wishing very much to get up one for the Amalgamation. Your Secretary has not given him much encouragement, but out of courtesy both he and E. Fookes brought it before meeting, with result that many a different Societies have expressed a wish to have an Emblem executed" (Modern Records Centre, MMS. 4/tg/sw/34/9).

The society would eventually pay for the emblem as was found in their Sixth Balance Sheet of the year 1894. They paid A. Gow a price of £100, 5 s., 0 d. for the concept of 1000 emblems and £9, 0 s., 6 d. to his printer A. Webb for printing the said emblems.

Surprisingly, *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* never agreed to join the West Midlands society, even though various entries on the matter were found on the *The National Amalgamated Tin Plate Workers of Great Britain* minutes for the year 1894 (Modern Records Centre, MMS. 5/tg/sw/34/9). However, they appropriated the design and adapted it to their liking, including the Royal flag of Scotland and changing the appearance of the female figure in the centre from brunette to blonde.

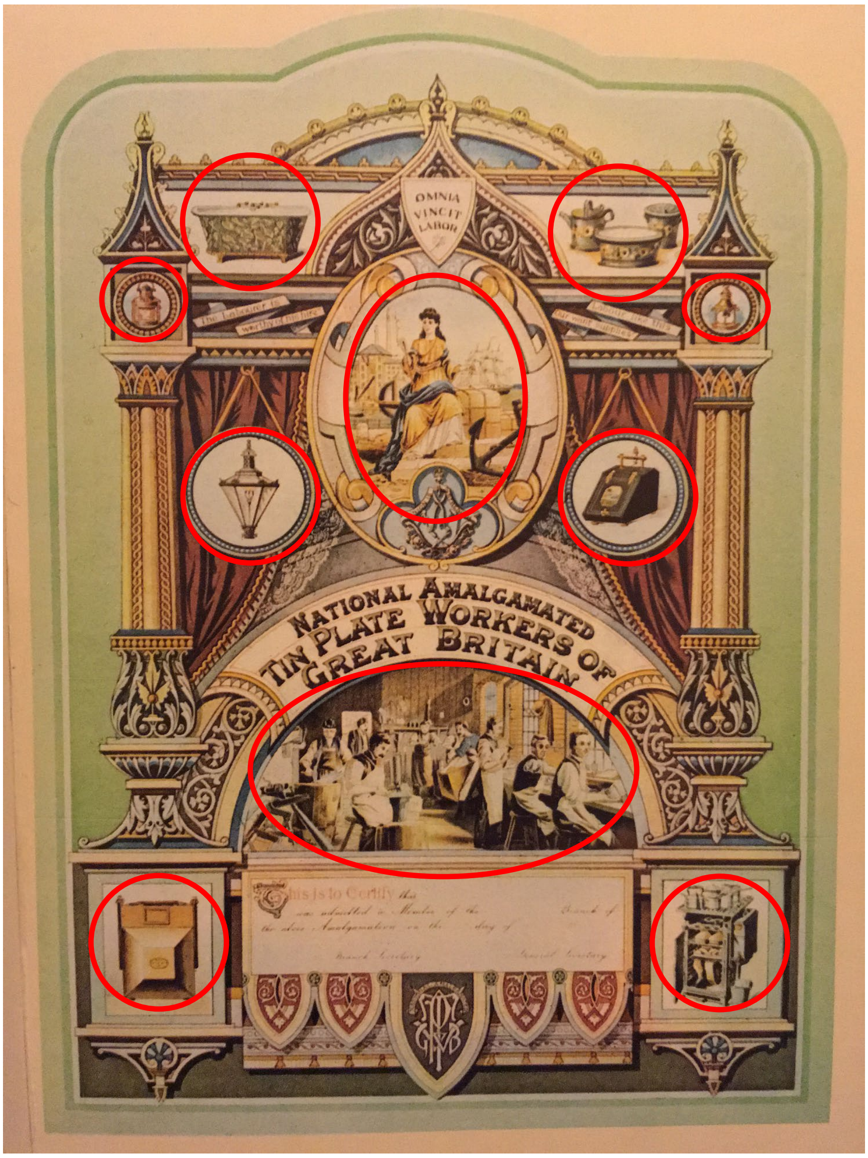


Figure 2.20 Emblem of the National Amalgamated Tin Plate Workers of Great Britain, A. Gow, 1894. (Image © Modern Records Centre, MMS. 4/tg/sw/34/9). Image from Leeson, 1971. Figures inscribed in red circles are included in the banner.

2.3.5.1 Brief historical account

The only surviving records from The Scottish Tin Plate Braziers and Sheet Metal Workers' Society, their Annual Reports from 1864 to 1922, are stored at the Modern Records Centre of the University of Warwick, which holds a copious number of Trade Union records from all around Britain (University of Warwick, n.d.).

The society was firstly instituted in April 1833, publishing their first Annual Report on the 14th of April 1834 (Brake, 1985; 153). As written by the Society's secretary between 1892-1893, Duncan Maitland, on the Sixtieth Annual Report issued in the year of their 60th anniversary (Maitland, 1893; 1):

> “Our Society was instituted in the year of 1833 by 34 Tinsmiths, and in one year they increased that number to 114 Members”.

The first name of the organisation in 1833 was the ‘United Tin-Plate Workers’ Protective Society of Glasgow’. At the beginning, they were “only a Protective Society”, which six years after would acquire the higher status of “Sick and Protective Society”, changing their name for the second time in 1839 to ‘United Tin-Plate Workers’ Sick and Protective Society of Glasgow’ (Maitland, 1893; 1).

After a lapse of six years, a third amendment was added to the Society’s name, changing into ‘United Tin-Plate Workers’ Friendly and Protective Society of Glasgow’ in 1846 (Maitland, 1893; 1). With this addition, the organisation became a friendly society, maintaining their name from that date until 1870, which was verified in their surviving Annual Reports (MSS.101/SM/TW/4/2/1-14).

The fourth name given to the organisation came into use after April 1871, as indicated in the front cover of their Thirty-Eighth Annual Report: the ‘United Tin-plate Workers’ Friendly and Protective Society of Glasgow and West of Scotland’. This would incorporate other kindred organisations to the initially local Society (Dunn, 1871). The change of their name was confirmed by the Secretary’s historical recount of 1893, noting that such was the name that the Society would still have by the same year, adding to his entry that for their last 60 years “you may say we have only had three different names – Tinmen of Glasgow, Tinmen of West of Scotland, and now Tinmen of Scotland.” (Maitland, 1891; 1). The Society would use their fourth name for a period of twenty years, between 1871 and 1890, as verified in their Annual Reports (MSS.101/SM/TW/4/2/9-14 and MSS.101/SM/TW/4/2/15-28).

By their following Fifty-Eight Annual Report and Financial Statement of April 1891, another change was added to the name of the Society, turning them into an all-Scotland organisation. They would be known as the ‘Scottish Tin-Plate and Sheet Metal Workers’ Friendly and Protective Society’, their fifth name in a 58-year period of existence (Edmond, 1891; 4). The Society kept the same name for the next 19 years, using it lastly on the cover of the Seventy-Seventh Annual Report and Financial Statement of 1910 (Burnet, 1910; 4). Additionally, the Society became branch of the ‘National Amalgamated Sheet-Metal Workers’ and Braziers’ Union’ in 1908, as indicated in the cover of their Seventy-Fifth Annual Report and onwards (Burnet, 1908).

The organisation changed their name for sixth time to the ‘Scottish Tinplate, Braziers, & Sheet-Metal Workers’ Friendly and Protective Society’ (Burnet, 1911), the designation that is actually included in the Glasgow Museums Collection banner and that lasted as such for a period of six years. This name-change could be related to their conversion as a branch of the ‘National Amalgamated Sheet-Metal Workers’ and Braziers’ Union’, as published in their following Seventy-Eighth Annual Report of 1911.

The seventh name of the Society was found in their Eighty-Fourth Annual Report of 1917, indicated as the “Scottish Sheet-Metal Workers’ and Braziers’ Friendly and Protective Society’ (Sanders, 1917), lasting as that for a total of three years, until the eighth name verified in their surviving records, when they became the ‘Glasgow Branch’ of the ‘National Union of Sheet-Metal Workers’ and Braziers’ (Clark, 1921). In July 1959 the Union amalgamated with the National Society of Coppersmiths, Braziers and Metal Workers to form the National Union of Sheet Metal Workers and Coppersmiths to which was added, in April 1967, the Heating and Domestic Engineers Union, forming the National Union of Sheet Metal Workers, Coppersmiths, Heating and Domestic Engineers (Marsh and Ryan, 1984, p. 120).

The National Union of Sheet Metal Workers, Coppersmiths, Heating and Domestic Engineers merged into the Technical, Administrative and Supervisory Section (tass) in 1983, which in turn merged into the Manufacturing, Science and Finance union (MSF) in 1988 and subsequently merged into the United Kingdom’s second-largest trade union, Amicus, in 2001. Finally, Amicus merged with the TGWU to form the current Unite the Union (Unite the Union, 2022).

2.3.5.2 Banner provenance

Although the primary sources relating to The Scottish Tin Plate Braziers and Sheet Metal Workers' Society are scarce, there is an entry on the Balance Sheet of their 1891' Annual Report regarding a banner. Included under the "Expenditure from April, 1890, till April, 1891" it mentions the following information: "Sketch for Banner, £0-5-0" (Edmond, 1891; 16).

In another entry on the Sixtieth Annual Report of the 'Scottish Tin-Plate and Sheet Metal Workers' Friendly and Protective Society', there is listed in their "Income and Expenditure from April, 1892, till April, 1893", the expense had "by Painter's Account - £16 – 3 – 11". This could be reporting the cost for the making of said banner, as it falls within the price range of the banner of the 'Glasgow Typographical Society' and of the 'United Kingdom Society of Coachmakers, Glasgow Branch' (National Union of Vehicle Builders, Glasgow Branch) described in sections 2.3.3 and 2.3.4 of this chapter.

Nevertheless, no further evidence was found of such sketch nor banner and the dates do not match with the printing of the emblem on which the banner of Glasgow Museums Collection is based on. Like the previously mentioned banner, an entry on the Scottish Tin-Plate Braziers and Sheet Metal Workers' Society Eighty First Report and Financial statement was found referring to a "Painters Account - £12-10-0" by the end of the year 1914 (MSS.101/SM/TW/4/2/52). This could correspond with the payment for their banner, as it matches the dates of the company that signs it, George Kenning & Son (1895-1937), and the emblem by A. Gow (1894). However, as it will be explained in section 2.3.4, the use of certain elements of brass as well as a single silk textile rather than multiple sewn strips, could indicate a later date for the manufacture of their banner, situating it c.1916.

The banner of the Scottish Tin-Plate Braziers and Sheet Metal Workers' Society was lent by 'The National Union of Sheet Metal Workers, Coppersmiths and Heating Domestic Engineers, Glasgow Branch', to the exhibition entitled Banner Bright, An Exhibition of Trade Union Banners from 1821, held at the Glasgow Art Gallery & Museum (today's Kelvingrove Art Gallery and Museum) from the 22nd of August to the 24th of September 1973 (Glasgow Art Gallery and Museum, 1973).

It was then gifted in 1981 by their secretary of the Sheet Metal Workers located at Glasgow's Berkley Street at the time, Mr Sharp, along with their office door plaque reading 'Tin Plate Workers' and Braziers Union' to the People's Palace Museum on the 17th of February of that year. Recorded on the People's Palace Museum Day-Book by Michael Donnelly, it was given the inventory number that still holds to this date: PP.1981.11.1 (People's Palace Museum Day-Book, p. 72). The banner is currently kept at Glasgow Museums Resource Centre Pod 12, along with its original wooden box containing the poles, ropes, harnesses, and banner tags of the banner.

The five Kenning banners of Glasgow Museums Collection are material evidence of the British trade union and labour movements from the time they were commissioned to the time they were gifted to the People's Palace Museum. All but one of the societies ended up merging into the same national organisation of Unite the Union. The Upholsterers, having taken a slightly different path of amalgamations, ended up merging into GMB. However, it was clear that in the five cases the role of their banners was impacted by the change of their organisations. Fortunately, rather than disposing their banner, they decided to gift it to a pertinent museum collection, showing the importance that still supposed to them, if anything just to remember their origins. The year of their gifting coincided with the demise of trade unionism highlighted by Gorman (1973), main reason for his research and pursue of banners' revalorisation and preservation for future generations.

2.4 Historical profile of George Kenning's companies

The development of Kenning companies is complex and understanding their changes helps understand the time and place of manufacture for the different banners. Previous research on British painted banners has not often discussed a clear timeline in the company's development, naming them as George Kenning and Sons when it was only one son (Thompson, Smith and Lennard, 2017, p. 70; Southwick, 2017, pp. 165-205), Toye Kenning without Spencer (Lennard and Lochhead, 2003) or as a company in a period to which it did not belong, like Toye, Kenning & Spencer before 1962 (Smith, Thompson and Hermens, 2016, pp. 1) The confusion is because little has been written until now about how

Kenning's companies evolved over time. The way that the company adapted and changed throughout history was important to understand at which stage in the company's development the five Kenning banners of Glasgow Museums Collection were produced.

From 1860 to date, the surname Kenning has been used in seven different companies (Figure 2.21), all of which are defined in this section. Of these, the first four were established by George Kenning while he was alive and only two of them were responsible for the manufacture of the five selected banners of Glasgow Museums Collection: the companies of George Kenning, and of George Kenning & Son.

1 – George Kenning

2 – Kenning & McKiernan

3 – George Kenning

4 – George Kenning & Son

5 – George Kenning & Son Ltd

6 – George Kenning & Spencer Ltd

7 – Toye, Kenning & Spencer

Figure 2.21 Timeline of Kenning's companies to date

2.4.1 Early days and the first George Kenning Company (1860-1863)

George Kenning, born 2nd of April 1836 and died 26th of October 1901) (Baptism record, 1836; Death certificate, 1901), began his professional career as an apprentice of gold lace embroidery with only 14 years of age (Census Returns of England and Wales, 1851). Two years later he started a seven year apprenticeship in 'The Worshipful Company of Loriners', specialists in the making of bridles, harnesses and similar horse apparel (George Kenning and Son. Summer Number [Supplement], 1901). Apprenticeships have been seen as a typical education route worthy for the Victorians (Picard, 2009), and their occurrence has been detected to be applied throughout society. For a period of typically seven years, a trade master or mistress would train a minor to earn his living with such a trade. The apprentice was hosted and nurtured by the master without the duty of paying him, changing towards the end of the period when the apprentice became helpful and profitable (Picard, 2009). George Kenning acquired in such way two specialties in his life: loriner and gold lace man, becoming liveryman of both (George Kenning and Son. Summer Number [Supplement], 1901).

George Kenning started working as a gold lace maker at the already established regalia firm of Edward Stillwell, lasting with the firm until his dismissal in 1860 related to a request for an increase in his wage (Freemasonry, 2010a, 2010b). Despite their apparent brief relation, similarities between Stilwell and Kenning's careers attest one of the pathways for the expansion of the middle class in Victorian Britain (Picard, 2009), as part of the emerging entrepreneurship of a changing consumer society (Briggs, 1990, pp. 147-166).

Coming from a background akin to Kenning, Stillwell took an apprenticeship with Daniel Atherly, a member of 'The Worshipful Company of Gold and Silver Wire Drawers' on the 11th of October 1802 (Stilwell, 2018). After the end of this apprenticeship, Stilwell established his own business as gold and silver drawer at least from the year 1830, located at No. 16 Princess Street in the area of Barbican, London (Commercial Directory of London, 1830). Stillwell subsequently joined his mentor to start the firm Atherly & Stillwell at least from 1845, located in the same area (Commercial Directory of London, 1845), and became master of The Gold and Silver Drawers Livery Company in 1836 (Drawers, 2016). George Kenning would also become master of such a company in 1882 and 1883.

Edward Stillwell's company changed its name to Edward Stillwell & Son from 1863 onwards, indicating their joint business at No. 25-27 Barbican and No. 6 Little Britain (Post Office Directory London, 1863). The firm remained at that Little Britain address at least until 1895 (Street Directory London, 1895), the same street where George Kenning would settle his companies between 1861 and 1931 (Post Office Directory London, 1861; 1931).

Kenning's entrepreneurship appeared to be impacted by the development of Stilwell's, as not only did he pursue similar specialties and livery memberships, but he also joined the same fraternal society of the Freemasons. Both Stilwell's and Kenning's companies advertised themselves as wholesale manufacturers of Masonic furniture, fittings, clothing, jewels and other regalia in addition to their gold lace and embroidery products ("Edward Stillwell & Son advert," 1883). This highlights the importance of friendly and fraternal societies during the nineteenth century and the connection with the rise of these types of entrepreneurships, previously exemplified for Britain's foremost banner manufacturer George Tutill, who was member of the Foresters (Logan, 2012), and the Manchester banner maker Henry Whaite, who was a member of the Oddfellows (Stephens, 1999; Smethurst 2000).

George Kenning opened his first business in the street of Little Britain within that same Barbican area of London. That part of the city would become the centre of the clothing trade by the end of the nineteenth century, housing many fabric and leather merchants, furriers, glovers, and many other tradesmen (Barbican, 2020), such as regalia makers of which Kenning seemed to be the only banner manufacturer at this location. Having been situated within such a commercial setting could have benefitted Kenning's production for the sourcing of materials like silk textiles and leather, but it was impossible to corroborate due to the lack of a historical archive from the company (Cope, 2018).

According to the only known surviving historical company profile of George Kenning's company, published as a supplement for the 1901 Glasgow Exhibition, his business began towards the early part of the year 1860 (George Kenning and Son. Summer Number [Supplement], 1901). The company was firstly included in the trades' directory of London a year later as:

> 'Lit. Britain, 175 Aldersgate St. (E.C.) (…) 18 Kenning, George. Gold lace maker.'(Post Office Directory London, 1861).

During those first two years Kenning worked and resided at No. 18 Little Britain, which would have made his company the “exceedingly small and unassuming establishment” described in the company profile, with just one assistant for all purposes (George Kenning and Son. Summer Number [Supplement], 1901). The product primarily offered at that time was the manufacture of gold lace (Post Office Directory London, 1861), which according to the company profile was hand-made off his premises by hired silk weavers and spinners in Bethnal Green and Spitalfields. During those early days, it is said that Kenning and a number of workmen and workwomen worked for a length of sixteen hours a day, looking after his customers during the day and seeking his supplies by night (George Kenning and Son. Summer Number [Supplement], 1901).

By the following year, Kenning’s business expanded their production, offering embroidery work in addition to gold lace at the same address of No. 18 Little Britain (Post Office Directory London, 1862). A possible reason for diversifying his line of products could have been to stand out from his two neighbouring competitors: David L. Tappolet & Co of No. 6 Little Britain and Johnson, Simpson & Simons of No. 9 and 10 Little Britain, both of whom were working in the vicinity solely as gold lace men since at least 1860 (Post Office Directory London, 1860). Nevertheless, there was no evidence found of banner making by this first George Kenning Company.

2.4.2 Kenning & McKiernan Company (1863-1865)

In 1863 Kenning established his second company, a co-partnership with another gold lace man named James McKiernan, under the name Kenning & McKiernan, located at No. 4 & 18 Little Britain (Post Office Directory London, 1863). The new company started advertising themselves as embroiderers and secured an important commission as Army & Navy Contractors that lasted jointly for two years. They worked together as gold lace men and embroiderers in the manufacture of military and naval accoutrements, as well as civil regalia until 1865 (Street Directory London, 1864; Trades' Directory, 1865).

In spite of the evident success, Kenning and McKiernan’s co-partnership was dissolved officially on the 28th of March 1865 by mutual consent, empowering

Kenning to carry on with the business and to deal with all debts and payments respectively due from that date onwards ("Notice of dissolution," 1865).

Kenning kept the newly acquired shop in Little Britain and James McKiernan established his own firm as army accoutrement maker and embroiderer at a different address, at No. 62 St. John's Square, Eastern Central London (E. C.), at least until 1875 (Commercial Directory of London, 1875). There was no evidence found about the making of banners during their jointly agreement, nor by McKiernan's subsequent sole company.

2.4.3 Second George Kenning Company (1865-1895)

After the dissolution from McKiernan in 1865, George Kenning Company, third in the timeline but second to have his sole name, continued their production at the address of No. 4 Little Britain for three more years (Post Office Directory London, 1868), maintaining the deal as Army & Navy contractor until 1870 (Post Office Directory London, 1870).

As part of his commitment to Freemasonry, of which he became a member from 1861 (Obituary, 1901), Kenning founded his very own Masonic newspaper for Freemasonry, literature, science and art entitled *The Freemason*, published every Saturday starting on the 13th of March 1869 (First type of advertisement published in the Freemason, 1869) and until the 29th of December 1951 (The Freemason, 1951). The journal was registered for transmission abroad from the first issue and became internationally renowned amongst the members of the Freemasons, promoting Kenning's business on almost every release.

By the time of the first issue of *The Freemason* in 1869, Kenning's company began to be advertised as 'Bro. [Brother of the Freemasons] George Kenning City Masonic Depot' (Figure 2.22), absorbing the adjacent No. 3 shop to offer the manufacture and selling of masonic clothing, jewels and furniture for all degrees in Freemasonry, listing banners for the first time in their list of products (First type of ad published in the Freemason, 1869). The company would then start to be advertised as "The Largest Stock in the United Kingdom (…) for all degrees in Freemasonry" from the second type of advert published on the 5th of June 1869 (Second type of ad published in the Freemason, 1869).

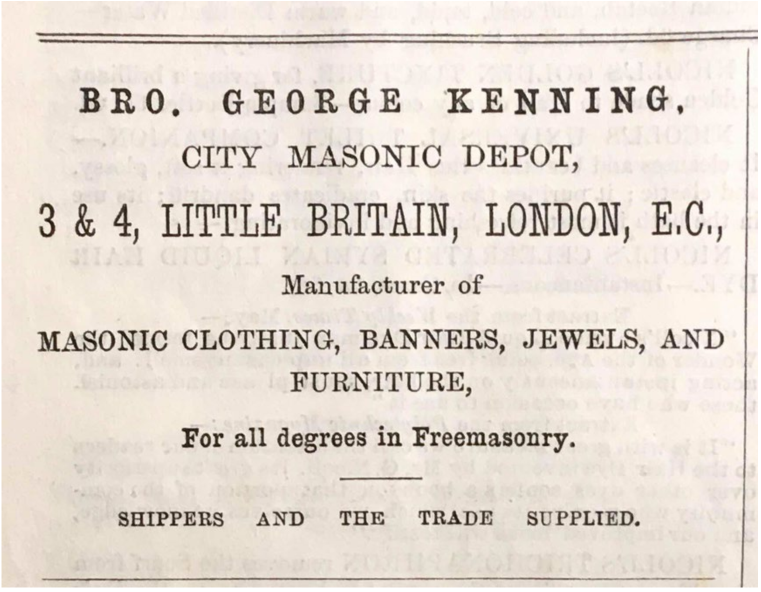


Figure 2.22 First company advert of George Kenning published in The Freemason on 13th of March 1869 (Image © First type of ad published in the Freemason, 1869).

Evidence suggests that Kenning's Masonic connection enabled him to establish his company where he did because of its proximity to Masonic institutions (Figure 2.23). He opened premises next to two lodges he founded in the City of London, Aldersgate and St Botolph's (Lane, 2011), and adjacent to other important Masonic institutions like the Great Lodge of England and the *Quatuor Coronati* lodge on Queen Street, as well as the Lion & Lamb lodge on Fleet Street, where he was first initiated as a Freemason (Obituary, 1901). He also opened two provincial branches in other significant English industrial cities at the time, Liverpool and Manchester; the first one where he belonged to the local Masonic lodge Mariners No. 249 and the second one where he held Masonic acquaintances to help him run the business locally (George Kenning and Son. Summer Number [Supplement], 1901). His Masonic membership also reached Scotland where he received a life membership of the Royal Order of Scotland on the 10th of October 1872 (Obituary, 1901), after which he established branches briefly in Edinburgh and permanently in Glasgow, becoming the only English firm to commercially produce banners with direct representation in Scotland.

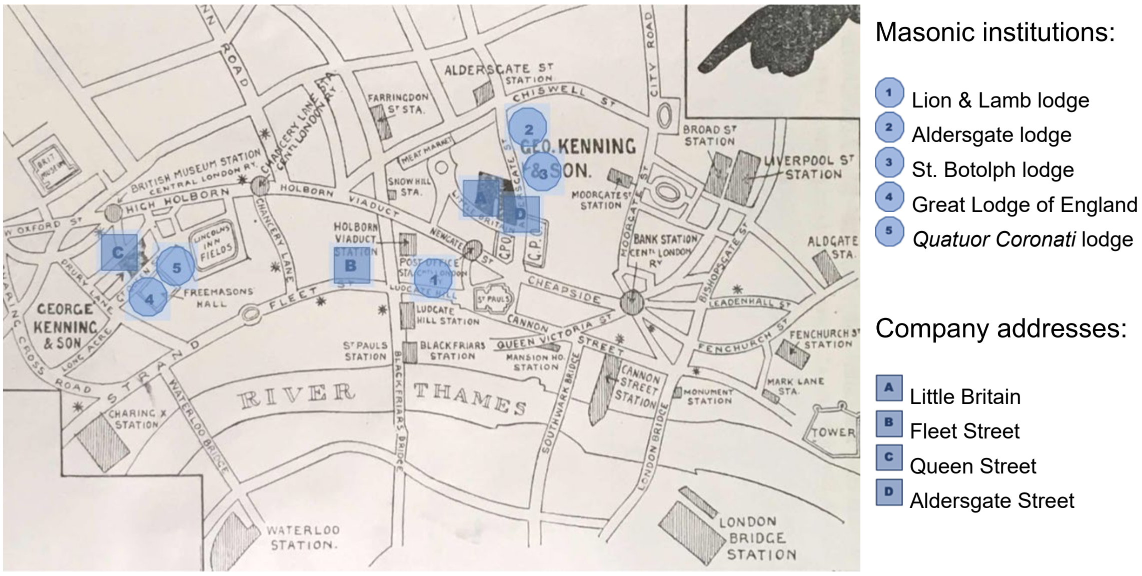


Figure 2.23 Detail of the London map included in the 1900's company profile (Image © George Kenning and Son. Summer Number [Supplement], 1901), with indication of Masonic and Kenning's company addresses as positioned in Lane's Masonic Records (Lane, 2011).

George Kenning's advertisements in *The Freemason* were both frequent and numerous and between the years of 1869 and 1894, a total of 21 variations to their design added a varied list of products (Table 2.1), all of which invariably included banners (First type of advertisement published in the Freemason, 1869; Twenty first type of advertisement published in the Freemason, 1894). In overseeing the manufacture of the diverse merchandises, Kenning would use both his specialties as gold lace maker and loriner.

Table 2.1. George Kenning's manufactured products as listed in *The Freemason* adverts between 1869 and 1894. (Banners are highlighted in bold for distinction).

Masonic clothing	**Banners**	Jewels
Furniture	Navy/Military clothing	Books
Music	War medals	Swords
Tracing boards	Fishing lines	Fly lines
Hats and caps	Stationary	Berlin wool
Fancy repositories	Theatres (products)	Milliners (products)
Ecclesiastic (products)	Sundries (products)	Ribbons
Tassels	Masonic aprons	Epaulettes
Buttons	Belts	Ball favours
Fringes	Braids	Embroidery

George Kenning Company grew at a steady pace, as evidenced by the expansion of his initial premises and clientele. In 1870, Kenning added another shop, expanding to No. 2, 3 and 4 Little Britain (Fourth type of ad published in the Freemason, 1870). He also started advertising the wholesale and export of his products for the India and China markets, particularly gold and silver threads, plates and similar (Seventh type of ad published in the Freemason, 1870). By 1871, Kenning had the honour of becoming a contractor to Her Majesty's Government from 1871, a privilege that his closest competitor Tutill's company did not attain. For that he added watches, chains, pins, studs and lockets to his already extensive list of products (Ninth type of ad published in the Freemason, 1871).

Another evidence to suggest a decisive factor in Kenning's commercial success was found in an advertisement of a different periodical of the time, *The Temperance Record*, published by the friendly society The National Temperance League. In there, not only did Kenning's supply for other societies became evident but also the affordable prices his company offered:

> "for good Templar's Regalia, go to the best and cheapest manufacturer, George Kenning" (The Temperance Record advertisement, 1873)

George Kenning's banner prices have not been previously considered in the research of British painted banners, unlike the prices of George Tutill (Gorman, 1973; Moyes, 1974; Edwards, 1997; Clark 2001), and the prices of Bainbridge & Co. of Newcastle (Moyes, 1974), of Toye, Kenning & Spencer (Edwards, 1997), and of Henry Whaite of Manchester (Smethurst, 2000).

George Kenning indicated in his adverts that the price lists of his products, banners included, were initially available on application (Second type of ad published in the Freemason, 1869; Seventeenth type of ad published in the Freemason, 1873). Eventually, such price lists became lengthy catalogues and by 1880 were advertised as containing 260 illustrations (Twentieth type of ad published in the Freemason, 1880). These publications continued into the twentieth century reaching an annual production cost of a thousand pounds (George Kenning and Son. Summer Number [Supplement], 1901), publishing a seventh edition by 1907 (G. S. Kenning, 1907).

On the fourth edition of the *Illustrated Price List of Masonic Clothing and Jewels Manufactured by George Kenning* (Kenning, 1878), George Kenning's price banners were found under the following description:

> "Banners and Flags Painted to Order in the highest style of art, on rich Corded Silk, with Emblematical Designs, for all Societies, on both sides" (Kenning, 1878, p. 96).

The prices were similarly listed in guineas as Tutill's (1guinea = £1,1s or £1.05 in modern money), a custom to quote luxury items and professional services like doctor's or lawyer's fees, which prevailed even after the coin ceased to circulate in 1816 (Flood, 1983). As Tutill's, Kenning's banners were likewise offered by size, indicating a maximum of 12 feet by 10 feet and a minimum of 8 feet by 7 feet, with an extra charge for carrying poles, sockets etc. (Table 2.2). Giving the similarities with Tutill's pricing, it can be assumed that the etcetera would have included similar items as those specified by his competitor in *Fittings and Accessories*:

> "Set of fittings, comprising two stained and varnished carrying poles with ornamental brass spearheads and sockets, silvered cross pole with brass ends and iron links, and a pair of leather straps with brass carrying-cups…" (Tutill, 1895, p. 4).

The banner of *The Glasgow Typographical Society*, approaching the offered dimension of 8 feet by 7 feet, was purchased in 1883 at a price of 16.10 guineas (University of Strathclyde, T-GTS1/1/4) (Figure 2.24), not much more expensive than a similar banner advertised in 1878 (Table 2.2). The implication of this is to do with increasing the knowledge about the pricing of British trade and society painted banners.

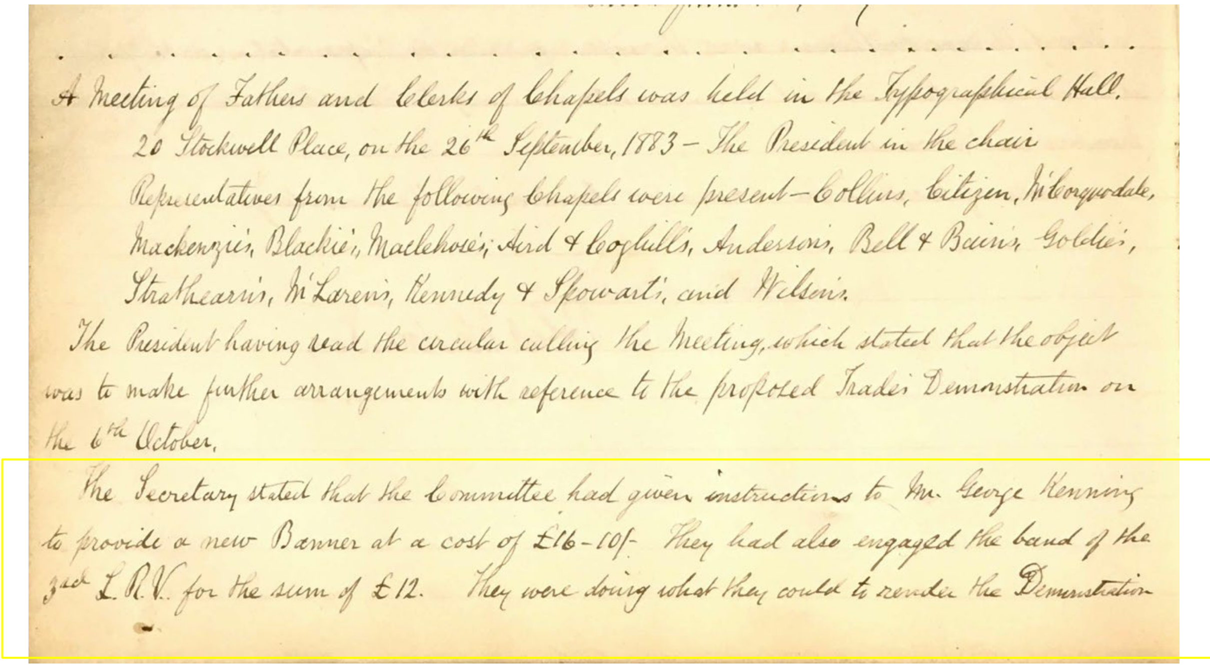

A Meeting of Fathers and Clerks of Chapels was held in the Typographical Hall, 20 Stockwell Place, on the 26th September, 1883 – The President in the chair
Representatives from the following Chapels were present – Collins, Citizen, McCorquodale, Mackenzie's, Blackie's, Maclehose's, Aird & Coghill's, Anderson's, Bell & Bain's, Goldie's, Strathearn's, McLaren's, Kennedy & Stewart's, and Wilson's.
The President having read the circular calling the meeting, which stated that the object was to make further arrangements with reference to the proposed Trades' Demonstration on the 6th October.
The Secretary stated that the Committee had given instructions to Mr George Kenning to provide a new Banner at a cost of £16-10/- They had also engaged the band of the 3rd L.R.V. for the sum of £12. They were doing what they could to render the Demonstration

Figure 2.24 Photograph of minute entry on 26th of September 1883 of the Glasgow Typographical Society, stating the purchase of their banner from Mr George Kenning at a price of £16-10/- Guineas (inscribed in a yellow rectangle for clarity). (Image © D.S.V.).

Table 2.2 Banner price comparison between the companies of George Kenning and George Tutill as published in their catalogues. Prices quoted in guineas. (*) indicates patent woven type.

Dimensions	Kenning (1878)	Tutill (1895)	Tutill (1930)
12 feet by 11 feet	21-0-0	32-0-0	50-0-0 / 53-0-0*
11 feet by 10 feet	18-18-0	29-0-0	42-0-0 / 45-0-0*
10 feet by 9 feet	17-17-0	23-0-0	36-0-0 / 40-0-0*
9 feet by 8 feet	15-15-0	20-0-0	31-0-0 / 35-0-0*
8 feet by 7 feet	13-13-0	18-0-0	27-0-0 / 30-0-0*
7 feet by 6 feet	11-11-0	Not indicated	24
Added cost for carrying poles, sockets and leather straps	2s. 6 d.	2s. 6d.	3-3-0 for 7 feet banners and 6-11-3 for 12 feet banners

To make a real comparison between the published prices of George Tutill and the published prices of George Kenning, added factors like the inflation had to be considered. According to the parameters of the Bank of England (Bank, 2020), between the years of their 1878 and 1895 catalogues, there was a deflation for the cost of goods and services of about 0.6%, meaning that 1895 prices would have been higher in 1878. Such price fall can be attributable, among other aspects, to the continuing strikes building up to the great strike of London Gasworkers' and Dockers' in 1889 (Hatton, et al., 1965; Gorman, 1973; Davis, 2004), which had a repercussion on all kind of manufacture. Consequently, a Tutill banner measuring 12 feet by 11 feet priced at £32-0-0 in 1895 would have cost £35-35-0 in 1878 (Bank, 2020). This supposes that a Kenning banner of similar dimensions would have been offered about 40% cheaper and a smaller banner, measuring 8 feet by 7 feet, nearly 33.5% lower than Tutill's.

Nevertheless, banners were expensive products. Comparing their value with that of a given commodity between the years 1830 and 2016, the relative cost of a £25 banner would nowadays rate around £2,054 for its equivalent price value (Lawrence and Williamson, 2018). Incidentally, the price of a painted banner made by the company of Toye, Kenning & Spencer was reported to have cost the Northumberland Miners Association 'Ellington Branch' a total of £3,000 in 1982 (Edwards, 1997, p. 21).

The expansion of Kenning's company continued with the opening of a third branch in 1873, second outside of London and the first one in Scotland, located in what was then regarded as 'the second city of the Empire', Glasgow (George Kenning and Son. Summer Number [Supplement], 1901). Yet, the manufacture of all his products continued to be carried out exclusively at his Little Britain headquarters.

By 1878, George Kenning added two more addresses to his company, having a total of three locations in London at No. 1-3 Little Britain, No. 198 Fleet Street and No. 175 Aldersgate Street; maintaining his first two provincial branches at No. 2 Monument Place, Liverpool and No. 9 West Howard Street, Glasgow, plus another branch opened in Manchester at No. 47 Bridge Street, becoming his third provincial branch and fourth named branch in total (Seventeenth type of advert published in the Freemason, 1878). The additional London address located at No. 175 Aldersgate Street was an extension of the Little Britain premises, taking over the whole block to expand the initial premises even further. Along with the multiple addresses, another indicator of his growing success as a businessman is evident in the following census of 1881, which indicated a total of 200 hands working for him at that time (Figure 2.25) (Census returns of England and Wales, 1881).

Figure 2.25 George Kenning's Little Britain Street staff in the 1890's (Image © George Kenning and Son. Summer Number [Supplement], 1901).

George Kenning retained his sole company until the end of 1894, as an advert dating 8th of December 1894 still referred to it as 'George Kenning's Masonic Depots' (Twentieth type of ad published in the Freemason, 1894). By that time the company's emporium in Little Britain became even bigger, having acquired No. 1, 2, 3, 3a, 3b and 4, along with No. 195, 196 and 197 Aldersgate Street. Their branch in Fleet Street would be substituted by a new one located at No. 16 and 16a Great Queen Street, West Central London (W.C.) but the other three branches outside London remained unchanged, evidencing the stability of the firm towards the end of the nineteenth century. In the following year's Trades' Directory of the City of London, Kenning's company remained amongst the 'Flag & Banner painters' list, alongside two of his major competitors: George Tutill of No. 83 City Road, E.C., and Turtle & Pearce of No. 18 Duke Street, London Bridge (Trades' Directory London, 1895).

After his death on the Saturday 26th of October 1901 (Death certificate, 1901), George Kenning left a total of £24,987 1s. 11d. worth of effects (Grant of probate, 1902), an amount that approached that of his closest competitor George Tutill, who left a total of £32,284 16s. 4d. worth of effects after his death on the 17th of February 1887 (Reynolds, 2010). Kenning's business was requested to be continued by his son Frank Reginald Kenning (Obituary, 1901), with whom he changed the company's name to George Kenning & Son seven years before his death.

2.4.3.1 Liverpool branch (opened 1870)

The Liverpool branch was Kenning's first establishment outside of London, opened in 1870 at No. 2 Monument Place under the management of the Lancashire Freemason, Joseph Wood (George Kenning and Son. Summer Number [Supplement], 1901). The earliest advert including the branch was published on the 28th of October 1871 (Ninth type of ad published in the Freemason, 1871). The business continued at the same address for the following 27 years, being transferred to No. 23 Williamson Street around 1897 (Figure 2.26). The staff there only dealt with the exhibition, delivery, and request of Kenning's products, as all of them were entirely manufactured at his premises of Little Britain, London. Having a privileged location in proximity to the Post Office, their deliveries coming from London were efficiently dispatched to the many shipping companies sailing out of Liverpool, making it the only recognised Masonic warehouse in the city and awarded a gold medal at the Liverpool Exhibition (George Kenning and Son. Summer Number [Supplement], 1901).

Figure 2.26 George Kenning's Williamson Street branch in Liverpool, c.1900. (Image © George Kenning and Son. Summer Number [Supplement], 1901).

2.4.3.2 Glasgow branch (opened 1873)

On the 1st February 1873, four months after having been awarded a life membership of the Royal Order of Scotland (Obituary, 1901), George Kenning advertised his third provincial branch in the city of Glasgow (Twelfth type of ad published in the Freemason, 1873). The branch was initially placed at No. 19 Sauchiehall Street, but it was only advertised in that address for a period of four months (Last use of the twelfth type of ad in the Freemason, 1873).

According to Kenning's company profile in *The Freemason*, the Glasgow branch started unofficially in 1871 with the appointment of the Freemason Mr George Wheeler, who acted as an agent on behalf of George Kenning's Co. to deal with the requests of his Scottish Masonic clientele (George Kenning and Son. Summer Number [Supplement], 1901). Mr Wheeler was also the superintendent of the Masonic and United Kingdom Assurance Companies at the time and his office at No. 108 Renfield Street was briefly included in the adverts of George Kenning company after the closure of the first Sauchiehall Street shop, for a similar period of four months (Fifteenth type of ad published in the Freemason, 1873). After that time, the company decided to open a more permanent establishment at No. 145 Argyle Street (Sixteenth type of ad published in the Freemason, 1873), added to the Post Office Directory of Glasgow in the subsequent issue (Post Office Directory Glasgow 1874-1875, 1874).

An attempt to open another Scottish branch in the city of Edinburgh was taken on the 27th of September 1873, at No. 67 Hanover Street, but only one advert was found of that shop, which suggests its failure (Sixteenth type of ad published in the Freemason, 1873).

George Kenning's Glasgow branch remained at No. 145 Argyle Street until the first half of 1875 (Post Office Directory Glasgow 1874-1875, 1874; Post Office Directory Glasgow 1875-1876, 1875), when it had to be relocated due to the construction of the new terminal station of the Glasgow and South Western Railway in St. Enoch Square (George Kenning and Son. Summer Number [Supplement], 1901).

Figure 2.27 Inside view of George Kenning's Howard Street branch in Glasgow, c.1900. (Image © George Kenning and Son. Summer Number [Supplement], 1901).

Around the second half of 1875, the branch moved to its longer lasting address, located on the first floor of No. 9 West Howard Street (Figure 2.27). The business was advertised in the local trades' directory as 'gold and silver lace ornament and regalia manufacturer' (Post Office Directory Glasgow 1875-1876, 1875). However, Kenning promoted his new address in *The Freemason* until 1877, to coincide with the release of the 1st issue of its Scottish counterpart *The Scottish Freemason* (First advert of the Scottish Freemason, 1877). This second periodical lasted on circulation until the early 1880's (George Kenning and Son. Summer Number [Supplement], 1901).

Glasgow branch was strategically located beside one of the main arteries of the city and its management was likewise carried out by distinguished Freemasons; initially by Mr W. H. Bickerton, then replaced after his death on the 14th of April 1881 by Mr F. W. Larter, who lasted until the date of writing of the company's profile in *The Freemason* on August 22nd, 1900 (George Kenning and Son. Summer Number [Supplement], 1901).

George Kenning's Glasgow branch was locally described as a "handsomely fitted warehouse showing all the jewelry (sic) and Masonic paraphernalia to be sold, as well as an office" (Company, 1888, p. 147). The business was labelled as 'George Kenning, Goldsmith, Manufacturer of Gold, Silver and Tinsel Ornaments, Masonic

Jeweler, etc.', specifying within the etcetera banners, flags and bannerettes (Company, 1888, p. 147). The company was very highly praised, as the Glasgow publication stated that no other house in the United Kingdom could compare with Kenning's and that his manufactures were unrivalled (Company, 1888, p. 147). Accordingly, the firm was handsomely displayed in the two Glasgow International Exhibitions of 1888 and 1901, receiving a Memorial Diploma for the latter (George Kenning and Son. Summer Number [Supplement], 1901).

Kenning seemed particularly interested in the overseeing of his Glaswegian branch, as he even acquired a house at No. 100 Buccleuch Street in the Garnethill area of Glasgow (Post Office Directory Glasgow 1876-1877, 1876). The property remained in the entry of his business until 1880 (Post Office Directory Glasgow 1880-1881, 1880).

As Kenning's manufactory was entirely based in London (Company, 1888, p. 147; George Kenning and Son. Summer Number [Supplement], 1901), the purpose of his Glasgow branch was to supply their merchandise at London prices, both wholesale and retail, to his clients 'from the border towns of Scotland to the far North' (George Kenning and Son. Summer Number [Supplement], 1901). Their success was the efficient communication with the London headquarters, which allowed the punctual dispatch of their goods by General Post and carriers and continued to do so with the turn of the century (George Kenning and Son. Summer Number [Supplement], 1901).

2.4.3.3 Manchester branch (opened 1878)

Kenning opened another branch of the company in the industrial city of Manchester (Figure 2.28), taking advantage of the growth of Freemasonry and the expansion of the Independent Order of Good Templars to the Midlands and North of England from the 1870's (George Kenning and Son. Summer Number [Supplement], 1901). Due to the abundance of factory work, both trade societies and friendly societies like the Foresters, Oddfellows and various Temperance Societies became very active in enrolling members, demanding an abundant supply of regalia and banners to fit their needs (George Kenning and Son. Summer Number [Supplement], 1901). Thus, a strategic position was acquired at No. 47 Bridge Street, to be managed by Kenning's own specialist in Society, Fancy and Theatrical departments Mr Richard Beckett, with approval and support from the local Freemasons. The branch was first advertised on the 19th of January 1878 (Eighteenth type of ad published in the Freemason, 1878) and like the two other provincial branches it was maintained by his subsequent companies.

Figure 2.28 George Kenning's Bridge Street branch in Manchester, c.1900. (Image © George Kenning and Son. Summer Number [Supplement], 1901).

2.4.3.4 London branch (opened 1894)

Kenning opened another London branch in Fleet Street, just west of Chancery Lane, on the spot where the Temple Bar branch of the Bank of England was to be built (George Kenning and Son. Summer Number [Supplement], 1901).

Figure 2.29 George Kenning's Queen Street branch in London, c.1900. (Image © George Kenning and Son. Summer Number [Supplement], 1901).

The establishment remained in there until the lease ran out c. 1900, being subsequently transferred to No. 16 and 16a Great Queen Street (Figure 2.29), just across the street from the Grand Masonic Lodge of England. Outstandingly, Queen Street branch remained, with further adjustments to the company's name, for a space of 120 years; from its first mention in 1894 (Twentieth type of ad published in the Freemason, 1894), to its definitive closure in 2014 (Pichel, 2017).

2.4.3.5 George Kenning banners and product branding

A total of eight known banners signed by George Kenning company were collated from the National Banner Database, the City of Edinburgh's Banner Collection published by Clark (Clark, 2001), and the research visits at Glasgow Museums Resource Centre and People's History Museum of Manchester (Table 2.3). In addition to the three banners belonging to Glasgow Museums Collection, three other banners of the table were inspected: *The Mersey Quay and Railway Carters Union, The Leith Shipwrights* and *The Leith Lodge of Free Gardeners*. Each of the banners showed a significantly different design, which supported the finding that Kenning's banner designs were bespoke and not standardised as those of Tutill. Nevertheless, some similarities seen suggested a pattern in their manufacture. Besides the example from the Grosvenor Museum that unfortunately was not located, all the listed banners have a blue-dyed textile as their main background colour, sharing as well the type of corded silk offered by Kenning in his catalogues. Another pattern or trend was detected in the colours of their scrollwork: three of the banners shared a similar combination of white and pink with an added colour, whilst the three of Glasgow Museums Collection shared a similar silver and red colour scheme.

Table 2.3 Information on 8 surviving George Kenning banners obtained from the National Banner Database, with added data from live inspections. (*) Not in the survey.

Banner tittle	Accession number	Textile(s) colour(s)	Scrolls colours	Measurements	Location
The Mersey Quay and Railway Carters Union	NMLH.1993.590	Blue with red borders	White, pink, and turquoise, black lettering	340 x 339 cm	Peoples' History Museum
The United Kingdom Society of Coachmakers	NMLH.1993.565	Blue	Red, gold lettering	325 x 382 cm	Peoples' History Museum
The Leith Shipwrights	4558/85	Blue	White, pink, and blue, white lettering	175 x 260 cm	Edinburgh Museums Collection
The Order of Druids	Not indicated	Not indicated	Not indicated	Not indicated	Grosvenor Museum
The Leith Lodge of Free Gardeners	*	Blue	White, pink, and blue, black lettering	248 x 266 cm	Edinburgh Museums Collection
The Glasgow Typographical Society	*	Blue	Silver and red, black lettering	241 x 225 cm	Glasgow Museums Collection
The Glasgow Upholsterers Society	*	Blue	Silver and red, black lettering	262 x 292 cm	Glasgow Museums Collection
The Grain Millers of Glasgow	*	Blue	Silver and red, black lettering	265 x 287 cm	Glasgow Museums Collection

Kenning's Catalogue and other surviving examples of Kenning's manufactures are also evidence of a consistent use of branding in his products (Table 2.4) (Figure 2.30). For the case of his silver manufactures, the initials G.K were inserted into a rectangle followed by the four official hallmarks that were in use until the 30th of April 1890: mark of city of assay, mark of sterling standard of purity, date mark and duty mark (Pickford, 1991). For the case of his banners, all the examples inspected indicate at least his surname and the city in which the company was based, London. Although some variations in the style and information on their signatures were detected, the lack of a company's historical archive made it impossible to trace the reason(s) behind such variations.

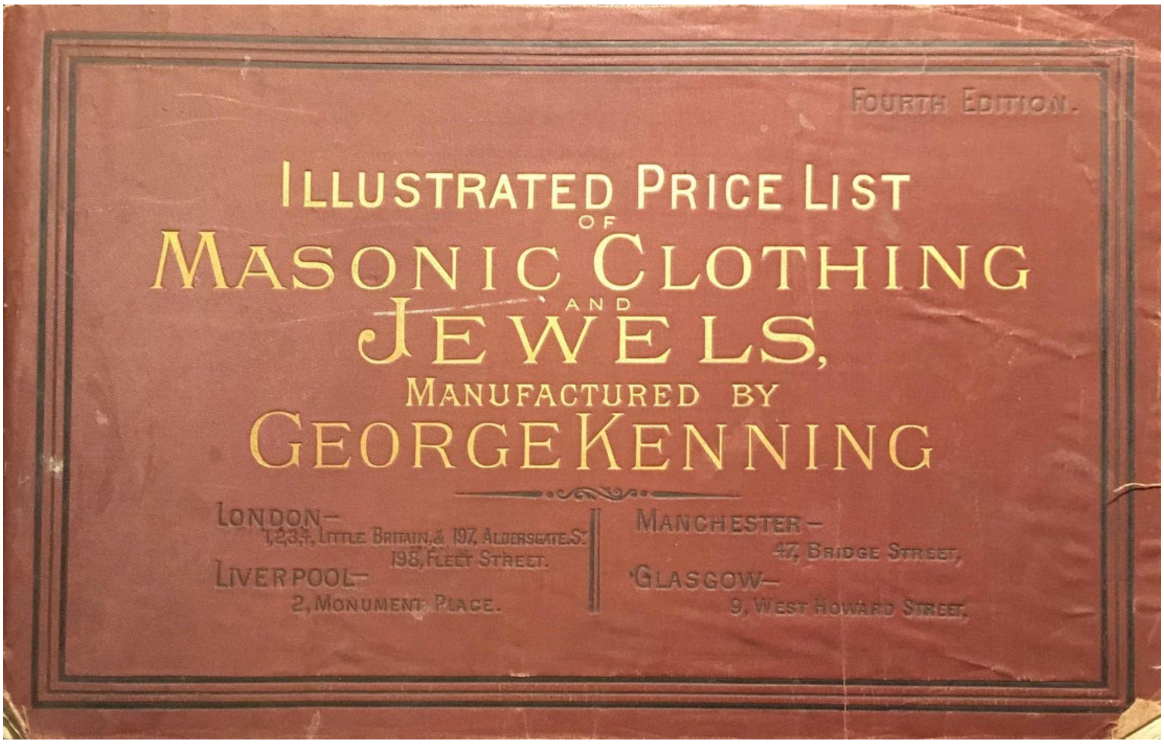
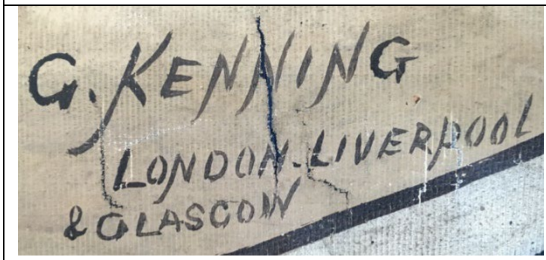


Figure 2.30 Cover of the fourth edition Illustrated Price List of Masonic Clothing and Jewels manufactured by George Kenning, published in 1878. (Image © D.S.V)

Table 2.4 Examples of George Kenning's branding on produces. (Image © D.S.V., unless otherwise stated).

	Detail of medal, back, indicating: G. K George Kenning,  City mark of London,  Sterling standard of purity,  Duty mark of London,  Date letter for 1881. Image © Giorgio Buse.
	Detail of signature on side A of the banner of the Leith Shipwrights, c.1873, City of Edinburgh Collection, indicating: G. Kenning London, Liverpool & Glasgow.
	Detail of signature on side B of the banner of the Leith Lodge of Free Gardeners, c. 1890, City of Edinburgh Collection, indicating: Kenning London.
	Detail of signature on side A of the banner of the Glasgow Typographical Society, 1883, Glasgow Museums Collection, indicating: G. Kenning London. Signed similarly on side B.
	Detail of signature on Side A of the banner of the Glasgow Upholsterers Society, 1884, Glasgow Museums Collection, indicating: G. Kenning London.
	Detail of signature on Side A of the banner of the Grain Millers of Glasgow, 1884, Glasgow Museums Collection, indicating: G. Kenning London.
	Detail of signature on Side B of the banner of the Mersey Quay and Railway Carters Union, c.1889, People's History Museum, indicating: Kenning London.

2.4.4 George Kenning & Son Company (1895-1937)

Towards the second half of 1895, George and his son Frank Reginald Kenning established a joint company by the name of 'George Kenning & Son', mentioned for the first time in an article regarding Masonic regalia on the 13th of July (Mention of Bros. George Kenning and Son's company, 1895). The new company was also included in that year's issue of the Post Office Directory of Glasgow as 'gold and silver lace ornament and regalia manufacturers' (Post Office Directory Glasgow 1895-1896, 1895). Evidence shows that Frank R. Kenning followed his father's footsteps, identified as a brother Freemason in the company profile (George Kenning and Son. Summer Number [Supplement], 1901) and likewise listed as a loriner of profession in the Electoral registers of London (Electoral register, 1898, pp. 62, 119; Electoral register, 1901, pp. 109,211). They would also share the properties of No. 2 and 3 Little Britain, which were registered as a joint tenement agreement from 1898 (Electoral register, 1898) and returned to a single tenement agreement in 1902 with Frank R. Kenning as the new sole proprietor (Electoral Register, 1902).

By the time of writing of the company's profile in *The Freemason* on August 22nd, 1900, the newly renamed firm was said to be manufacturing and dealing with the following products:

> "…every description of article which can be classified under the headings of gold and silver wire work, jewelry (sic), embroidery, military and naval swords, accoutrements, and gold and silver laces in thread or wire, epaulettes, church vestments, vessels and **banners**, corporation robes and regalia, regimental caps, 'colours' and flags, **trade and society banners**, drums, cockades, tassels, ornamental buttons, spangles, sequins and beads, theatrical properties of every description and a host of other similar etceteras" (George Kenning and Son. Summer Number [Supplement], 1901)).[1]

Although banners were advertised by the company since their first add on 13th of March 1869 (First type of ad published in the Freemason, 1869), this is the first mention of trade and society banners as specific manufactured products. It does not mean that the company was not making them before, as the oldest banner

[1] The words banners, and trade and society banners are highlighted in bold for emphasis, but they are not highlighted in the original text.

inspected of the Leith Shipwrights Trade Protection Society appears to have been manufactured circa 1873.[2]

George Kenning & Son company had by the turn of the century an in-house manufacturing facility in Little Britain, composed of six different departments with all their workshops inside the premises (Figure 2.31). The six departments were the Masonic Jewellery Manufacturing Department, the Masonic Clothing Department, the Military and Naval Accoutrement and Embroidery Department, the Gold Embroidery Department, the Theatrical and Fancy Department Manufacturing Room, the Navy-Ribbon Weaving Department and the Banner-painting Department.

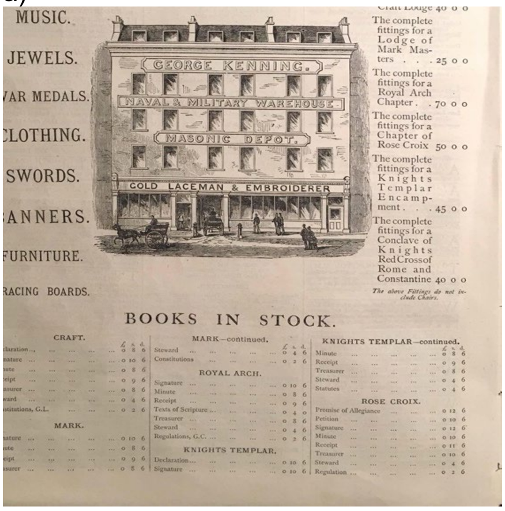
Figure 31 George Kenning & Son's Manufactory and Show Rooms at No. 1, 2, 3a, 3b, 4 Little Britain, London, 1901. (Image © George Kenning and Son. Summer Number [Supplement], 1901).

[2] Although no minutes were found stating the purchase of their banner, the society was established in 1873 (Clark, 2001, p. 140), the same year that Kenning opened his Glasgow branch (George Kenning and Son. Summer Number [Supplement], 1901). Thus, the year in the banner is likely to indicate both dates of establishment, which is supported by the addition of Liverpool and Glasgow to the usual indication of London in the signature, probably as a marketing strategy publicising their two provincial branches and the newly opened Scottish branch.

Along with the departments, there were eleven specialised workshops for stitching clothing, flags and banners; embroidering in gold, silver and silk; embroidering in worsted; furniture making; jewellery making; gilding and plating; engraving and enamelling; fringe making and thread spinning (including the spinning of gold thread on silk); flatting gold and silver wire; making gold and silver tinsel braids; weaving gold lace by power looms; weaving ribbons by power looms; tinsel and spangle dyeing; and purl and button making (George Kenning and Son. Summer Number [Supplement], 1901). Additionally, the firm opened a new embroidery room in 1900 on their recently acquired address of Great Queen Street, meaning that for the first time since 1860, some of the manufacture was to be carried out outside the Little Britain premises.

After the death of his father on the 26th of October 1901 (Obituary, 1901), Frank R. Kenning gave a boost to his recently inherited company, commissioning more striking adverts on *The Freemason* and the company's catalogues, to specially promote his banner-making department for friendly societies and trade unions. Such impulse coincided with the fastest growing rate of trade unionism ever seen, which happened between 1888 and 1918, where the official membership figures rose from 750,000 to six and a half million (Davis, 2004). Example of that commercial impulse is the advert published on the 16th of November 1901 (George Kenning & Son, Manufacturers of Silk Banners advert, 1901), in which the company was headed for the first time as "George Kenning & Son, Manufacturers of Silk Banners (painted and embroidered)" (Figure 2.32).

a)



b)

Figure 2.32 Advert comparison from *The Freemason*: a) George Kenning company, 8th of January 1870, b) George Kenning & Son, 16th of November 1901. (Image ©George Kenning & Son, Manufacturers of Silk Banners advert, 1901)

The same approach extended to the company's catalogues and in the 1915 issue of their *Illustrated Catalogue of Masonic Clothing Jewels Etc.* of George Kenning & Son (G. S. Kenning, 1915b), an extended list indicated the different Masonic and Civic companies or societies the firm would manufacture banners for:

> "George Kenning & Son, Manufacturers and Designers, Banners, Flags and Bannerettes for the following - Masonic (Companies). Foresters, Shepherds, Oddfellows, Old Friends, Loyal United Friends, Comical Fellows, Free Gardeners, Good Templars, Blue Ribbon Army. Civic Companies. Orangemen, Cadets of Temperance, Ivorites, Cardinal League Guards, Phoenix, Rechabites, Mechanics, Buffaloes, Boiler Makers and All Societies."

Another advert emphasised "Trades Unions" amongst all the other organisations, having been printed in bold and with bigger typeface (G. S. Kenning, 1915b, p. 129) (Figure 2.33). Nevertheless, no particular trade union banners catalogue of the company was found, only those related to their Freemasonry merchandise dating 1907 and 1915. Contrarily to his father's catalogue dating 1878, the two subsisting Kenning & Son’s catalogues do not included a general list of banner prices, only for their Masonic bannerettes which are not comparable to the Kenning banners of Glasgow Museums Collection for being significantly smaller and only painted on one of their sides (G. S. Kenning, 1907, 1915a).

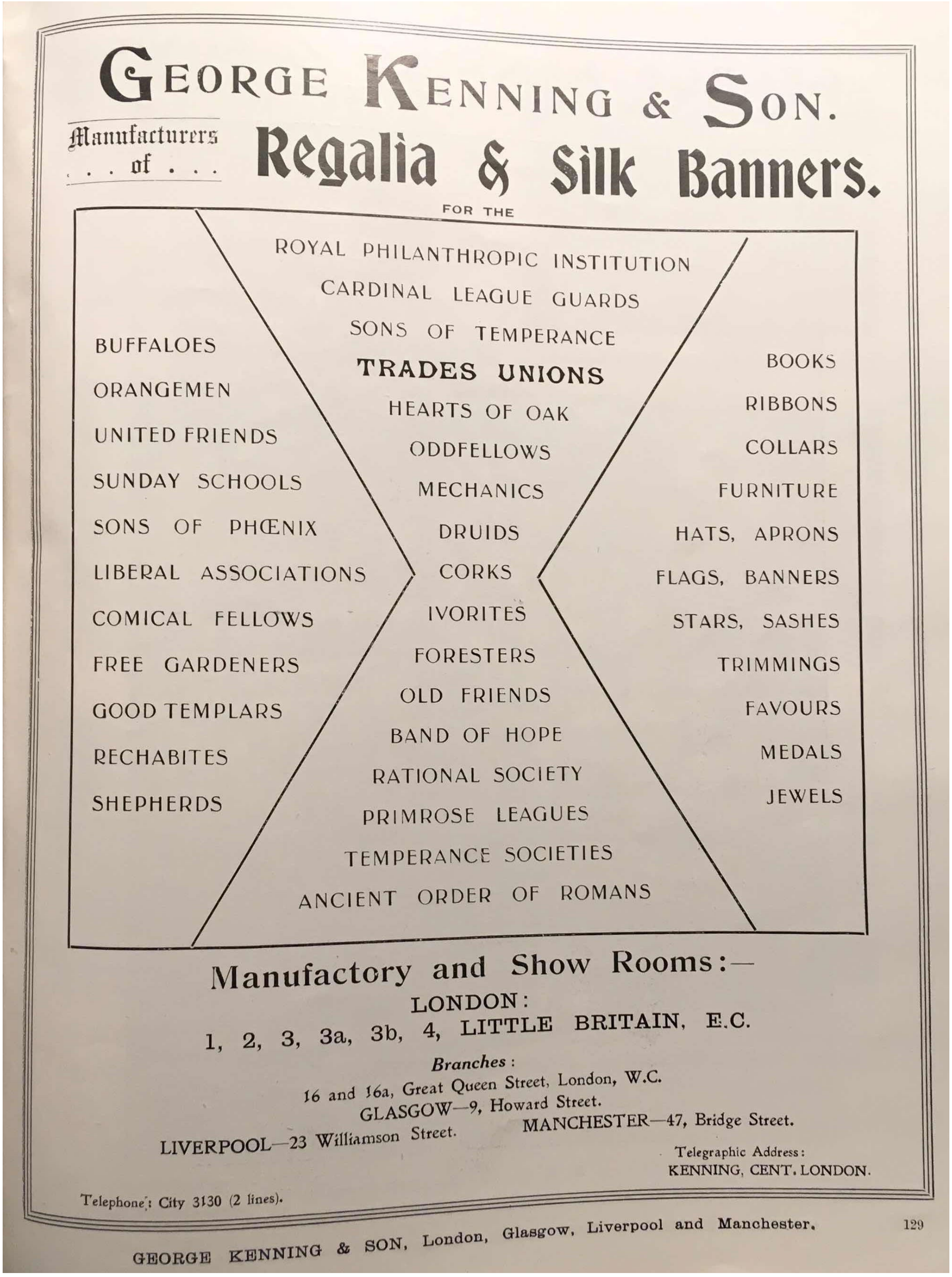
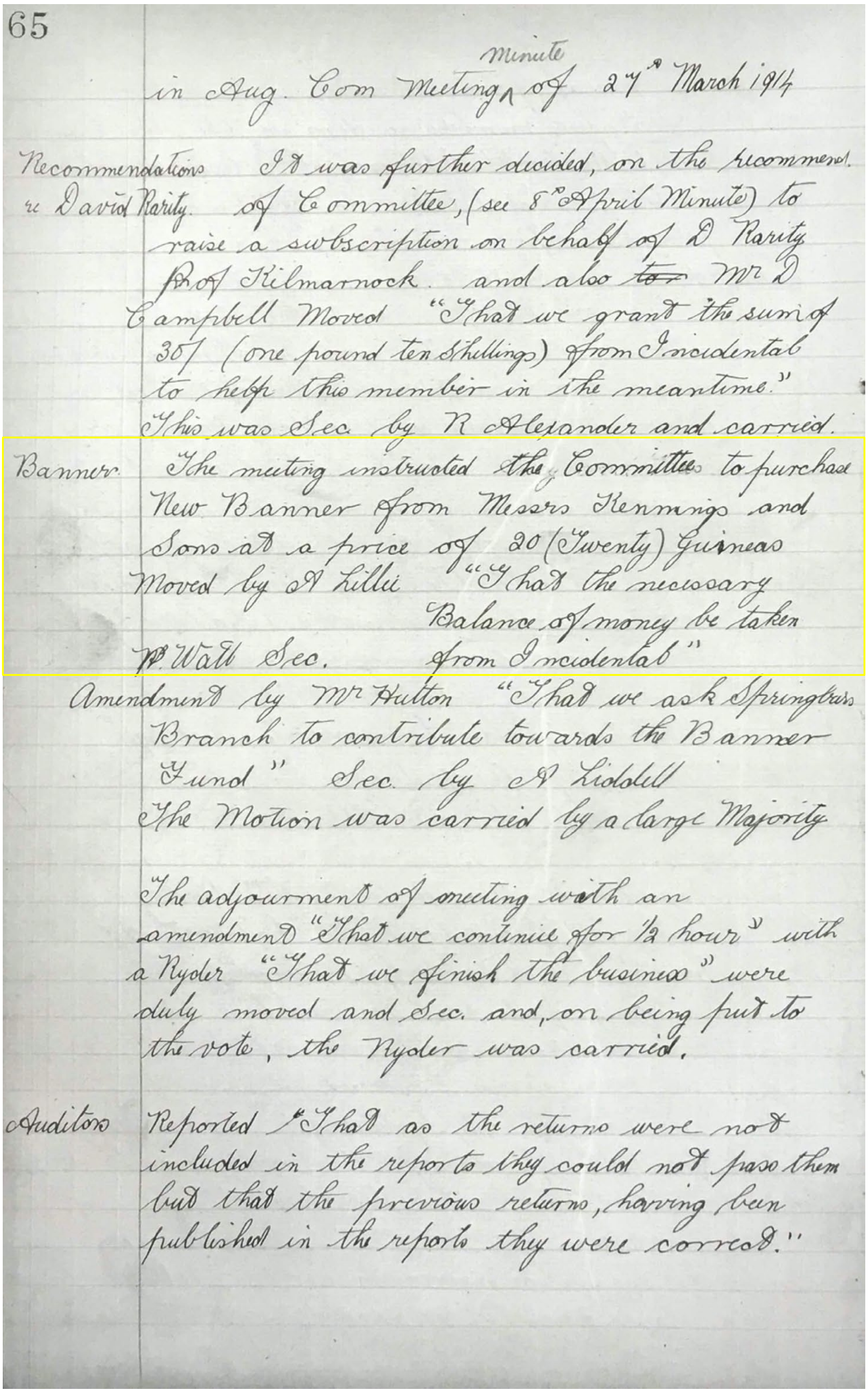


Figure 2.33 Banner advert on the 1915 George Kenning & Son Illustrated Catalogue of Masonic Clothing Jewels Etc. (Image ©G. S. Kenning, 1915b, p. 129).

Kenning & Son's banner adverts in *The Freemason* started including the wording "Designs and Estimates Free", denoting a feature that defined their banners: their bespoke nature ("Silk Banners" advert in *The Freemason*, 1901, p. 597). They would also advertise the possibility of overseeing their production as "The only Masonic House where Customers can see the Painting of Banners being carried out on the Premises" ("Manufacturers of Banners" advert in *The Freemason*, 1907, p. 45), attempting to imitate the offer of their competitor George Tutill "The whole manufacture of Silk Banners can be inspected, from the raw silk to the completely finished article" (Tutill, 1896, p. 2).

Kenning & Son's banners were portrayed in the company profile published in *The Freemason* as "very expensive" (George Kenning and Son. Summer Number [Supplement], 1901). They indicated an estimate cost of £40 to even £60 apiece but the lack of measurements made it impossible to compare with Tutill's prices at the time. Thus, the provenance and archival research yielded another significant finding for the banner of *The National Union of Vehicle Builders, Glasgow Branch* (former *United Kingdom Society of Coachmakers*). Their banner, approaching a dimension of 9 feet by 8 feet, was purchased on the 27th of March 1914 for a price of 20 guineas (Mitchell Library Special Collections, T.U. F331.881847 NAT (Vol 2)) (Figure 2.34). This price would match a similar banner offered at £31 by Tutill's company in 1930 considering the inflation values (Bank, 2020). Kenning's banner was considered so expensive by the *United Kingdom Society of Coachmakers, Glasgow Branch* that not only did they organised a "Banner Fund" with contributions from all their members, but they even had it insured as it was found on a minute entry dating the 29th of September 1914 (Mitchell Library Special Collections, T.U. F331.881847 NAT (Vol 2)).



65

in Aug. Com Meeting minute of 27th March 1914

Recommendations re David Rarity. It was further decided, on the recommend. of Committee, (see 8th April Minute) to raise a subscription on behalf of D Rarity of Kilmarnock. and also ~~to~~ Mr D Campbell Moved "That we grant the sum of 30/ (one pound ten shillings) from Incidental to help this member in the meantime." This was Sec by R Alexander and carried.

Banner. The meeting instructed the Committee to purchase New Banner from Messrs Kennings and Sons at a price of 20 (Twenty) Guineas
Moved by A Lillie "That the necessary Balance of money be taken from Incidental"
W. Watt Sec.

Amendment by Mr Hutton "That we ask Springburn Branch to contribute towards the Banner Fund" Sec. by A Liddell
The Motion was carried by a large Majority

The adjournment of meeting with an amendment "That we continue for ½ hour" with a Ryder "That we finish the business" were duly moved and Sec. and, on being put to the vote, the Ryder was carried.

Auditors Reported "That as the returns were not included in the reports they could not pass them but that the previous returns, having been published in the reports they were correct."

Figure 2.34 Photograph of minute entry on 27th of March 1914 of the United Kingdom Society of Coachmakers, Glasgow Branch, stating the purchase of their banner from Messrs Kenning and Son at a price of 20 Guineas (inscribed in a yellow rectangle for clarity). (Image © D.S.V.)

Further indication of the commercial growth of George Kenning & Son's company, was the opening in 1907 of their fourth and last provincial branch, fifth in total, in the city of Coventry, which was first advertised on the 13th of July ("Established 50 Years" advert in *The Freemason*, 1907, p. 29). Unlike their other branches outside London, this one would not only deal with the distribution of their merchandise but will chiefly carry out the manufacturing of their ribbons, being referred to as "Our Weaving Factory" in their subsequent catalogue (G. S. Kenning, 1915a).

George Kenning & Son's success culminated with the opening of a much larger and purpose-built factory located in the North side of London, which saw the final closing of their initial premises of Little Britain by the end of 1931 (Post Office Directory, 1931). Located at No. 1-4 Eagle Wharf Road, the new setting was specially designed for the manufacturing needs of the company, with two separate buildings that comprised a total area of 30,000 square feet (G. S. Kenning, 1932, p. 2).

As detailed in their correspondingly edited catalogue, the new departments were arranged to allow the continuous flow of the production, from the original design in the studio, to the final packing and dispatching of the products (G. S. Kenning, 1932, p. 1). George Kenning & Son Co. had at that time a total of 400 hands employed in the Eagle Wharf Road factory (Figure 2.35).

Figure 2.35 Outside view of the Eagle Wharf Road factory with staff, London, 1932. (Image © G. S. Kenning, 1932, p. 7).

2.4.4.1 Coventry branch (opened 1907)

The only provincial branch opened during the lifespan of George Kenning & Son company would oversee the manufacture of their ribbon, with a staff of 109 employees (Figure 2.36) (G. S. Kenning, 1915b, p. 140). The factory was settled in West Orchard Street, specialising in “every possible description of ribbon for Masonic and Friendly Societies” as advertised in the local *Commercial Yearbook* (Chamber of Commerce, 1920). It would eventually disappear as a consequence of WWII bombings in 1940, recalled in an interview regarding Coventry’s Silk Weaving industry (Hill, 1972) and confirmed in the company’s brief historical account by its current owner Toye (Toye, Kenning & Spencer, 2022), losing all their records on ribbon manufacture from 1907 onwards.

Figure 2.36 Outside view of the Coventry weaving factory with staff, 1st of July 1915. (Image © G. S. Kenning, 1915b, p. 140).

2.4.4.2 George Kenning & Son banners and product branding

A total of nineteen known banners signed by George Kenning & Son company were collated from the National Banner Database and the research visits at Glasgow Museums Resource Centre and People's History Museum of Manchester (Table 2.5). In addition to the two banners belonging to Glasgow Museums Collection, two other banners of the table were inspected: *The National Union of Railwaymen, Hither Green Branch No. 537* and *Electrical Trades Union.* Like the previous company's banners, these four Kenning & Son examples showed different designs between them, supporting the custom-made nature of all their banner manufactures. However, some similarities seen also suggested a pattern in their production. Eight of the nineteen banners shared a similar coloured scrollwork of red background and gold lettering, including the two banners form Glasgow Museums Collection. The second most common combination in the scrolls was blue background and gold lettering with four cases. This stood out as another resource of the company to copy the banner style of his competitor George Tutill, as those are the two-colour combinations most commonly seen in the examples published by Gorman (Gorman, 1973), Clark (Clark, 2001), Edwards (Edwards, 1997) and Emery (Emery, 1998). Of the remaining scrollwork colours of the banners in Table 2.5, two relate to the combinations previously seen in the George Kenning examples: silver and red, and white and pink with another colour. Only one was considered atypical, the *Electrical Trades Union* banner, but that was expected as the banner copies the design of another banner of the same union designed by Walter Crane (Gorman, 1973, p. 90). Regarding the colour of their textiles, six banners continued having the same blue-dyed textile as background, but two other colours were added to the list: green with six examples, and red with three banners. Only four banners lacked an entry on their colour or a colour image in the database to corroborate. Unlike Kenning's examples, with only one bordered banner (*The Mersey Quay and Railway Carters Union* banner), most George Kenning & Son's banners in Table 2.5, twelve, had contrasting borders. This also replicates the style adopted by Tutill for his banners, as all of his banners in the National Banner Database have contrasting borders.

Table 2.5 Information on 19 surviving George Kenning & Son banners obtained from the National Banner Database, with added data from live inspections. (*) Not in the survey.

Banner tittle	Accession number	Textile(s) colour(s)	Scrolls colours	Measurements	Location
National Union of Railwaymen, Manchester & District Council	NMHL.1990.25.7	Blue with red borders	Blue, gold lettering	268 x 292.1 cm	Peoples' History Museum
National Union of Railwaymen, Acton and Ealing Branch No. 2	NMLH.1993.636	Green with red borders	Red, gold lettering	252 x 307 cm	Peoples' History Museum
National Union of Railwaymen, Bethnal Green Branch No. 503	NMLH.1993.638	Green with red borders	Red, gold lettering	253 x 305 cm	Peoples' History Museum
National Union of Railwaymen, Chalk Farm Branch No. 1076	NMLH.1993.639	Blue with red borders	Red, gold lettering	257 x 287 cm	Peoples' History Museum

Table 2.5 (continued) Information on 19 surviving George Kenning & Son banners obtained from the National Banner Database, with added data from live inspections. (*) Not in the survey.

Banner tittle	Accession number	Textile(s) colour(s)	Scrolls colours	Measurements	Location
National Union of Railwaymen, Clerkenwell Branch No. 1176	NMLH.1993.640	Green with red borders	Red, gold lettering	258 x 288 cm	Peoples' History Museum
National Union of Railwaymen, Hither Green Branch No. 537	NMLH.1993.642	Green with red borders	Red, gold lettering	262 x 308 cm	Peoples' History Museum
National Union of Railwaymen, Paddington No. 2, Branch No. 1226	NMLH.1993.647	Green with red borders	Red, gold lettering	230 x 265 cm	Peoples' History Museum
London & Provincial Union of Licensed Vehicle Workers	NMLH.1993.709	Red with blue borders	Blue, gold lettering	235 x 301 cm	Peoples' History Museum
National Union of General and Municipal Workers, Lancashire District	NMLH.1993.720	Red with red borders	Blue, gold lettering	228 x 182 cm	Peoples' History Museum
Electrical Trades Union	NMLH.1998.26.5	Green with red borders	White, orange, and yellow, black lettering	285 x 298 cm	Peoples' History Museum
NMG Merseyside	1972.135.2	Not indicated	Not indicated	Not indicated	Museum of Liverpool Life
Caledonian Order of United Oddfellows, Motherwell Thistle Lodge No. 31	1992/248/2	Blue	Silver and red, black lettering	300 x 230 cm	North Lanarkshire Council
Loyal Order of Ancient Shepherds, Motherwell Lodge 1834	1992/248/1	Blue with red borders	White, pink, and blue, black lettering	270 x 310 cm	North Lanarkshire Council

Table 2.5 (continued) Information on 19 surviving George Kenning & Son banners obtained from the National Banner Database, with added data from live inspections. (*) Not in the survey.					
Banner tittle	Accession number	Textile(s) colour(s)	Scrolls colours	Measurements	Location
NBWTMU Temperance Movement, County of Durham	Not indicated	Not indicated	Not indicated	Not indicated	Beamish Museum
St George's Sunday School (1)	Not indicated	Not indicated	Not indicated	Not indicated	Tameside Museum
St George's Sunday School (2)	Not indicated	Not indicated	Not indicated	Not indicated	Tameside Museum
Pendleton Co-Operative Society, Broughton Branch	*	Red with dark blue borders	Blue, gold lettering	Not indicated	Peoples' History Museum
The National Union of Vehicle Workers, Glasgow Branch	*	Blue	Red, gold lettering	271 x 261 cm	Glasgow Museums Collection
The Scottish Tin Plate Braziers and Sheet Metal Workers' Society	*	Blue	Red, gold lettering	240 x 266 cm	Glasgow Museums Collection

Another sign of the apparent copy of Tutill's banner style would be the adoption of similarly designed brass banner tags (Figure 2.37 and Table 2.6). These corner elements seem to have been added after WWI, as they were not included in the banner of the N.U.V.B. Glasgow Branch (former United Kingdom Society of Coachmakers Glasgow Branch) dated 1914 but are seen in the other two Kenning & Son's banners inspected dating c.1916: *The National Union of Railwaymen Hither Green Branch No. 537* and *Electrical Trades Union* banners of People's History Museum Collection. The banner of *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* banner of Glasgow Museums Collection, although not clearly dated due to the insufficient historical evidence (see section 2.2.5), could therefore have been made c.1916. Another characteristic of the banners holding the brass tags is that they all were manufactured on a single piece of silk textiles, not multiple strips, which supports the idea of an addition after 1914, the last year where multiple strips were documented on a George Kenning & Son banner.

a)


b)

Figure 2.37 Comparison of Tutill's and Kenning & Son's banner tags as published by Gorman (Image © Gorman, 1973, p. 63). Gorman dated Tutill's after 1861 and Kenning & Son's about 1880s but Kenning & Son's Coventry branch opened until 1907. Evidence shows that Kenning & Son's tags could have been added from 1916 onwards.

The surviving catalogues and other examples of Kenning & Son's manufactures also evidence the use of branding in all their merchandise (Figure 2.38). For the case of their silver products, the initials GK&S were inserted into a rectangle followed by the three official hallmarks that were in use after the 30th of April 1890: mark of city of assay, mark of sterling standard of purity and date mark (Buse, 2020). For the case of his banners, the signature clearly indicated G. Kenning & Son to differentiate them from the previous company's branding, along with the City of London (Table 2.6).

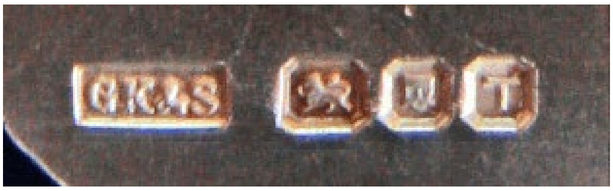
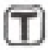
<table>
<tr><th colspan="2">Table 2.6 Examples of George Kenning & Son's branding on produces. (Image © D.S.V., unless otherwise stated).</th></tr>
<tr><td>
</td><td>Detail of medal, back, indicating: GK&S George Kenning & Son (the mark was retained for George Kenning & Son Ltd),  Sterling standard of purity ,  City mark of London,  Date letter for 1954. Image © Irish Masonic History and Jewels 2014.</td></tr>
<tr><td>
</td><td>Brass banner tag (front and back) from the banner of the Scottish Tin Plate Braziers and Sheet metal Workers Society, c.1916, Glasgow Museums Collection, indicating: George Kenning & Son London Manchester Glasgow & Coventry/George Kenning & Son Manufacturers.</td></tr>
<tr><td>
</td><td>Brass banner tag (front and back) from the banner of the National Union of Railwaymen, Hither Green Branch No. 537, c.1917, People's History Museum Collection, indicating: George Kenning & Son London Manchester Glasgow & Coventry/George Kenning & Son Manufacturers.</td></tr>
<tr><td>
</td><td>Brass banner tag (front and back) from the banner of the Electrical Trades Union, c.1916, People's History Museum, indicating: George Kenning & Son London Manchester Glasgow & Coventry/George Kenning & Son Manufacturers.</td></tr>
<tr><td>
</td><td>Detail of signature on side A of the banner of the N. U. V. B., Glasgow Branch (former United Kingdom Society of Coachmakers), 1914, Glasgow Museums Collection, indicating: G. Kenning & Son London E. C. (Eastern Central). Signed similarly on side B.</td></tr>
<tr><td>
</td><td>Detail of signature on side A of the banner of the Scottish Tin Plate Braziers and Sheet metal Workers Society, c.1916, Glasgow Museums Collection, indicating: G. Kenning & Son London. Signed similarly on side B.</td></tr>
</table>

Table 2.6 (continued) Examples of George Kenning & Son's branding on produces.	
	Detail of signature on side A of the banner of the National Union of Railwaymen, Hither Green Branch No. 537, c.1917, People's History Museum, indicating: G. Kenning & Son.
	Detail of signature on side A of the banner of the Electrical Trades Union, c.1916, People's History Museum, indicating: G. Kenning & Son London E. C. (Eastern Central). Signed similarly on side B.

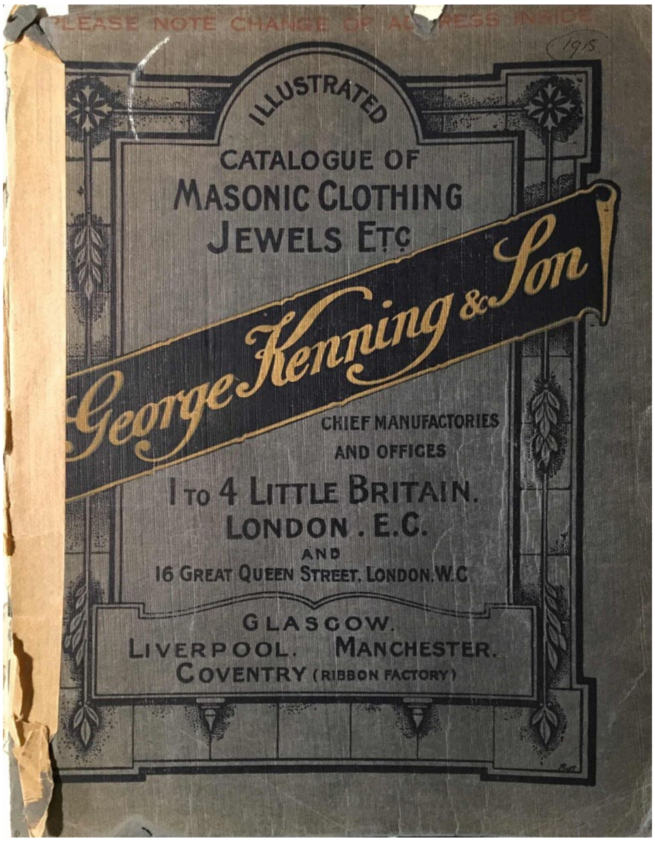


Figure 2.38 Cover of the Illustrated Catalogue of Masonic Clothing Jewels Etc. (Image © George Kenning & Son, published in 1915).

2.4.5 George Kenning & Son Limited Company (1937-1955)

George Kenning & Son's firm had a slight change by the year of 1937, when it was decided to turn into a private limited company by the name of 'George Kenning & Son Ltd.' (Post Office Directory Glasgow 1937-1938, 1937). This meant that the owner became legally responsible for the debts of the company, only to the extent of the amount of invested capital.

2.4.5.1 George Kenning & Son Ltd product branding

The evidence found on the company shows that George Kenning & Son Ltd did not change their silver marks as presented on Table 2.4. However, the company went through another rebranding having just changed their image on the 1932 edition of their catalogue (Figure 2.39), using a different style of lettering than any of the previous companies (Figure 2.40).

Figure 2.39 Cover of the catalogue of George Kenning & Son, Masonic outfitters, Goldsmiths, Goldlacemen and Embroiderers, published in 1932. (Image © D.S.V.)

Figure 2.40 Set of Masonic items and case with the branding of George Kenning & Son Ltd. Manufacturing Outfitters. Image from Whittaker and Biggs Auctioneers. (Image © https://auctions.whittakerandbiggs.co.uk/catalogue/9CC3EE5DAACE1BD065707E245330C060/1000000001/general-auction-including-antiques-collectables-online-o/)

2.4.6 George Kenning & Spencer Ltd Company (1955-1962)

George Kenning & Son Ltd Company continued as such for another 18 years, after which it joined the well-established regalia manufacturing company of Spencer & Co., changing the company's name to 'George Kenning & Spencer Ltd" (Post Office Directory Glasgow 1955-1956, 1955). As stated in the most recent entry on the current company's website (George Kenning & Son, 2022), George Kenning & Son decided to acquire Spencer & Co. during 1947, considered as the original manufacturer of Masonic clothing, whom in turn had previously bought their metal manufacturer company's W.J. Dingley of Birmingham. However, the new company name Kenning & Spencer Ltd was included in the Post Office Directory of Glasgow until 1955 (Post Office Directory Glasgow 1955-1956, 1955). The company George Kenning & Spencer would then be acquired by Toye & Co. during 1956/57, but did not become Toye, Kenning & Spencer until 1962 (George Kenning & Son, 2022).

2.4.6.1 George Kenning & Spencer Ltd product branding

Due to the merging of practically three companies, Kenning & Son Ltd, Spencer and Dingley, locating specific branding of the newly formed George Kenning & Spencer Ltd was not prolific. However, a new edition of their Masonic Illustrated Price-List shows yet a different style as that of the previous George Kenning & Son Ltd edition (Figure 2.41).

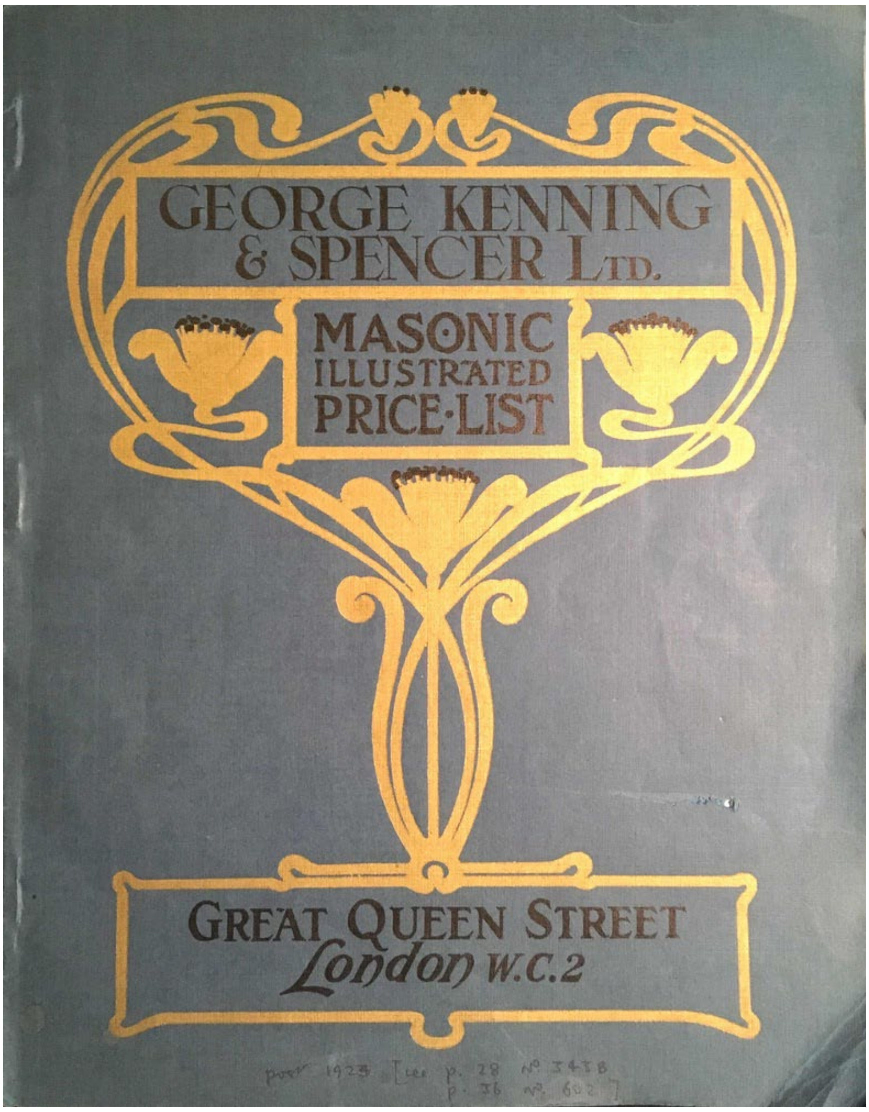


Figure 2.41 Cover of George Kenning & Spencer Ltd. Masonic Illustrated Price-List, published year unknown. (Image © D.S.V.)

2.4.7 Toye, Kenning & Spencer Ltd Company (1962-)

Within a space of 7 years, the newly formed company of Kenning & Spencer Ltd was acquired by a bigger and older competitor, the Huguenot firm of 'The House of Toye' established in 1685 (Toye, 2017), adopting in 1962 the name that still subsists to date: Toye, Kenning & Spencer Ltd (Post Office Directory Glasgow 1962-1963, 1962). The firm would continue offering banners for Masonic institutions by 1968, finally stopping their production after 1983 (Freemasonry, Regalia Catalogue). They would also retain the royal warrant once held by George Kenning's company. It seems that in an attempt to acknowledge the achievements of George Kenning and his company of George Kenning & Son, in 2022 the company of Toye, Kenning & Spencer Ltd branched out their regalia department under the name of George Kenning & Son Manufacturing Outfitters (George Kenning & Son, 2022). In the "About us" section, they included a brief historical account on Kenning's companies written by the current owner of Toye Group of Companies, Bryan Toye.

2.4.7.1 Toye, Kenning & Spencer Ltd product branding

The merged company of Toye, Kenning & Spencer Ltd portents two of their most important achievements on their product branding: the starting year of the House of Toye in 1685 and the Royal warrant once owned by George Kenning company (Figure 2.42). Interestingly, they decided to separate their jewellery and ceremonial works of art, which are still offered by the brand of the joined company, from their Masonic and friendly society regalia, which is now offered by their new brand George Kenning & Son Manufacturing Outfitters (Figure 2.43). In doing that, they recovered the style and typography of the fifth company under the name of Kenning (see section 2.3.5). This shows a revalorisation for the company on the 162nd year since its founding.

Figure 2.42 Screenshot of Toye, Kenning & Spencer's home website, visited on 31st May 2022, http://toye.com. (Image © Toye, Kenning & Spencer Ltd.)

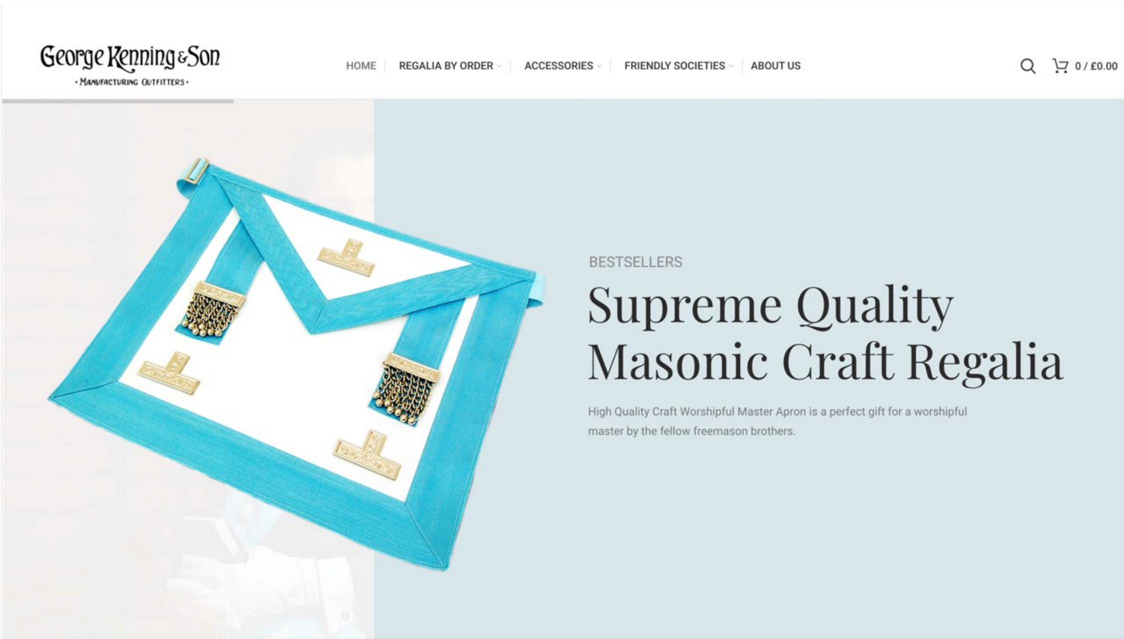


Figure 2.43 Screenshot of George Kenning & Son Manufacturing Outfitters' home website, visited on the 31st of May 2022, http://gkmasonic.com. (Image © Toye, Kenning & Spencer Ltd.)

The five Kenning banners of Glasgow Museums Collection were manufactured at different stages of the company's development. They attest the complex history of the firm and details the changes and expansions the company had over its lengthy existence. Given the evidence shown in this section, the manufacturers of the five banners will be addressed as two different companies in the following chapters of the thesis, George Kenning (1865-1895), and George Kenning & Son (1895-1937).

3 Literature Review on the Manufacture of double-sided painted silk banners

3.1 Introduction

For comprehending the manufacturing techniques used by the companies of George Kenning and George Kenning & Son to produce the five Kenning banners of Glasgow Museums Collection, a review of the available literature on the making of painted silk banners was conducted. This had the aim of achieving a better understanding of the making of this type of cultural heritage objects and to situate their production within a wider art historical context.

The previous research on painted banners has mostly referred to a single art historical source for setting the origin of the tradition, *Il Libro dell'arte (The Book of Art)* by Cennino Cennini (c.1390). Possibly one of the earliest indications was given in 1983 by Eastop in a Conservation Report of the former Textile Conservation Centre, stating that the technique identified in British trade union banners derived from Cennini (TCC-0600, Archives and Special Collections University of Glasgow). Although the connection proves to be correct, other important art technological sources usually considered for the study of European paintings have been overlooked. This is partly caused by the practical and conceptual separation between textile and painting conservation, formerly acknowledged by Lochhead (Lochhead, 1995, p. 96) and Pollack (Pollack, 2003, pp.127-129), which tends not to recognise a painted banner as a painting but as a painted textile (Thompson, Smith and Lennard 2017, p. 64). Whilst that distinction is true in terms of their conservation requirements, treatment, and use, it seems to be much more alike in terms of their materiality and as such was interpreted in this chapter.

The historical contextualisation of the manufacture of double-sided painted silk banners is presented in this chapter in two sections. Section 3.2 discusses the historical sources related to the specialty production of this type of painted textiles in the Western world, while section 3.3 focusses on the British counterparts. To complement the discussion and set the basis for the experimental chapters to follow, a review of the material characterisation of nineteenth and twentieth centuries British double-sided painted silk banners is presented in section 3.4.

3.2 Historical sources on the manufacture of double-sided painted silk banners in Europe and North America

The production of painted banners and flags on silk textiles is part of the tradition of technical developments of Western culture. Their origin has been suggested to be linked to the upsurge of heraldry in the twelfth century (Eve, 1908, p. 392; Jones, 2010, pp. 54-55), being the preferred vehicle for the heraldic display of civic and royal pageantry up to the sixteenth century (Coldstream, 2013, pp. 11-15; Eve, 1908, p. 394). Methods for the application of paint and gilding onto a textile support can be traced back at least as early as the twelfth century in the anonymous *Mappae Clavicula* (Smith and Hawthorne, 1974, pp. 43-44), as part of a series of recipes intended for the decorative arts (Smith and Hawthorne, 1974, p. 18). Specific methods for painting and gilding on silk textiles are included in three other European manuals on the craft of the painter, the Montpellier *Liber Diversarum arcium* (c. 1300), *The Strasbourg Manuscript* (c. 1400-1570) and a compilation of treatises from the twelfth to the eighteenth centuries by Merrifield (Clarke, 2011, pp. 152, 222; Merrifield, 1849, p. 156; Neven, 2016, pp. 131, 133). These instructions are not about producing easel paintings, but rather for decorating cloths (textiles) at a lower cost than embroidery or tapestry, as suggested by Smith and Hawthorne and Mander (Mander, 1997, pp. 119, 135; C. S. Smith and Hawthorne, 1974, p. 18). For the English context, most of the mediaeval examples of decorated silk textiles are ecclesiastical, notwithstanding the secular work that has not survived (Walton, 1991, pp. 344-345). Examples of decorated textiles bearing designs of animals or birds, as specified in the Montpellier *Liber* and the manuscript of Le Begue/Audemar (Clarke, 2011, p. 152; Merrifield, 1849, p. 156), have been reported by Henshall for the silk ribbons attaching the seals of medieval charters belonging to Durham Cathedral and the Countess of Erroll (Henshall, 1964, pp. 154-162).

Banners, along with other types of painted textiles, differ from traditional Western painting techniques on canvas in that they are not permanently fixed to a stretcher and maintain the ability to drape (Thompson et al. 2017). Alas, they also differ from other non-Western paintings on textiles like Tibetan thangkas (Elgar 2006) and traditional Chinese (Liang and Hong-Zhe Liu 2010) and Japanese paintings (Gettens, 1976, p. 241-250) in that they are not made with water-soluble paints.

Precise instructions to produce painted silk banners are described in the Italian treatise *Il Libro dell'arte (The Book of Art)* by Cennino Cennini (c.1390), the Flemish manuscript by De Mayerne (1646), the Spanish treatises of *El Arte de la Pintura (The Art of Painting)* by Francisco Pacheco (1649) and *El Museo Pictórico y Escala Óptica* (*The Pictorial Museum and Optical Scale)* by Antonio Palomino y Velasco (1714). Later, a number of American technical manuals instruct the painting of silk banners for sign painting: *Haney's Manual of Sign, Carriage and Decorative Painting* by S. Gibson (1870), *The Sign Painter's Guide* by James t. Gardiner (1871), *The Universal Assistant* by R. Moore (1880) and *The Expert Sign Painter* by Ashmun Kelly (1911). These sources are the basis for understanding the production of painted silk banners in general and the five Kenning banners of Glasgow Museums Collection in particular. It will be shown that banners indeed are part of a practical tradition of painting, adapting the technique to produce a particular type of object with specific technical requirements.

3.2.1 Italian context fourteenth century

The earliest known and published source describing the specific manufacture of double-sided painted silk banners is included in *Il Libro dell'Arte* (c.1390) by Cennino Cennini, as part of a series of instructions for painting on different types of textiles made of silk but also linen, velvet and wool (D. Thompson, 1988, pp. 183-186).[3] The first step of Cennini's method for the painting of double-sided silk banners was the taut stretching of the silk textile onto a strainer, instructed to be done in the same way as for the other types of paintings on cloth (D. Thompson, 1988, pp. 183-186). The silk textile is said to be firstly nailed to the strainer down the lines of the seams, going around with tacks in an even and

[3] The most up-to-date edition of Cennino's treatise is that of Lara Broecke (2015: Archetype), which unfortunately was not available during the writing of this chapter due to COVID restrictions. It was revised afterwards but not substituted for not changing the narrative significantly. However, it is still included in the bibliography.

systematic manner, so that every thread was perfectly arranged (D. Thompson, 1988, p. 183).

The second step for painting double-sided silk banners was related to one of the characteristics that defined them as a particular type, the partial application of their paint layers (K. Thompson et al., 2017, p. 69). Villers recognised such characteristics while discussing Cennini's method for works that were likely to be loosely draped and identical on both sides, stating that in some cases, the fabric would remain visible in the unpainted areas (Villers, 2000, p. 6).

To achieve this partial or better-said selective application of paint, the design would be drawn on the stretched silk textile as an outline on each of its sides (D. Thompson, 1988, p. 185). Depending on the colour of the silk textile, this could be done with a black or white crayon and to ensure the correspondence of the design, Cennini suggested the use of transmitted light (D. Thompson, 1988, p. 185). The outline would be drawn first on one side of the stretched silk textile, to then be traced against the sun, a window or a candle, drawing the line on the other side. Although Villers interpreted the use of light as a way of speeding the production of banners by working both day and night (Villers, 2000, p. 7), it is clear that Cennini's instruction had the practical purpose of facilitating the tracing of the design correspondingly on both sides.

The third step of the method was the selective application of a size layer, which was prepared by mixing one egg white with four goblets or glasses of diluted parchment glue (D. Thompson, 1988, p. 185). This size would only be applied to the areas that were to be painted, not fully as otherwise instructed for paintings entirely covered in paint (D. Thompson, 1988, p. 183). Still, Cennini stressed the fact that every painting on cloth, regardless of its type of textile, had to be flexible enough to be rolled up, hung or transported without the "hurting"[4] of the applied layers of paint and gold (D. Thompson, 1988, p. 183). The need to transport painted cloths and banners, has been discussed with reference to the fourteenth and fifteenth centuries by Eve (Eve, 1908, pp. 392-398), Thompson (D. V. Thompson and Berenson, 1956, pp. 37-38), Mander (Mander, 1997, pp. 119-148), Villers (Villers, 2000, pp. 1-10) and Bury (Bury, 2000, pp. 19-30). They

[4] In this context, the term hurting can be interpreted as either cracking or delamination.

agree that the lightness and flexibility of the paintings, as opposed to those on wooden supports, were part of the development in their production for religious and civic displays over the fifteenth and early sixteenth centuries.

The functionality of banners and particularly the double-sided silk banners was also another characteristic that defined them as a specific category of paintings, as they were specifically designed to be held aloft during processions (Broecke, 2015, p. 216; Rogerson and Lennard, 2005, p. 12).

Cennini's method continued with the application of a ground layer, intended for the specific laying of gold leaf (D. Thompson, 1988, p. 185). This ground was prepared by mixing *gesso sottile*, a little Armenian bole, a little sugar and a small amount of lead white, all bound in the same mixture of parchment glue and egg used for the sizing (D. Thompson, 1988, p. 185). Cennini instructed the laying of the gold leaf in the same way as for its application on panel paintings, adding five thin layers of Armenian bole bound in diluted egg white, over which the gold leaf would be adhered (D. Thompson, 1988, pp. 166-167). The use of egg white for adhering gold also predates Cennini, having been included in the Northern European manual by Theophilus *On Divers Ars (On Diverse Arts)* (c.1120) (Theophilus, Hawthorne, and Smith, 1979, p. 31). The gold laid in such manner was ready for being stamped, punched and burnished over a smooth surface, just as it would on a panel painting (D. Thompson, 1988, p. 185). On this point, an advice is given in *De Coloribus Diversis Modis Tractatur in Sequentibus (A Treatise upon Colours of Various Kinds)* (c.1410) which calls for caution when gilding on linen and silk fabrics, as the excessive pressure usually applied when gilding on wood, would produce the breaking or crumbling of the gold and paint layers (Merrifield, 1849, p. 264). Although not specified in the instructions, it can be assumed that the same kind of work was likely to be done on the other side of the banner after its completion.

Cennini's instructions for double-sided silk banners carried on with the actual application of paint. Here an important differences with the other types of paintings is included in his text, advising that the pigments should be bound in egg yolk instead of egg white or animal glue (D. Thompson, 1988, pp. 183-186). This type of egg yolk tempera was considered by Cennini much better (and durable) than the types mixed with egg white or animal glue, describing it as a universal paint media suitable for wall, panels and iron (D. Thompson, 1988, p. 102), making it more resistant to the outside elements. Manual also instructed that paint should be applied in many more layers than when painting panels, of up to ten coats, given the lack of “body” of silk textiles in comparison to wood (D. Thompson, 1988, p. 184).

The penultimate step on Cennini’s method was the further decoration of the painted sections with mordant[5] or oil gilding (Thompson, 1988, p. 185). The technique of mordant gilding also predates the time of Cennini and it is instructed in sources including the *Mappae Clavicula*, where gold-size is prepared with a mixture of cooked linseed oil, pine resin, gum and saffron (Smith and Hawthorne, 1974, pp. 43-44). Cennini’s recipe, which also contained cooked (linseed) oil, had the addition of lead white and verdigris with a little varnish (Thompson, 1988, pp. 178-179).

The final step in the method for double-sided painted silk banners was correspondingly related to their characteristic of being paraded outdoors. Cennini instructed that the painted parts of the banner would have to be varnished at the end, not advised for the other types of paintings on cloth (Thompson, 1988, p. 185). His concern was to protect the banners from the rain, which would be achievable with an oil-resin varnish like those used at his time (Villers, 2000, p. 7).

Unfortunately, no Italian fourteenth century banners survive which are painted with Cennini’s technique for double-sided painted silks (Villers, 2000, p. 7). That is not the case for banners and other paintings on linen, which have been particularly researched from the fourteenth to the fifteenth centuries (Aldrovandi, Ciatti, and Rossi Scarzanella, 2000, pp. 11-18; Bury, 2000, pp. 19-30; Kleiner, 2013, pp. 69-76; Villers, 1995, pp. 338-358; 2000, pp. 1-10; Westerman Bulgarella and Conti, 2003, pp. 135-142). One reason for this disparity could be related to the chemical composition of silk (fibroin), which makes it more prone to degradation by heat, acids and photo-oxidation than

[5] According to a practical gilding manual, “under the name ‘mordants’ are included all vehicles or media used as an adhesive coat, for attaching the metals firmly to the surface of treatment, whether in the nature of a water size, oil gold size, japanners’ gold size, varnish or spirit preparation” (Scott-Mitchell, 1905, p. 53).

linen (cellulose), as well as being considered the most sensitive of natural fibres to electromagnetic radiation (Timár-Balázsy and Eastop, 1998, pp. 31-48; 2011). This can be particularly harmful for unpainted areas of silk banners, as the painted sections are more protected from these environmental factors. In addition to that, the constant use and particularly the increased shear stress happening at the interface of paint and silk greatly contributes to their deterioration, as it has been explained for the mechanical damage of traditional easel paintings (de Willigen, 1999).

Another category of paintings considered by Cennini and referred to as *cortine* (hangings) has been researched for its equivalents in Northern European called *tüchleins* (Heydenreich, 2007; Wolfthal, 1989) and English stained cloths and theatre scenery (Mander, 2013, pp. 24-32; K. Thompson and Lennard, 2013, pp. 108-115; Young, 2013, pp. 99-107). Mander related their manufacturing technique with the art of staining, following a process in which the linen textile remained fully wet throughout the application of paint often referred to as water-work (Mander, 1997, pp. 137-138). The same technique was described by Le Begue/Alcherius (Merrifield, 1849, p. 6) and later on by Francisco Pacheco using the term *aguazo* that can be translated as watery. However, having also been painted on linen and entirely covered in paint of a glue-size distemper technique (Mander, 1997, p. 138), they differ in materials and method of application with the particular technique of double-sided silk banners.

The differences in materials and method of application between the linen banners, hangings, stained cloths and the double-sided silk banners makes them difficult to compare. Their techniques seem to have been conceived with a different practical purpose: the partial or selective application of paint on both sides, in contrast to the entire application of paint on one or both sides of the textile.

3.2.2 Flemish context seventeenth century

Another source that briefly deals with the specialty of painting on silk is the seventeenth century manuscript by Sir Theodore de Mayerne (1646). Although his guidance is not as systematic as other art technological sources, the basics of silk banner painting are considered in two of his notes, namely numbers 30 and

214. In his note 30 for making textiles watertight, including the types of silk textiles taffeta, grosgrain, drill and serge, the author mentioned the painters of flags and emblems (banners) as a different specialised genre (Fels, 2001, p. 155). In doing so, he stressed their need for a more supple preparation to avoid the "pulling of the colours applied with oil paint", reporting a sizing with fish glue and a little honey that produced "softer" fabrics that "in no way crack and do not hold wrinkles".

Further on, in his note 214, De Mayerne summarised the methods for sizing paintings on textiles, wood and cardboard, including a specific mention for painting on taffeta, silk, woollen fabric or cloths of silk. Having previously considered the specialty of flag and banner maker and listed the same supports as Cennini for the making of flags and emblems (banners), his brief method can also be interpreted as intended for the painting of silk banners. He too explained the stretching of the textile for the selective sizing of the areas to be painted or gilded, writing that "only the places that one wants to paint or gild are marked (undercoated), the rest being left empty for ornament" (Fels, 2001, p. 233). He recommended as the best undercoating a mixture of glue and lead white with only a small addition of ochre, red lead or other required pigments.

3.2.3 Spanish context seventeenth and eighteenth centuries

The use of silk textiles as a support for paintings has been highlighted by Young, quoting extracts from *Diálogos de la Pintura (Dialogues on Painting)* by Antonio Carducho and *El Libro del Arte* by Francisco Pacheco (Young, 2012, p. 132). Carducho lists silk textiles as one of the materials upon which painting in oil may be executed, in addition to linen, panel, walls, metal plates, glass, paper and parchment (Carducho, 1633, p. 132). However, no mentions are given in the treatise for painting on silk and no extant examples were found in online databases.

Francisco Pacheco referred particularly to the category of double-sided painted silk banners[6] for a royal context, described in detail as part of his best method for painting in oil and gilding over silk textiles (Pacheco, 1866, p. 90).

Pacheco described a method akin to Cennini's, except for the use of egg yolk as a painting technique which was at that time surpassed by the use of oil paint. Tempera techniques were only recommended for a different painting category called *sargas*, which were technically equivalent to the previously mentioned *cortine*, *tüchleins* and stained cloths (Santos Gomez and San Andres Moya, 2004, pp. 59-74). Veliz acknowledged the connection with the Italian tradition through the authority that the Spanish authors ascribed to the opinions of Alberti, Leonardo, Michelangelo, Vasari and Lomazzo, along with the Northern Europeans Dürer and Carel van Mander (Veliz, 1986, p. xiv). She even suggested the indirect influence of Cennini's text as a model for the Spanish type of erudite treatise, through the work of Leon Battista Alberti *Della Pittura (Of the Painting)* (1547) (Alberti and Sinisgalli, 2011). Moreover, Brady's paper on Guido Reni's paintings on silk, elaborates, amongst other matters, on the use of such special support outside the making of processional banners (Brady, 2019, pp. 151-154).

Pacheco instructs the taut stretching of the silk textile on a strong wooden strainer, fastening the textile that could measure up to 4 meters length[7] by sewing its borders with string, not nails as Cennini. In the example given, the textile was a crimson damask that after being stretched, would be placed in a way that light could pass on both sides (Pacheco, 1866, p. 92), taking advantage of the transmitted light for transferring the design to the other side. Young has also mentioned how damask in Spain was expensive in comparison to other weaves during the seventeenth century and how its use may have had an added significance in the religious context (Young, 2012, pp. 131-132). This devotional and prestigious value of silk fabrics is also discussed by Brady, strengthening the relevance of such material in the seventeenth century (Brady, 2019, pp. 159-161). Thus, the use of damask for the support of the banners can be justified by

[6] Zahira Veliz translated *estandartes* as standards (Veliz, 1986, p. 78). However, the word translates also as banners.

[7] The text indicates the maximum length of fifty *varas*, which by 1568 would have had the approximated equivalence of 83.5 cm (Pastor, 2012, p. 13).

their importance, having been painted for the Royal fleets sailing to New Spain (Veliz, 1986, p. 78).

The example given by Pacheco had a design comparable to what would be seen much later in painted silk banners of nineteenth-century Britain. The banner is described as having surrounding decorations of intricate foliage motifs or *romano*[8], that were to be gilded and silvered; with a painted escutcheon and a contoured figure of Saint James the Major holding a sword, both to be gilded and silvered accordingly (Pacheco, 1866, p. 90).

Pacheco suggested working on one side of the banner to its completion and then continuing to the other side. The decoration was transferred with the method of pouncing, requiring the previous drawing of the motifs in a paper that would later be pricked. The silhouettes of the saint and of the escutcheon were drawn with chalk directly onto the silk textile, just as it would be done for big canvases (Pacheco, 1866, p. 92).

With the sections outlined, the next step was the selective application of size. Two types of size are given (Pacheco, 1866, p. 92). For areas to be gilded with gold, the size applied was prepared with ochre bound in diluted animal glue. For areas to be gilded with silver or painted, the ochre was substituted with lead white. A further layer of animal glue was added to both types of sizes after they had dried (Pacheco, 1866, p. 92), serving as a barrier against oil absorption.

Everything that was to be gilded in either gold or silver was done first, using a mordant (gold-size) made either of Italian umber and lead white ground with (linseed) oil, or of old colours, both types heated on the fire with added gilder's varnish[9] (Pacheco, 1866, pp. 92-93). The oil paint was then applied to the figure and escutcheon, and the gilded areas were decorated with contrasting colour

[8] The term *romano* referred to the classical orders of architecture: Doric, Ionic and Corinthian, but fundamentally to their decorative elements, as explained by Diego de Sagredo, first published in 1526 (Sagredo, 1986, pp. 7-10).

[9] Such varnish was made with cooked linseed or lavender oil with added sandarac resin (Pacheco, 1866, pp. 103-104).

glazes. The sequence was repeated in the same order for the other side of the silk textile.

Pacheco remarked that this type of painted silk banner was very highly praised at his time, often to be taken into New Spain (Pacheco, 1866, pp. 91-92). He even gave an example of the price of one of his own works, which was valued at more than 200 *ducados*, stating that it was a fitting price for the quality and costliness of the materials.

Following this pictorial tradition, Palomino would include in his eighteenth-century treatise a specific methodology for making double-sided silk paintings, described in full on a single page (Palomino de Castro y Velasco, 1714, p. 34). Even though he did not specify banners, the parallels with Pacheco's method and the cautions given to prevent the silk fabric from getting stiffed and stained, suggests a similar purpose.

In Palomino's method, the silk textile was mounted onto a stretcher before painting and the design was firstly drawn on paper and then transferred by the same method of pouncing. After having the outlines fixed with ink, a size layer was laid only to the sections to be painted. Palomino suggested two options: a similar kind of size made of clippings as Pacheco and Cennini, as well as a new material, a size made of gum (Arabic). The role of the size, as explained by Palomino, was to avoid the spreading of the oil towards the unpainted areas of the textile and prevent its detrimental staining. To achieve that, he advised to either exceed slightly the drawn contours with the application of the size or apply a full layer of diluted gum Arabic size to the entire silk textile prior to painting. It may be implied that parchment glue was not suggested as a full sizing option given the stiffness it would add to the silk fibres.

The last step described by Palomino was the application of a coloured ground layer to the areas that were to be painted. This ground was made with a finely grinded mixture of red clays and linseed oil, with the addition of two portions about the size of an egg of old colours,[10] to speed up the drying of the oil media.

[10] The use of leftover oil paint or 'old colours', gathered from cleaning up brushes and recipients no longer needed, is recommended for the preparation of driers, considering that there would be

On top of this layer, after it had dried, the design for the painting would be transferred and the oil paint applied.

3.2.4 English context eighteenth century

Treatises or handbooks for the specific manufacture of double-sided painted silk banners have not yet been located in other European sources following Palomino's, neither untranslated nor translated into English.

A method for painting on silk cloths and satin was included in an English instruction manual from the late eighteenth-century, *The Artist's Assistant in Drawing*, published in London by Carington Bowles (Bowles, 1770, p. 55). Satin as a type of silk is considered in this source for the first time, although it is listed since the 15th century along cendal, taffeta, samite, lampas and damask as one of the types of silk cloths available in England (King, 1993, pp. 457-464). The technique relates to a specific type of painting that would become fashionable during the second half of the nineteenth century in Britain, referred to by them as transparency painting (Williams, 1855), also preceded in De Mayerne manuscript, note 305 (Fels, 2001, p. 355).

Similar cautions as those given for double-sided painted silk banners are also considered in Bowles's text, looking to keep the suppleness of the silk textile and avoid its potential staining. The drawing of the design is followed by the full application of a size made of isinglass (swim bladder of fish glue) in water, intended to remove the smoothness and glossiness of the silk fabric that would interfere with the application of paint (Bowles, 1770, p. 55). Dossie had previously considered isinglass as a size material, particularly used for miniature painting (Dossie, 1758, p. 157) in *The Handmaid to the Arts*, a particularly influential source for the nineteenth century technical manuals for painting according to Carlyle (Carlyle, 2001, p. 5). Stols-Witlox reported on its use as a size layer in the manuscripts of 1809-1871 and 1873 by the American painter Thomas Sully (Stols-Witlox, 2017, pp. 256-257).

drying pigments in the mixture like lead white, red lead and verdigris. A recipe for making linseed oil drier using leftover paint is given by Palomino later in the text, not recommended for blues or whites as it would alter their colour (Palomino de Castro y Velasco, 1714, p. 38).

After the sizing of the silk textile, the paint was applied directly, using the whiteness of the textile to accomplish the lights, similarly to the watercolour technique on paper (Bowles, 1770, p. 55). Bowles suggested the use of water-colours bound in diluted gum (Arabic) and white-sugar candy to prevent its cracking, as previously considered by the seventeenth-century English limner Nicholas Hilliard (Hilliard, Kinney, and Salamon, 1983, pp. 36, 43). Starch, another common sizing material in paintings (Witlox & Carlyle, 2005), was not found recommended for paintings on silk presumably for its stiffness, as was warned against by Volpato in his manuscript (Volpato, 1670, pp. 729).

3.2.5 French context nineteenth century

The mention of the use of woven silk as a painting support is described in two French instruction manuals from the 1830s: *Manuel des jeunes artistes et amateurs en peinture* by Pierre Louis Bouvier (1827) and *De la peinture à l'huile* by Jean-François-Léonor Mérimée (1830). Carlyle considered both texts as particularly influential for the nineteenth-century painting tradition in Britain, explaining that their contents would be included in a number of subsequent English and American publications on the materials and methods for painting (Carlyle, 2001, pp. 9-11).

Bouvier lists silk taffetas as one of the best textiles for painting, only convenient for small works like snuffboxes, as otherwise they would tear (Bouvier, 1832, p. 508). Merimee describes a method for priming silk taffetas before painting, adding a mixture of wax and lead white in fat oil as both size and ground. This would maintain the suppleness of the woven silk while making it water resistant, two important features for a type of painting intended to be placed under glass (windows) and possibly in the open (Mérimée, 1830, pp. 245-246).

3.2.6 North American context nineteenth and early twentieth centuries[11]

An American manual by the practical sign and decorative painter S. Gibson (active around 1870) entitled *Haney's Manual for Sign and Decorative Painting*

[11] Unfortunately, COVID restrictions made it impossible to access any British archives, which potentially contain sources predating the American examples found on the Internet Archive. Hence the lack of a British context for the nineteenth and early twentieth centuries.

(Gibson, 1870, p. 30), gives a more condensed version than in the texts by Cennini, Pacheco and Palomino; Gibson's method also includes some of the main precautions considered necessary for this particular type of painting. The manual was listed in the 1871 number of the London periodical *The Publisher's Circular*, a general record of British and foreign literature at the time containing all new works of interest published in Great Britain and abroad ("The Publishers' Circular," 1871), which shows of its spread to the British context.

The method started with the same preparatory stages, fixing the woven silk upon a stretcher and completing the outlines of the design before the selective application of the size (Gibson, 1870, p. 30). However, a different material is suggested for sizing: the resin shellac, made from the products of the resinous secretions from the insect *Laccifer Lacca* (Derry, 2012, p. vii). The product is said to have been introduced to Europe from India at the end of the seventeenth century as stick lac (Heaton, 1947, p. 301) and one of its sub-products, lac dye, was said to be used as a cheaper alternative red dye to cochineal throughout the century (Gardner, 1941, p. 265).[12] Robert Dossie uses the terms 'shell-lac' and 'seed-lac' varnish interchangeably as the best composition for glazes over metal leaves in his eighteenth century English manual *The Handmaid to the Arts* (Dossie, 1758, p. 177). Towards the nineteenth century, two technological developments improved the use of seedlac for varnishes and other preparations. Firstly, the increased availability of alcohol as a solvent in the early 1800s (Rivers, 2003, p. 30) and secondly, the discovery of aniline dyes by Henry Perkin in 1869. The first facilitated its preparation and made it more affordable, and the second displaced its use as a red dye product (lac dye), boosting the production and commercialisation of the resin (Hicks, 1961, p. 12). By the end of the nineteenth century, shellac became the most common resin varnish for artisans, cabinet-makers and restorers (Rivers, 2003, p. 632), also reported by Carlyle as one of the spirit varnishes frequently mentioned in the nineteenth-century technical sources (Carlyle, 2001, pp. 87-93) and by Stols-Witlox as an experimental additive for nineteenth-century painting grounds (Stols-Witlox, 2017, p. 56). In Gibson's book he instructed to prepare the size by dissolving bleached shellac in alcohol and dilute it as much as required for covering the

[12] The red on the seedlac or Lac dye is given by its content of laccaic acid (Derry, 2012, p. 21), whilst the red on the cochineal dye is given by the carminic acid present (Phipps, 2010, p. 47).

surface of the sections to be painted and gilded (Gibson, 1870, p. 30). According to Carlyle, bleached shellac would become available in Britain after 1835, having a lighter colour than the other varieties (Carlyle, 2001, pp. 131-132). However, the invention of the method is attributed in 1827 to the American professor Hare of Philadelphia in *The Painter's, Gilder's and Varnisher's Manual*, simultaneously published in London and New York, suggesting it might have been available earlier in the United States (Anon, 1836, p. 64). For the application of the shellac size, Gibson added the same note of caution as Palomino: it had to be applied a little beyond the outline to prevent the oil paint from spreading into the silk textile. Given that shellac varnish is usually a brittle and rather inflexible material, its use as a size layer for banners could be explained by its convenient speed of drying and its possibility of forming an impermeable layer at a highly diluted ratio, although this would have to be tested through the making of reconstructions. Brites has conducted research on the reconstruction of a size made of gelatine and shellac found in a Portuguese nineteenth century painting, following recipes by Vibert (1892) and Davies (1870) (Brites, 2015). The capability of that mixture of forming a flexible film could explain why it was recommended for flexible paintings like silk banners.

Egg-white is given as a second option in the manual, recommended for works that were not intended to be taken outdoors, or that required to be done with haste (Gibson, 1870, p. 30). Unlike the example given for shellac, further instructions are given for the gilding. The application of the gold leaf had to be done while the egg-white size was still wet, in order to be fixed by the albumen in the egg, doing the sizing and gilding almost simultaneously. The correspondence with Cennini's method suggests a possible unacknowledged reference of the author to his work, translated into English for the first time in 1844 (C. Cennini, Tambroni, and Merrifield, 1844). This is based on the fact that another contemporary author, the English painter William Jabez Muckley (1829-1905), explicitly referred to the works of Cennino Cennini amongst the references used for the writing of his manual, first published in America[13] (Muckley, 1876, p. vi).

[13] Carlyle includes this source in her *Annotated Bibliography of Primary Sources*, but she mentions a first edition published in London in 1880 (Carlyle, 2001, p. 314). The fact that there is an earlier edition not previously known by Carlyle published in New York in 1876, stresses the

A similar method to Gibson is given in a series of editions of *The Universal Assistant* by R. Moore between 1878 and 1907, a compilation intended for commercial, manufacturing and mechanical trades published simultaneously in New York, London and Montreal (Moore, 1880, p. 261). Moore also included another material for sizing: a little honey combined with thick glue. This type of size is described in the English compilation by Godfrey Smith *The Laboratory of the Arts*, where he noted that “if you add a little honey to your size it will keep it from cracking” (Smith and Hulett, 1750, p. 69). Flexibility was one of the main concerns noted by Carlyle and Labreuche for the ground application of canvas during the nineteenth century (Carlyle, 2001, p. 176; Labreuche, 2011, pp. 14-30), which is particularly applicable to the material needs of double-sided painted silk banners.

In another American manual, the sign painter James T. Gardiner suggested another option for sizing silk fabrics in preparation for painting and gilding, using Japan varnish (Gardiner, 1871, pp. 39-40). The material, also known as Japan or japanners gold-size, would be included along with shellac as the two preferred sizes for painting silk banners in subsequent manuals for sign and decorative painters (Allen, 1899, pp. 32-33; Kelly, 1911, pp. 105-110; Warren, 1890, pp. 66-67).[14] The earliest mention of japanners gold-size was found in Dossie’s publication (Dossie, 1758, pp. 384-390), describing it as a versatile and efficient size composed of mixture of linseed oil, asphalt, gum animi,[15] red lead and litharge, all boiled together and diluted with turpentine before its use. Although not considered as a sizing material, Gibson would also instructed its preparation, introducing it as “the ’secret size’ used by the best artists of London and Paris, and (…) the celebrated japanners of Birmingham” (Gibson, 1870, p. 22), confirming the link between the American and English context.

connection between the American and English context in the availability of sources. This could possibly relate to the use of American sources in the English context of the late nineteenth century.

[14] There is no consensus in the reviewed sources about the spelling of the material, naming it Japan, Japan gold-size or japan gold-size and japaners gold size or japanners gold-size indistinctly. Winsor & Newton labels it to date as Japan Gold Size (Newton, 2019).

[15] Gibson also added the note that gum animi and copal were not the same, as many dealers of his time stated (Gibson, 1870, p. 22). However, it is nowadays accepted that gum animi is in fact fossil or Zanzibar copal (Gooch, 2010, p. 41).

Similarly to Pacheco's opinion, this particular genre of banner painting would be considered a very profitable specialty during the late nineteenth and early twentieth centuries. Proof of that are the numerous publications intended for sign painters, both British and American, which included amongst their practical contents, indications and plaques of the appropriate designs for the so-called society banners (Collins and Brooke, 1877, p. 44; International, 1906, pp. 73-76; Sutherland, 1889, p. XIX-XX; 1898, pp. 31-36). What is important to note here is the highly praised value that these banners had both in materials and handywork. The most expensive ones were said to be made of extra-heavy twilled or grosgrain silk, equivalent to that mentioned by De Mayerne, which due to its popularity at the time would get to be known as "banner silk" (International, 1906, p.73).

The most detailed methodology for the making of double-sided painted silk banners was published in 1911 by another American author, Albanis Ashmun Kelly, who was a former instructor at the Indianapolis Technical Institute (Kelly, 1911, pp. 105-110). In his book *The Expert Sign Painter*, designed for the use of practical sign-painters and letterers, a full chapter is dedicated to silk and satin banner painting. It is evident that the author considered the American sources described above, not only for the inclusion of the same materials, but also for the way in which they are described, replicating the same wording used by the previous authors. Kelly states in his preface that he also consulted "all the books there are, of domestic and foreign origin, relating to the subject of sign painting" (Kelly, 1911, p. 4). There is correspondence between Kelly's information and that given by Dossie in *The Handmaid of the Arts* (Dossie, 1758), as well as the use of a similar wording than William George Sutherland for the description of sizing methods for painted banners (Sutherland, 1989). There is also mention of the method used by the main commercial manufacturer of painted banners in Britain at the time, George Tutill, which suggests the author's awareness of the English context (Kelly, 1911, p. 108).

Kelly's method began with the stretching of the silk fabric on a stout wooden stretcher of about 2 and a half inches wide, with keys in the corners as those used for canvas, but explicitly without a crossbar, as the whole field of the silk textile needed to be available to be painted on both sides. A band of a different textile, stronger than the silk fibres, had to be sewn to the borders, to protect it when attaching the tacks and increase its holding (Kelly, 1911, p. 106). The stretching was begun in the centre of the four sides of the stretcher and finished in the corner, drawing up the silk textile as tight as possible with tacks about half an inch apart from each other. Kelly recommended tilting the mounted silk textile over a little at the top, to prevent the fabric from any chance drops of paint, a practice said to be followed by the English banner-maker George Tutill for the painting of his banners (Gorman, 1973, p. 51).

Similarly to Pacheco and Palomino, the design was transferred to the silk fabric with the method of pouncing, which considering the size of the work, had to be done in separate parts. The centre of the design would only have the outline pricked in the paper, not the detail, as the difficult design would make the pouncing impossible. Thus, the image was suggested to be subsequently sketched in with charcoal (Kelly, 1911, p. 106).

The areas to be gilded and painted had to be previously sized, to protect the silk fabric from staining with the oil of the paints by exceeding the outline with the application of the size, specifying a width of ¼ inch all around the areas where the paint would go (Kelly, 1911, p. 107). For the sizing, Kelly gives all the possibilities previously considered like parchment glue, shellac, japan gold-size, isinglass[16] and egg white, using almost the same wording as Gibson and likewise indicating its use only for indoor works (Kelly, 1911, pp. 107-111). He also adds three sizing materials to the previous options:

- distemper made with (animal glue) size, Chinese white[17] and a little glycerine
- gelatine size
- coat of flatting colour made of lead white, varnish and a little turpentine

The use of glycerine has also been noted by Carlyle as another nineteenth century resource to improving the flexibility in the size layer (Carlyle, 2001, p. 176). In Kelly's text, both the use of glycerine with Chinese white and the application of flatting colour seem to have been taken literally from the sign-

[16] The diluted isinglass is taught to be laid over a previously applied layer of alum water (Kelly, 1911, p. 110). Stols-Witlox considered an experimental recipe of Winsor & Newton that mixed shellac mixed in ammonia to an animal glue size, in order to render it impermeable (Stols-Witlox, 2017, p. 56). Kelly's recipe could have had a similar intention.

[17] Carlyle considers Chinese white as a synonym of zinc white (Carlyle, 2001, p. 556).

painting English manual *The Art of Signwriting* published by William George Sutherland in 1889 (Sutherland, 1989, p. 11), evidencing the relation that Kelly had with the English practice.

The instructions of Kelly continue in a separate way for the painting of the centre scenes and the peripheral ornamentation (areas to be silvered), implying that they were carried out separately. For the painting, he advises always to add a layer of oil mixed with white lead without turpentine as a ground, and that it should be used in a thin condition and well rubbed out, to maintain the flexibility of the banner for rolling them without cracking.[18] He then gives the example of Tutill's method of applying a coat of rubber solution for the same purpose, without giving any details about it (Kelly, 1911, pp. 107-108).

The painting of banners had to be 'solid painting', as the texture of the fabric must not be shown through the work. To accomplish such type of painting, he mentions that lead white and oil should form the body of the paint, without the addition of turpentine or varnish as they both would render the painting brittle (Kelly, 1911, p. 105). The concept of 'solid painting' was previously instructed by Muckley as the best way of making a paint durable (Muckley, 1876, p. 70). It was also advised by other English painters and authors of manuals towards the end of the century such as Tristam James Ellis (1844-1922) and John A. Collier (1850-1934) (Collier, 1886, pp. 52-60; Ellis, 1887, p. 187). Carlyle discusses this system of painting in her monograph of painting sources in Britain during the nineteenth century (Carlyle, 2001, pp. 197-198). She says that the previous technique followed by the 'old masters' of using both opaque and transparent layers of paint, gave way towards the later part of the century to a preference for opaque (solid) painting, either applied at once (*alla prima*) or in three stages (background colouring, detail colouring and finishing), with a very restricted use of transparent layers. The main reason for the use of that system is clear in the words of Ellis, proving to be a major concern of all kind of painters at the time (Ellis, 1887, p. 187):

[18] In this context, the indication of "well rubbed out" suggests the filling of every interstice of the textile and its total impregnation with the ground, likely to be done with the rubbing of the brush against the fabric. This indication is important to consider, as evidence of the white ground seeping into the silk fibres has been previously documented in commercially manufactured painted banners (Rogerson & Lennard, 2005; Smith, Thompson and Hermens, 2016).

> "A picture is best done at 'one painting', what we might call a single 'coat'; it then retains its freshness longest. Those with many paintings or glazings (sic) are more liable to deteriorate".

For the ornaments, Kelly reiterates the need of having the same shape on both sides of the banner, as well as making them as brilliant as possible, reason why they had to be silvered. He then gives a practical tip to take advantage of the method of oil-gilding, stating that "to save labor (sic), the filling-up (ground layer) and the gold sizing (adhesive for the gold leaf) is done in one coat" (Kelly, 1911, p. 108). This meant that the composition of the ground and the gold size were done with the same materials, described therein as a sole mixture of pure fat oil and white lead, laid on both sides of the banner at once and silvered when it became ready (mordant or tacky to touch) after about twelve hours.

Kelly recommended in another chapter the use of aluminium leaf in substitution of the silver leaf, as it did not have the problem of tarnishing and it was considered so cheap that no care was needed for its use (Kelly, 1911, pp. 136-140). However, he insisted in applying a protective coating right after being adhered to the gold-size, applying a layer of weak parchment size (Kelly, 1911, p. 108). Once dried, the decoration was done with glazes made of diluted oil paints in transparent colours like Vandyke brown, raw umber and pure crimson lake, all commercially purchased in tubes (Kelly, 1911, pp. 31, 36, 59, 108). The letters were added with ivory drop black in plain letter.

3.3 Historical sources on the manufacture of double-sided painted silk banners in late nineteenth and early twentieth century Britain

The manufacture of painted banners became increasingly professionalised in Britain from the second quarter of the nineteenth century (Mansfield, 2004, p. 92), adopting the design that is now recognised as the typical British society and trade union banner. Before that period, the manufacture of banners is said to have been carried out by amateurs, local sign writers and talented members of the workers' organisations (Edwards, 1997, p. 14; Gorman, 1973, p. 49; Mansfield, 2004, p. 92). The flourishing of the banner-maker profession have been identified as a result of the growing demand for these forms of display and identification by the organised workers (Moyes, 1974, p. 49), particularly from the upsurge of the Chartist movement (1838-1857) (Mansfield, 2004, pp. 81-99; Smethurst, 2000, p. 29) and the rise of civic ritual and pageantry between the 1880s and 1914 (Cannadine, 1982, pp. 128-129; Donnelly, 1973, pp. 1-2; Weinbren, 2006, pp. 167-191). In addition to changes in the role of consumer goods in Victorian society, which replaced the older traditions of local production and consumption with mass-produced objects from a larger market, increasingly available through the changes in transport, retail and marketing (Briggs, 1990, pp. 147-166; Mansfield, 2004, pp. 92-93).

As discussed in Chapter 2 for the companies of Kenning, Stillwell, Tutill and Whaite, it was of particular importance to the success of commercial regalia and banner-making firms, the increase of fraternal and friendly societies over the course of the Victorian period and their impact in the development of trade unions (Mansfield, 2008, pp. 133-143; Martin, 2002, pp. 1-19; Weinbren, 2006, pp. 167-191).

Some of the major firms had indeed a direct connection with a particular fraternal society, by both advertising the specialised production and retailing of their banners and regalia, or by being in addition active members of one. The most notable examples were the manufacturers George Tutill, a member of the Foresters (Logan, 2012, pp. 11-14), Henry Whaite, a member of the Oddfellows (Smethurst, 2000, pp. 27-35; Stevens, 1999, pp. 64-68), as well as Edward Stillwell, George Kenning and A. M. Jockel, all members of the Freemasons ("Edward Stillwell & Son advert," 1883, p. 1; Freemasonry, 2010a, p. 3; *George Kenning and Son. Summer Number [Supplement]*, 1901, pp. 1-22; Clark, 2001, p. 16;). Similarly, long- lasting companies like the House of Toye and Spencer Co. would publish adverts throughout the late nineteenth and early twentieth-centuries indicating the manufacture and retailing of specialised Masonic products and banners, suggesting their affiliation to that fraternal society (*The Freemason*, 1916, p. 249; *Twenty first type of ad published in the Freemason*, 1895, p. 230).

Twenty-two different commercial manufacturers have been identified in previous research on British society and trade union banners[19] (Clark, 2001; 19; Gorman, 1973; Moyes, 1974; Nixon, Pentland, and Roberts, 2012; Pathé, 1958; Smethurst, 2000; Stephens, 1999; K. Thompson et al., 2017). At least eight of the companies were also manufacturers of badges and a variety of regalia products for fraternal societies and trade societies or unions alike[20] (Clark, 2001, p. 16; Martin, 2002, pp. 129-135). Nevertheless, there are only two companies to date that have been submitted to technical studies for the identification of their materials: the London based firms of the Victorian entrepreneurs George Tutill (April 16, 1817-February 17, 1887), and George Kenning (April 2, 1836-October 26,1901), published by Rogerson and Lennard (2004), Macdonald et al. (2004) and Smith, Thompson, and Hermens (2016).

3.3.1 George Tutill's historical sources

The manufacturing technique of George Tutill for painted banners has been interpreted by Gorman (Gorman, 1973), Moyes (Moyes, 1974), Emery (Emery, 1998) and Logan (Logan, 2012) from the primary sources that survived the destruction of his company archive after the London blitz in 1940 (Gorman, 1973, p. 54). These include two of his catalogues published in 1896 and 1930, his patent for treating materials for the manufacture of banners and flags dating 1861, three boxes of negatives with studio images and banner examples from the 1890s to the 1920s. As well as footage from a short documentary filmed in 1963. Tutill's biography is included in the Oxford Dictionary of National Biographies (Reynolds, 2010). In addition to that, three technical studies have analysed the materials used for the making of his banners between 1860 and the 1950s (Macdonald et al., 2005; Rogerson and Lennard, 2005; Smith, Thompson and Hermens, 2016). Incidentally, the original source of many of the photographs

[19] George Tutill of London and Chesham; George Kenning of London, Liverpool, Glasgow, Manchester and Coventry; William Elam of London; Bainbridge & Co. of Newcastle; E. D. Nichol & Co. of Sunderland; S. M. Peacock of Sunderland; Riley, Edwards & Co. of Leeds; Adams & Co. of Manchester; Henry Whaite of Manchester; Thomas Peake & Son of Bedworth; Henry Slingsby & Son of Nuneaton; Henry and Thomas Hales of Strand; R. Hodge of South Shields; George Cooper & Co. of Newcastle; Fattorini of Birmingham; Toye, Kenning & Spencer of London; A. M. Jockel & Co. of Edinburgh; Simpson & Sons of Glasgow; Turtle & Pearce of Southwark; Chippenham Designs of London and Overstrand; Durham Banner Makers of Durham; Herbert Sharp of Hitchin.

[20] George Tutill, George Kenning, Henry Slingsby, House of Toye, Spencer, Fattorini, A. M. Jockel and Toye, Kenning & Spencer.

and anecdotical information published unreferenced by Gorman was located in his personal archive donated after his death to the People's History Museum; an 1899 article published in the renowned Victorian periodical *The Windsor Magazine*, written by Leonard W. Lillingston with photographs by C. Pilkington (Lillingston, 1899, pp. 320-324).

According to the company's catalogues, George Tutill established his banner-making business in 1837 (Tutill, 1896, 1930) and the earliest indication of his profession as an "artist" was located by Logan in his marriage certificate of 1838 (Logan, 2012, p. 6). However, there is no evidence of his commercial address in the Post Office directories of London until 1847, when it was located at 52 Banner Street, moving to 14 Douglas Road by 1859 and remaining between 1860 and the 1940s at his own premises in 83 City Road (Logan, 2012, pp. 15-16). After the Second World War, Tutill's company was relocated to Chesham, Buckinghamshire due to the destruction of their premises. Moyes found the earliest evidence of that new address in a letter communication between the secretaries of the Trade Union Congress and the Durham Miners' Association dating August 1945, indicating the new location at 9 Higham Road (Moyes, 1974, p. 51). In an episode of the program 'Mining Review' from June 1963, Tutill's company in Chesham is shown still active in a short documentary on trade union banners (Unit, 1963). However, it is stated that the company joined forces with the company of Turtle and Pearce in the 1950's, with whom they are still active to date under the new name of Flagmakers (Flagmakers, 2019). There are 199 painted banners included to date in the National Banner Database signed by George Tutill's company (Initiative, 2018).

3.3.2 George Kenning's historical sources

The manufacturing technique of painted banners by George Kenning has only been considered in the technical studies of Rogerson and Lennard, and Macdonald et al. (Macdonald et al., 2005; Rogerson and Lennard, 2005). However, they refer to the company of George Kenning & Son, which is only one of the seven different companies associated with George Kenning (see Chapter 2).

The only primary sources related to the manufacturing technique of his company were located in Kenning's own Masonic periodical *The Freemason.*[21] These include his obituary and the extended company profile written in Glasgow a year before his death (*George Kenning and Son. Summer Number [Supplement]*, 1901; *Obituary*, 1901). Additionally, five different editions of his companies' catalogues were located (G. Kenning, 1878, 1881; G. S. Kenning, 1900, 1915a, 1915b, 1932).

Unlike Tutill, no evidence was found to say that Kenning was an artist but a "gold lace maker" by profession, as indicated in his marriage certificate (*Marriage certificate*, 1861). In addition to that, Kenning had the specialty of being a loriner, specified in the company profile (*George Kenning and Son. Summer Number [Supplement]*, 1901) and in the electoral registers of London dating 1891, 1895, 1898 and 1901 (*Electoral Register*, 1891; *Electoral register*, 1895; *Electoral register*, 1898; *Electoral register*, 1901). There are eight George Kenning banners located to date, four included in the National Banner Database and four elsewhere (see Chapter 2, Table 2.3), and there are nineteen George Kenning & Son banners located to date, sixteen included in the National Banner Database and three elsewhere (see Chapter 2, Table 2.5).

3.3.3 Banner Manufacturing stages

By comparing the available primary sources of Tutill's and Kenning's companies it was possible to detect similar manufacturing stages in the making of their painted banners. The stages also corresponded with those located in the art technological sources described in the previous section. In addition to that, a 1958 short film showing the work of a former Tutill painter, Mr Herbert Sharpe (Pathé, 1958) was used as a comparison to illustrate particular stages of the manufacturing process.

Tutill listed his manufacturing stages for painted banners in the 1896 catalogue as follows: dyeing, winding, warping, turning-on, twisting-in, weaving, finishing, designing, drawing, painting, ornamenting, lettering, trimming and fitting up

[21] In a personal communication with Bernie Cope, the general director of the current company of Toye, Kenning & Spencer, he indicated that there is no archive of any kind regarding their banner-making division (Cope, 2018).

(Tutill, 1896, p. 2).[22] Although Tutill was also a regalia manufacturer, it is evident in his catalogues that banners were his specialty. According to Gorman, the 83 City Road premises were purposely designed for their production, having three galleries with natural light from a glass roof and ample space for the other processes involved in their manufacture, including the weaving of the large central silk textiles (Gorman, 1973, p. 50).

Kenning on the other hand, had a more varied production as it has been detailed in Chapter 2. Painted banners were only one of their specialties, although promoted since his first company advert *(First advert of the Scottish Freemason, 1877)*. Nevertheless, all of the designing and manufacture of Kenning's products was entirely carried out at their London premises (*George Kenning and Son. Summer Number [Supplement]*, 1901) and by the year of 1901 the company of George Kenning & Son maintained six different departments for the manufacture of a large variety of regalia products and painted banners (*George Kenning and Son. Summer Number [Supplement]*, 1901). Similarly to Tutill, Kenning & Son company would eventually benefit from a purposely designed factory for the production of their products, located towards the Northern side of the city (G.S. Kenning, 1932, p.1).

Unlike Tutill, Kenning did not specify the processes for the manufacture of his banners further than offering designs and estimates for free in all of his advertisements, as well as listing painting, mounting on poles, fringing and rolling for delivery in the company profile (*George Kenning and Son. Summer Number [Supplement]*, 1901).

The stages for the commercial manufacture of painted banners considered in this section were grouped as follows:

- Silk textile manufacturing
- Stretching of the silk textile

[22] The processes concerning the manufacture of silk fabric correspond with the key steps reported by Murugesh Babu, although not listed in the correct order of application or with the commonly used terms (Murugesh Babu, 2013, pp. 41-42). It should be winding, doubling (instead of turning-on), twisting (instead of twisting-in), dyeing, warping and weaving. The initial stage of soaking is omitted in the list, but in the cover of Tutill's 1896 catalogue there is a drawing of a silk watering machine (Tutill, 1896), which could correlate with that process. This indicates that the manufacture of silk fabric at Tutill's began with the raw silk hanks, as the stages listed by Murugesh Babu begin with such material (Murugesh Babu, 2013, p. 42).

- Sizing of the silk textile (including the drawing of the general design for the banner)
- Gilding and painting (including the application of ground and the preparatory drawing for the painting)
- Trimming and packing

3.3.3.1 Silk textile manufacturing

Gorman stated that Tutill initially acquired the silk textiles for his banners from the silk-weavers of Spitalfields and Bethnal Green that were close to his 83 City Road premises, importing from France larger woven silks with pattern backgrounds (Gorman, 1973, p. 50). Such information is not specified in any of the available primary sources, so it might be part of the statements given to Gorman by Tutill's worker Ronald Caffyn during the 1970s interview, unfortunately unreferenced in his text. Similarly, Gorman indicated that Tutill secured the weaving of silk within his own premises from 1860 by introducing handlooms and a large custom-made Jacquard loom made by the firm Maddox of Bethnal Green in the early 1880s (Gorman, 1973, p. 52). Although no reference is given for this information either, the photographic evidence that survives and the explicit indication given in the 1896 catalogue of having his own looms (Tutill, 1896, p. 2), confirms that Tutill's company manufactured the silk textiles within their premises at least from that date onwards.

As specified in the same catalogue, Tutill's silk fabric manufacture started with the raw silk, carrying out the all the processes within his premises. The photographs published by Gorman show the use of the Jacquard loom for the weaving of the central pieces and a smaller 12 inch loom for the banners' borders, of which Gorman stated there were four of them in use until 1940 (Gorman, 1973, p. 65). Tutill labelled his banners as "Pure English Silk Banners", seen in the label of one surviving wooden box where the banners got delivered now in the City of Edinburgh's Collection (Clark, 2001, p. 13). However, that is not an indication of the origin of his raw silk but simply an assurance that they were constructed in England. No evidence has been found of where he purchased the raw silk or where it originated.[23]

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[23] For definitions of raw silk, degumming and weighting of silk textiles see Garside (2002).

According to the former senior textile conservator of the People's History Museum of Manchester, Vivian Lochhead, Tutill produced six different patterns to be woven in his Jacquard loom, identified by her during the treatment of the museum's banner collection and private works (Lochhead, 2018). Five of those designs were located in three of the reviewed publications on British painted banners (Figures 3.1 to 3.5) (Clark, 2001; Emery, 1998; Gorman, 1973).[24] The sixth design has not yet been located.

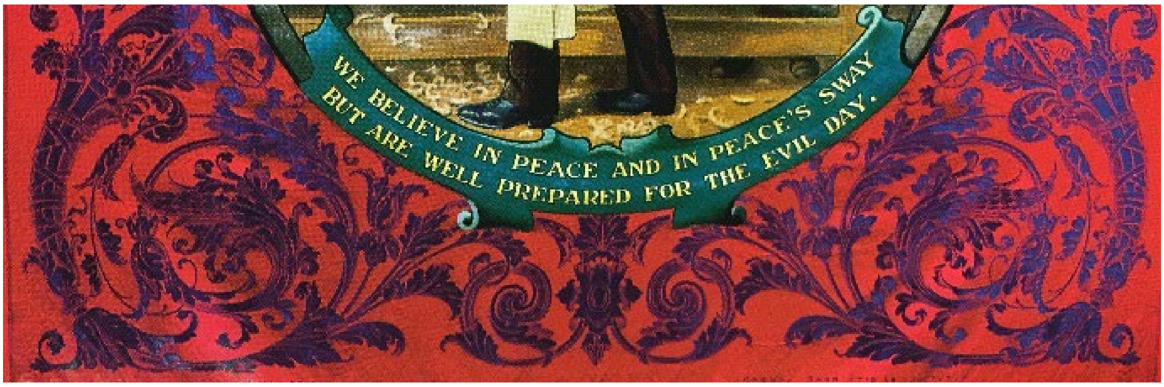


Figure 3.1 Tutill's woven design 1 *cornucopias*. Detail of Amalgamated Society of Woodworkers banner, People's Story Museum, Edinburgh. (Image © Clark, 2001, p. 147).

Figure 3.2 Tutill's woven design 2 *tied batons bow*. Detail of the Scottish National Operative Plasterers Federal Union Edinburgh District banner, People's Story Museum, Edinburgh. (Image © Clark, 2001, p. 129).

[24] The names given to the five designs are only for their distinction, as no evidence of their original names has been located.

Figure 3.3 Tutill's woven design 3 *thistle leaves garland*. Detail of the Loyal Order of Ancient Shepherds A. U. banner, People's Story Museum, Edinburgh. (Image © Clark, 2001, p. 217).

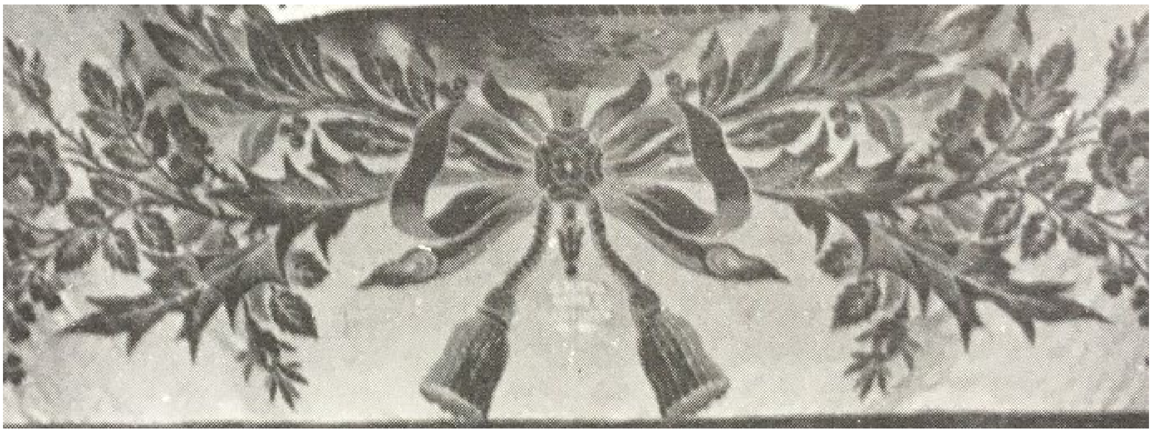


Figure 3.4 Tutill's woven design 4 *large tassels bow*. Detail of the North Stafford Miners Federation Burslem No. 1 Lodge banner, Miners' Hall, Stoke-on-Trent. (Image © Gorman, 1973, p. 80).

Figure 3.5 Tutill's woven design 5 *bannerette*. Detail of the Filey Primitive Methodist Primary Department banner, Englesea Brook Chapel and Museum, Cheshire. (Image © https://artuk.org/discover/artworks/banner-from-the-filey-primitive-methodist-primary-department-103210/search/actor:tutill-george-18171887/page/1/view_as/grid).

Tutill's decoration woven into the silk textile and the use of single pieces of silk without seams became trade-marks of his banners' production, advertised in both of the surviving catalogues (Tutill, 1896, 1930) and in periodic publications of the Order of Foresters (Logan, 2012, p. 14). His company offered two types of banners: those with the decoration woven into the silk textile (Figure 3.6) and those with the decoration gilded and painted over it (Figure 3.7) (Tutill, 1896, p. 3). The majority of Tutill's banners were made with contrasting woven silk borders attached to the central painted piece, as seen in the examples published by Gorman, Moyes, Emery and Clark and in the National Banner Database (Clark, 2001; Emery, 1998; Gorman, 1973; Initiative, 2018; Moyes, 1974).

Correspondingly, silk fibres have been identified in nine central painted pieces of Tutill's banners made between 1860 and the 1950s by Rogerson and Lennard using optical microscopy (Rogerson and Lennard, 2005, p. 13) and one by Smith et al. using Fourier Transform Infrared spectroscopy with Attenuated Total Reflection (FTIR-ATR) (Smith, Thompson and Hermens, 2016, p. 18).

Figure 3.6 Woven decoration in the banner of the Amalgamated Society of Carpenters and Joiners by Tutill, People's Story Museum, Edinburgh. (Image © Clark, 2001, p. 5).

Figure 3.7 Gilded and painted decoration in the banner of Loyal Order of Ancient Shepherds, Penny Well Lodge by Tutill, People's Story Museum, Edinburgh. (Image © Clark, 2001, p. 15).

Kenning's manufacture of silk textiles was focused on the production of gold lace and other related products used for regalia like fringes, tassels, ribbons and cords, as documented in the company profile published in *The Freemason*. George Kenning's silk lace production was initially made by the means of manual hand-looms, which were only able to produce one length of gold lace at a time, in comparison to the industrial power-looms available towards the beginning of the twentieth century, capable of woven up to twenty-four lengths at a time, benefitting their production in one third of the time and cost (George Kenning and Son. Summer Number [Supplement], 1901). The only mention of a potential manufacture of silk fabric by the company is included in an add published in 1901, where "silk" is listed as one of their manufactured products (*George Kenning & Son, Manufacturers of Silk Banners advert*, 1901):

> "George Kenning & Son, Manufacturers of Silk Banners (painted and embroidered), Silk and Bunting, Seamless & Sewn Flags, for Masonic Lodges, Ecclesiastical, Friendly Societies, Temperance Societies, Political Societies, Schools, Sports, Regimental Colours, Pipers' Banners, Naval Flags, Yacht Flags, Municipal Banners, Trades' Unions, Colonial Flags. Flags for All Nations. Designs and Estimates Free/Illustrated Price Lists Free."

However, it is not very likely that this indication meant they produced silk as a material or even as woven fabric, as it is explicitly mentioned that Kenning's banners were made by "painting enormous squares of the finest Chinese silk" (*George Kenning and Son. Summer Number [Supplement]*, 1901). The mention of the origin of the woven silk used for the banners suggests that the company imported the material from the Chinese market likely from an intermediary supplier not identified, in comparison to George Tutill who labelled his banners as made out of pure English silk (Clark, 2001, p. 13) and were woven at his premises. Not much is published about the measurements of the imported silk textiles that arrived in Britain during the Victorian and Edwardian eras. However, a comparison between the fabric widths of eighteenth-century English and French silks with the official widths of the corresponding Chinese dynasty, shows a considerable variation between the European production and a highly regulated consistency maintained by China up to the twentieth century (Table 3.1). By further comparing such widths eight of the eleven Kenning banners so far measured, could support indeed the possibility of a far East supplier (Table 3.2).

<table>
<tr><td colspan="4">Table 3.1 Maximum width comparison between silk textile manufacturing countries</td></tr>
<tr><th>Country</th><th>Period</th><th>Width</th><th>Source</th></tr>
<tr><td>England</td><td>18th century</td><td>45.72 – 53.34 cm</td><td rowspan="2">Miller (2014)</td></tr>
<tr><td>France</td><td>18th century</td><td>54.5 cm (Lyonnais figured silks)
49.5 cm (Tours silks)</td></tr>
<tr><td>China</td><td>Qing dynasty
(1636–1912)</td><td>64 cm</td><td>Kuhn et al. (2012)</td></tr>
</table>

Table 3.2 Maximum width comparison of eight Kenning's banners inspected

Banner	Maker	Width	Year
Leith Shipwrecks	George Kenning	56 cm	1873
Leith Lodge of Free Gardeners	George Kenning	60 cm	c.1880
Glasgow Typographical Society	George Kenning	59.20 cm	1883
Glasgow Upholsterers Society	George Kenning	59.80 cm	1884
Grain Millers of Glasgow	George Kenning	59.30 cm	1884
N.U.V.B. Glasgow Branch (former U.K.S.C.)	George Kenning & Son	61.60 cm	1914
Scottish Tin Plate Braziers and Sheet Metal Workers Society	George Kenning & Son	230 cm	c.1916
The National Union of Railwaymen Hither Green Branch No. 537	George Kenning & Son	261 cm	c.1917

Further information supporting the possible Far East manufacture of Kenning's silk textiles, is related to a manufacturing process traced back to the seventeenth century known as silk weighting. Such process compensated the lost weight of the silk after the degumming process by adding artificial weighting agents to the fibres like tin (Macke, 2008, p. 3).[25] Although this practice significantly detriments the silk (Garside, et al., 2014), it became very popular in Europe and North America towards the 1870s (Macke, 2008, p. 3). However popular during Kenning's times, weighted silk fabrics were not recommended for parasols, curtains, and flags for being exposed to direct sunlight (Macke, 2008, p. 6), and they were explicitly disqualified from banner making (Lillingston,1899, p. 320):

> "Twilled silk, again, is 'weighted' with dye and adulterated with cotton. For banners, pure silk, and nothing but pure silk, is suitable".

[25] See Chapter 6 section 6.6.5.

As it will be elaborated in Chapter 7, the inspection of eleven banners made by George Kenning and George Kenning & Son detected minor differences in the types of weaves and thread count of their silk textiles. This is a possible indication of different suppliers of the ready-made material in contrast to the controlled in-house production of Tutill. Nevertheless, Kenning seemed to prefer the type of weave identified as silk rep, silk grosgrain or even “banner silk” as it was contemporarily called (International, 1906, p.73), explicitly offered in his banner’s prices as “rich Corded silk” (Kenning, 1878, p.96) (see Chapter 5, Figure 5.12 for weave detail).

Unlike Tutill’s, Kenning’s banner production seemed to be more variable in their textile construction. The use of contrasting borders is not seen as consistent in the Kenning banners reviewed on the National Banner Database, as some banners have them and others not (Initiative, 2018). In addition, two of the eleven banners inspected in Manchester, the *Mersey Quay and Railway Carters Union* banner and the *Electrical Trades Union* banner, were constructed of two separately painted silk textiles, sewn, and trimmed together by a folded single layer of textile border. This type of construction has also been reported to be used by the Manchester banner-maker Henry Whaite, identified by Stevens in two of the four surviving banners by his company, *The National Union of Railwaymen, Manchester Branch No.13* and the *Wilmslow Economical and Friendly Society* banner (Stevens, 1999, pp. 66-67). After the inspection of eleven Kenning banners for this research, as it will be explained in Chapter 7, it was noticed that any later additions or replacements of textile edges, hanging loops and fringes after significant damage, tried to follow their original construction, suggesting that most of the formal differences between all Kenning’s banners are likely to be original and not subsequent alterations.

The only other banner-maker that is said to have manufactured his own silk fabric was Henry Slingsby of Nuneaton, who according to Emery took “skeined and hanked […] silk” or raw silk hanks from China and Europe to wove it at his premises in Seymour Road by means of Jacquard looms (Emery, 1998, p. 10).

It is evident in Mr Sharpe’s footage that he used original Tutill’s woven silks for his banners, as the same woven patterns and the woven name of Tutill is seen in the recording. Having also worked in Tutill’s company between the 1930s

(Gorman, 1973, pp. 60-61) and the 1960s (NCB, 1963), this could hinder the distinction between Sharpe's new banners and those made for Tutill.

3.3.3.2 Stretching of the silk textile

The next step of Tutill's manufacture was to stretch the woven silk in preparation for painting. This can be attested in a series of photographs included in the catalogues (Tutill, 1896, 1930) and published by Gorman from a selection of the three boxes of negatives that survived Tutill's archive (Gorman, 1973, pp. 57-65). Gorman also included an unreferenced anecdote useful for inferring the tautness to which the silk fabrics were stretched (Gorman, 1973, p. 51). The original information as told to Lillingston by Mr Tutill himself reads as follows (Lillingston, 1899, p. 320):

> "Mr. Tutill told me an amusing anecdote, illustrating the tremendous powers of resistance a banner of pure silk possesses. He was explaining it to a visitor. There was a square of silk stretched upon a frame near them, awaiting the artist. 'You might throw yourself bodily against it" said Mr. Tutill, 'it would not break'. The visitor, without more ado, took him at his word. He was painfully surprised, a moment later, to find himself lying upon his back, in the middle of the floor, six feet from the banner!"

In the historic photographs of the Gorman Collection, Tutill's woven silks are seen fixed onto the front face of large wooden-strainers or stretchers[26] (Figure 3.8) and in a close-up of one of the banners it is evident that the silks were attached with multiple tacks with a regular spacing between them (Figure 3.9). Likewise, every example shows a thin white tape surrounding the perimeter of the stretched silk textiles, possibly as an interface that could prevent damage to the textile, increased the pressure between the tacks and the wood and facilitated their removal after the completion of the painting. This same system closely resembles that instructed by Kelly for painting large silk banners (Kelly, 1911, pp. 105-106).

[26] The term strainer refers to a fixed wooden or other material frame onto which a textile is attached taut. It is different from a stretcher as this last one is a movable frame that has in addition keys inserted in their corners to expand them and make the textile even tauter, allowing the adjustment to variations of Relative Humidity (Buckley, 2012, p. 148-9). Given that some sources recommend the use of keys and they cannot be seen in the historical photographs to confirm, both terms will be used in the text unless it has been confirmed.

Figure 3.8 View of Tutill's ground floor studio in the 1930s. (Image © Gorman, 1973, p. 61).

Figure 3.9 Close up to a banner in process in the 1930s showing the regular spacing of the tacks. (Image © Gorman, 1973, p. 61).

The silk textiles for Kenning's banners seem to have been prepared in a similar way as Tutill's, although the evidence of the historic photograph of his studio shows a reduced loom of a similar size as the silk fabric (Figure 3.10). In the image, two banners are seen stretched and being worked in two different stages: the outlining of the areas to be gilded on the far-right side and the application of the lettering in the centre. Both textiles also appear to be fixed to the front face of the stretcher with tacks, with a similar white tape following the perimeter. Another finished banner that is seen hanging un-stretched at the bottom front, probably being left to dry.

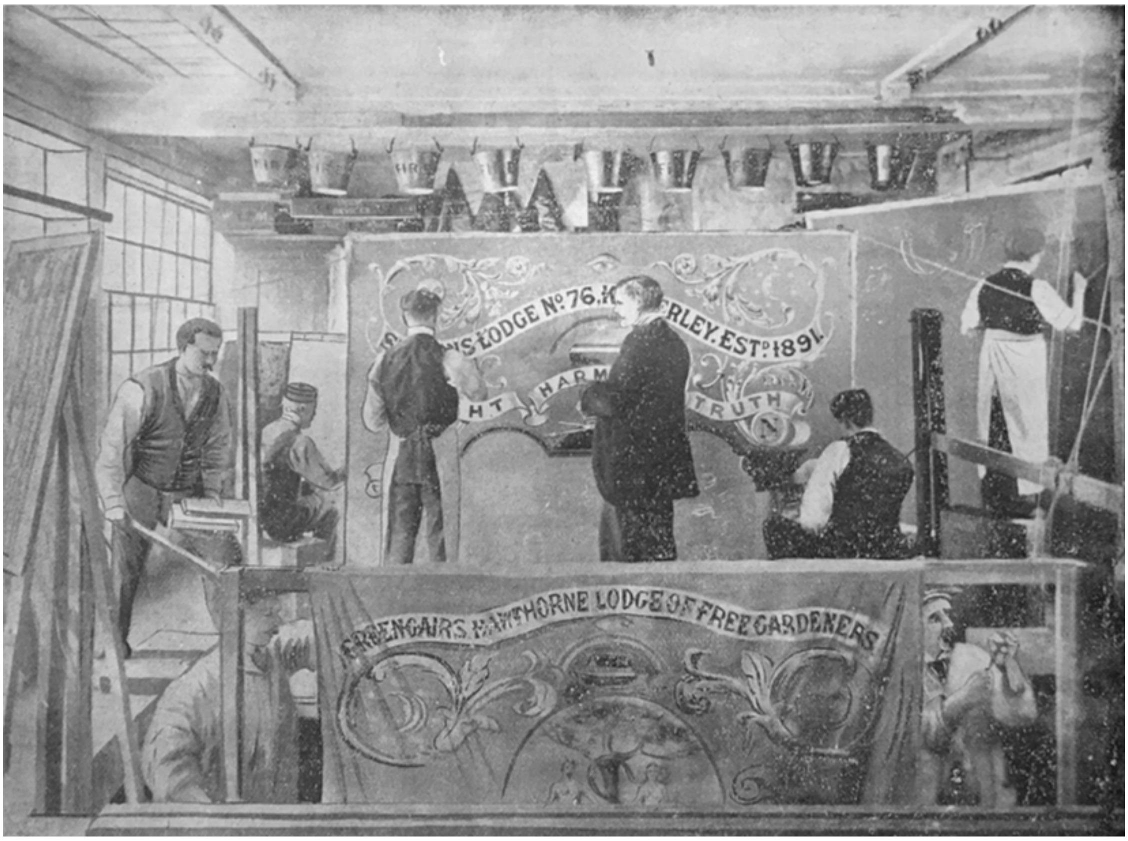


Figure 3.10 View of Kenning's top floor studio in the 1900s. (Image © *George Kenning and Son. Summer Number [Supplement]*, 1901, p. 28).

In the footage of Mr Sharpe's studio work, the woven silks of the banners are clearly seen stretched and fixed to the front of the looms by means of tacks, having the white tape as an interface seen in both Tutill's and Kenning's images (Figure 3.11).

Figure 3.11 Still from the film 'Banner Artists' (1958) showing the even spacing of the tacks and the thin white tape used as interface. (Image © British Pathé).

3.3.3.3 Sizing of the silk

Tutill's patent No. 1728 for 'Treating Materials for the Manufacture of Banners and Flags' explains the preparation of his silks prior to painting (Tutill, 1861, pp. 1-3). There it is indicated that he and his workers would firstly apply a coat of diluted India-rubber with a brush or any other method to the portions of the banners or flags that were intended to be painted and in some cases to the parts that were to be gilded too (Tutill, 1861, p. 3). Although not stated in the patent, it is possible that the general design was probably transferred to the silk fabric before the sizing, as it was recommended in the technical sources reviewed in section 3.2.

Tutill's patent states that the first coating of rubber was either naturally dried or by means of a heated chamber, but there is no evidence of the latter in the surviving photographs published by Gorman (Gorman, 1973, pp. 57-65). After the drying of the first coat, a second coating of diluted India-rubber mixed with linseed oil was added, with an additional third coat of just oil paint to serve as ground layer for the designs (Tutill, 1861, p. 3). However, the patent also specifies that: “in some cases I [Tutill] omit the coating of india-rubber solution and oil before applying the paint” (Tutill, 1861, pp. 2-3). This could explain why rubber was not detected in all Tutill banner samples and why there were differences observed by Smith et al. in the layering system within the same Tutill banner (Smith, Thompson and Hermens, 2016, pp. 1-19). It could also be that the use of rubber might have been discontinued by the time of its production, as it is a much newer example. However, rubber has been positively identified in four Tutill banners dating 1884, 1896, 1905 and 1914-1918 using FTIR-ATR (Garside, 2018; Rogerson and Lennard, 2005, pp. 13-14), confirming that Tutill did use rubber in some cases for the making of banners between those years.[27] Heat-treated linseed oil has also been identified,[28] using gas chromatography-mass spectrometry (GC-MS), throughout the painted regions of Tutill banners dating approximately from 1860 to 1918 (Rogerson and Lennard, 2005, p. 13).

The purpose and main advantages of Tutill’s patented technique were that the banners became more durable and flexible, with the paint less liable to crack or delaminate (Tutill, 1861, p. 3). The pursuit of flexibility and the incorporation of rubber and other materials including honey and sugar, thought to prevent the cracking of the paint layer, have been highlighted by Carlyle for British nineteenth century paintings on canvas (Carlyle, 2001, pp. 58, 172, 176, 424). The use of india-rubber for the production of painting grounds in Britain and France has been investigated by Labreuche, who reported recipes and patents between the 1830s until the 1850s, predating Tutill’s (Labreuche, 2011, pp. 14-30). Tutill’s “invention” was in fact responsive to the developments of his time, as Lennard and Rogerson have also pointed out (Rogerson and Lennard, 2005, p. 14).

[27] This will be further discussed in Chapter 7.

[28] Heat-treated linseed oil refers to partially polymerised drying oil by means of temperature, either in presence of oxygen (sun-thickened, thickened, and boiled oils) or in absence (stand oil).

In the case of Kenning's production, the sizing of their silk textiles is not mentioned in the company profile and has only been considered and analysed in the study of Rogerson and Lennard. They report that Kenning used an oil ground as a preparation layer before the application of paint, having penetrated between the silk fibres based on the UV fluorescence images of their cross-sections (Rogerson and Lennard, 2005, p. 14). This interpretation differs from the recommendations of the technical manuals reviewed, which consistently instructed the sizing of the woven silk to prevent its staining with the oil of the paints. Therefore, a methodological approach using fluorescent staining was designed for trying to achieve the mapping and identification of potential binders in painted silk banners, to be eventually applied to the five Kenning banners of Glasgow Museums Collection. This forms part of Chapters 5 and 6.

Contrastingly, the footage of Mr Sharpe's work did not offer any further information about the sizing of the woven silks before painting.

3.3.3.4 Gilding and painting

The stages of gilding and painting are seen in different order in the photographic evidence of Tutill's studio and in the footage of Mr Sharpe's studio. The majority of the banners are seen with the metal leaf already applied onto their stretched silk fabrics, but in some cases the central painting is being carried out before the decoration of the leaf, while in others the opposite happens. This may be dependent of a practical reason, as it was experienced during the making of the banner *Reconstruction 2* for this research (see Appendix IV).

In a general view of Tutill's ground-floor studio from the 1930s (Figure 3.12), nine painters are seen working at different stages of the process (Gorman, 1973, p. 60). It seems likely that the painting on one side was completed before turning the strainer/stretcher over and working on the opposite, as it is also recommended in the technical sources reviewed. The setting of the strainer/stretcher leaning along the walls of the studio suggest that the work was accessible only on one of their sides at a time.

Figure 3.12 View of Tutill's ground floor studio in 1899. (Image © Lillingston, 1899, p. 320).

Tutill specified in his patent that the paints used for his banners should be made with old oil or oil that had been subjected to the atmosphere for a considerable period, to speed up the drying of the paint over the india-rubber coating (Tutill, 1861, p. 3). It is not clear if the indication meant that Tutill prepared his own paints by mixing the pigments with old oil or if he added the old oil to readymade paints, which became commercially available inside collapsible tubes following the American patent No. 2252 by John Goffe Rand dating 1841 (Izzo, 2010, p. 18). However, important evidence was found in the original glass slide of one of C. Pinkington photographs from 1899 (Lillingston, 1899, p. 320), which ended up in the Gorman Archive. In the lifted lid of a wooden box is written the indication “PLEASE PUT TUBES BACK [WITH] CAPS ON” (Figure 3.13), which proves that at least from 1899 onwards Tutill used commercially produced paints for his banners. Ready-made painting materials became commercially available in Britain as early as the 18th century (Jones, p. 112), with paints being industrially produced at large from the 1840s and largely automated, mechanised and industrialised by the closing decades of the 19th century (Sinclair, 2019, p. 2). Thus, it is likely that the oil paints used by commercial banner-makers were most, if not all, manufactured by specialised firms.

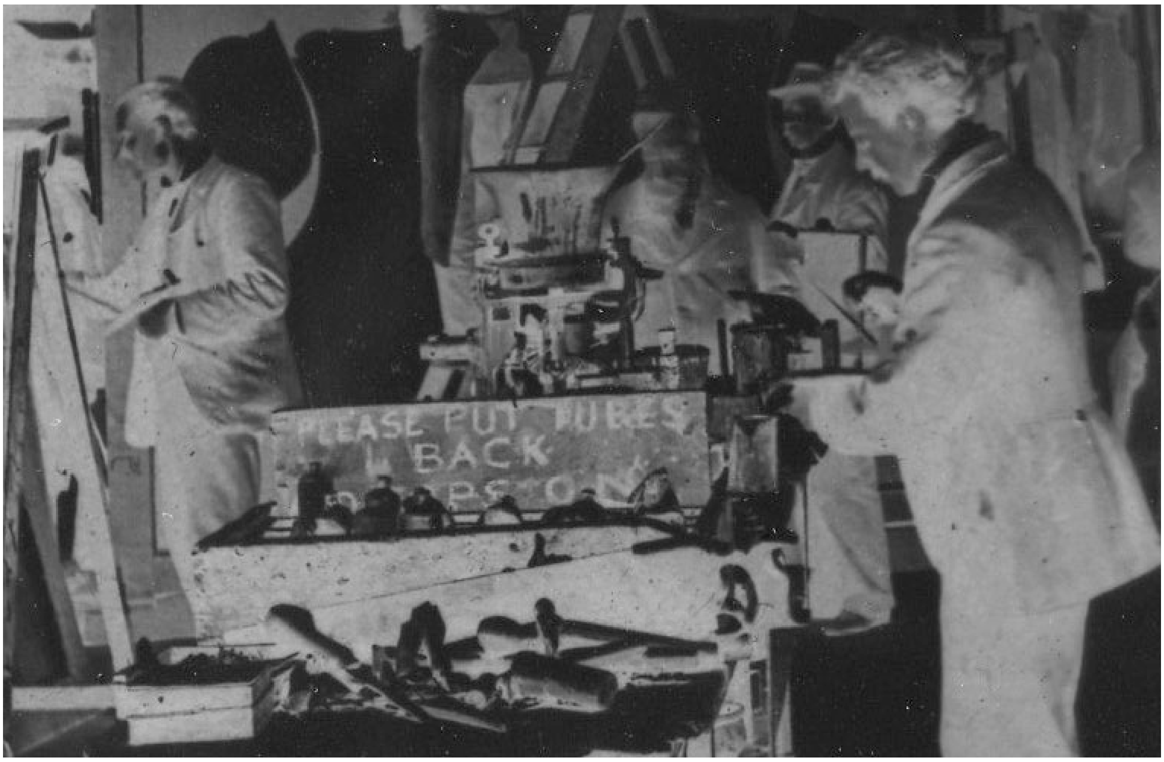


Figure 3.13 Close up of Pilkington’s original negative for Lillingston’s article (1899) in the Gorman Archive. (Image © People’s History Museum Manchester).

Kelly suggested the use of commercial paints for the majority of colours used for sign painting, including banners, indicating that only those used in abundance for instance lead white, should be purchased as pigments and prepared in the studio (Kelly, 1911, p. 56). The recommendation of using commercially produced paints was also located in other technical manuals for sign painters, gilders and decorative painters (Allen, 1899, pp. 30-31; Scott-Mitchell, 1905, p. 42; Williams, 1855, p. 35), the last one published by the manufacturer Winsor & Newton, showing its self-advertisement. There is also evidence to suggest that a contemporary banner maker to both Tutill and Kenning, Henry Whaite of Manchester, might have purchased his materials from the London colourman Roberson, as he kept an account under his name and commercial addresses in the *Index of Account Holders* of the company (Woodcock, 1995, p. 233).[29]

The binding media of the Tutill's banners of Rogerson and Lennard's study has been identified by Eastaugh using GC-MS, detecting a partially heat-treated linseed oil in both paint and ground layers of the selected banners dating between 1860 and 1918 (Rogerson and Lennard, 2005, pp. 13-14). Additionally, Smith et al. have identified linseed oil in cross-sections and paint-scraping samples from a 1950's Tutill banner using FTIR-ATR (Smith, Thompson and Hermens, 2016, pp. 1-19). In both cases, the analytical results seemed to confirm some aspects of the technique described in the patent. Eastaugh's identification of a partially heat-treated oil could be the case for the "old oil" described in Tutill's patent. However, it is important to bear in mind the differences in the handling properties between the different types of linseed oil available at the time, as the current research has highlighted (Bonaduce et al., 2012a, 2012b). Examples of two types of paint preparation with radically different properties in between, is detailed in the report of the historically informed banner reconstructions made for this study (Appendix). Incidentally, the molar ratios which could help evaluate the differences between heat-treated and pre-oxidised linseed oils with GC-MS have been published by Izzo (Izzo, 2010, pp. 71-72) and are considered for the Scientific Examination section of this thesis, in the corresponding GC-MS analysis of samples from the banners of this research.

The pigments used by Tutill are referred to by Emery as having a standard palette (Emery, 1998, p. 18). Accordingly, a limited range of pigments has been identified in four Tutill's banners dating between 1884 and 1920 (Macdonald et al., 2005, p. 227). These include predominantly lead white for the ground layers and vermilion, synthetic ultramarine, Prussian blue, chrome yellow and lead

[29] The contents on his accounts were not possible to be verified, as the archive was closed for research from 2019 (Cambridge, 2019) to the date of submission of this thesis.

white for the different paints. Red lead has been additionally identified in the study of Smith, Thompson and Hermens (2016, p. 18).

In the 1958 film of Mr Sharpe's studio, there is evidence of other stages being carried out by him and his team, like the preparatory drawing of a central scene with charcoal (Figure 3.14) and the application of metal leaf (Figure 3.15) (Pathé, 1958). In the example of the drawing, the work is being done by Mr Sharpe with the gilding undecorated, while in the sequence of application of leaf the paint appears to be finished.

Figure 3.14 Still from the film 'Banner Artists' (1958) showing Mr Herbert Sharpe doing the preparatory drawing before painting with charcoal. (Image © British Pathé).

The type of metal leaf showed in the footage is identified as transfer leaf, patented around the 1880s and regarded as a more economical and easily handled version than regular metal leaf (Rauskolb, 1915, p. 19). Transfer leaf was applied by means of a mordant or oil-gilding method. By the turn of the century a variety of metals could be prepared in such way: gold, silver, aluminium, platinum, tin, *Schlag* metal, Dutch metal, copper and brass (Scott-Mitchell, 1905, pp. 19-27). Transfer leaf is still applied with the method of oil-gilding by professional gilders and sign painters to date (Ritson, 2018). Smith et al. have identified aluminium in a 1950s banner by Tutill (Smith, Thompson and Hermens, 2016, p. 4) interpreting it as a metallic paint, although may in fact correspond to an aluminium transfer leaf. The oldest mention of aluminium leaf located so far was found in an American sign-painting manual written by the sign painter C. J. Allen (Allen, 1899, p. 20).

Figure 3.15 Stills from the film 'Banner Artists' (1958) showing the manual application of transfer leaf over a white ground layer. (Image © British Pathé).

In Kenning's company profile it is recorded that their Banner-painting department had men suspended from 'travelling cradles' busily painted silk banners with appropriate designs that after being fringed and tasseled, would be mounted on poles to be paraded by trade or friendly societies and similar (*George Kenning and Son. Summer Number [Supplement]*, 1901).

From the two surviving images of Kenning's Banner-painting department (Figures 3.10 and 3.16), it is evident that the making of banners for trade and friendly societies was a prolific part of the business, as they show a total of twelve workers carrying out different stages of their manufacture (*George Kenning and Son. Summer Number [Supplement]*, 1901). It is mentioned in the company profile that "the greatest care has to be exercised in colouring the designs upon them so that they can be folded or rolled without cracking" (*George Kenning and Son. Summer Number [Supplement]*, 1901). The access to the different parts of the banners was accomplished with a set of scaffoldings and ladders distributed in a two-story room, as seen in the surviving images (Figures 3.10 and 3.16).

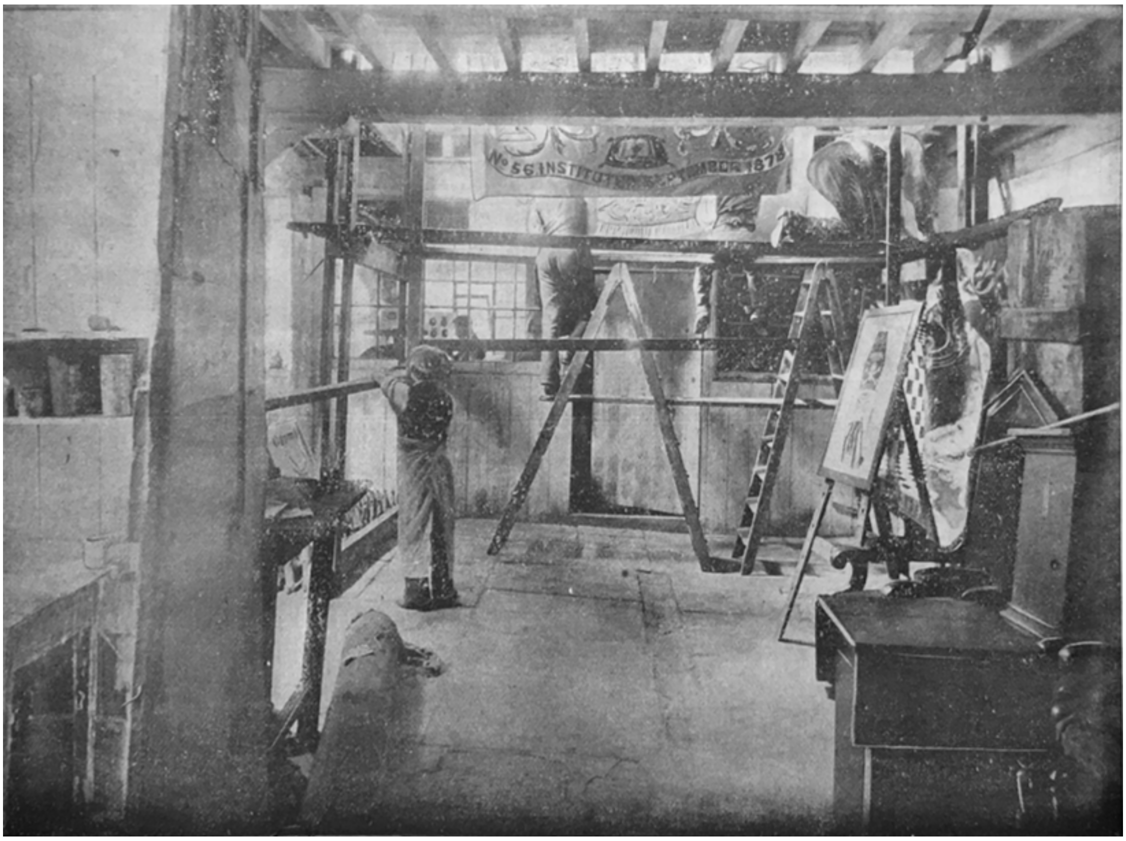


Figure 3.16 View from Kenning's ground floor studio in the 1900s. (Image © *George Kenning and Son. Summer Number [Supplement]*, 1901, p. 28).

In the top view of Kenning's studio (Figure 3.10) the three banners photographed show the progression of their manufacture. On the right-left side of the image there is a banner having the outlining white ground applied, whilst on the centre another banner is having the lettering and decoration of gilding carried out. Hanging from a lower beam, an un-stretched finished banner is likely left to dry, without having any fringing yet (Figure 3.16).

According to the company catalogue, the production of Kenning's banners continued after their moving to the Eagle Wharf Road premises in 1932 (Post Office Directory, 1932). An image of their new studio shows an open space similarly located on the top floor, benefitting from the natural light and ventilation from the skylight windows and high ceilings, with only two people working at the time the photograph was taken (Figure 3.17) (G. S. Kenning, 1932, p. 15).

Figure 3.17 View from Kenning's Eagle Wharf Road top floor studio. (Image © G. S. Kenning, 1932, p. 15)

A smaller stretched-silk textile is shown on an easel, depicting the design of one of the Masonic 'Royal Arch' banners offered since his 1915 catalogue (G. S. Kenning, 1915a, p. 26). At the left side of the image, a working table is shown with a set of three lidded tin cans, one glass jar, two palette knives and a wooden box with what seems to be collapsible paint tubes, giving a brief insight into the painting materials they used at that time (G. S. Kenning, 1932, p. 15).

Similarly to Tutill's evidence, it is very likely that Kenning used commercially produced paints for the manufacture of his banners. As stated by Sinclair Dootson, by the final decades of the nineteenth century saw the largely automatisation, mechanisation and industrialisation of oils colours (Sinclair Dootson, 2019, p. 2), which judging by the recommendations of the contemporary sources for sign painters discussed in section 3.2, could have been closely followed by the commercial banner makers.

Additional evidence to suggest that Kenning could have been used commercially produced paints is the proximity to which his headquarters of Little Britain were to the most renowned colour-men of that time: Winsor & Newton, Roberson and Reeves & Son. The three companies were also the only manufacturers that lasted for as long as Kenning's, as listed in the British Artists' Suppliers 1650-1950 of the National Portrait Gallery website (Simon, 2011). Having not been listed in the account holders of the Roberson archive, it could then be possible that Kenning procured his paints from either Reeves & Son or Winsor & Newton, respectively located in London at No. 113 Cheapside between 1845-1940 and No. 38 Rathbone Place between 1833-1938 (Figure 3.18).

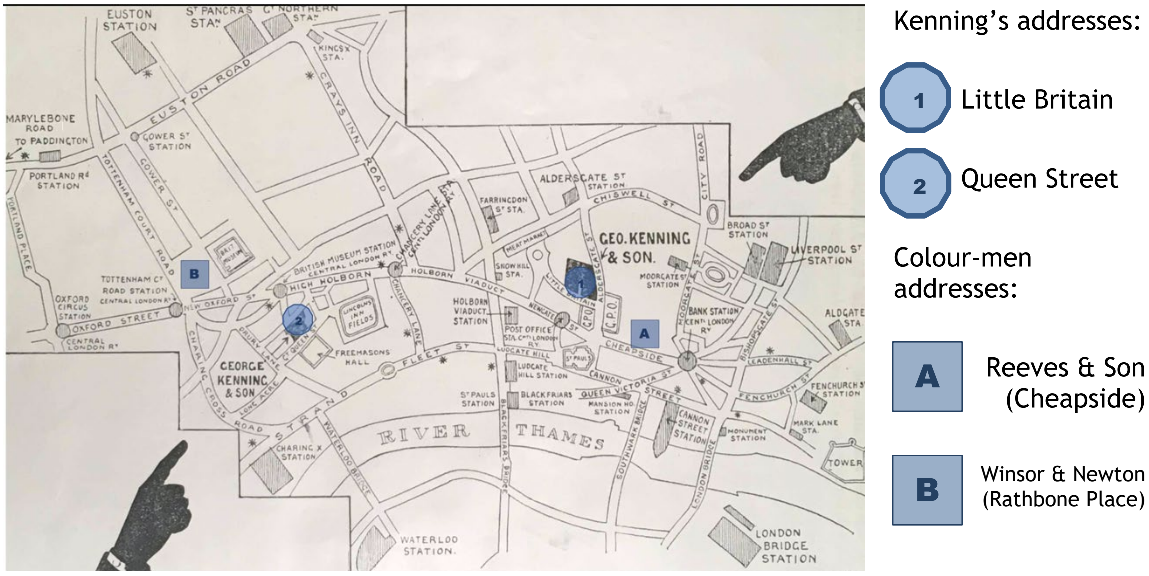


Figure 3.18 Location map of Kenning's companies by 1901 with indication of colour-men addresses adapted from Google Maps. (Image © *George Kenning and Son. Summer Number [Supplement]*, 1901).

Macdonald et al. have analysed paint samples from four George Kenning & Son banners with Raman spectroscopy for the identification of pigments (Macdonald et al., 2005, pp. 222-229). The four banners belonged to the People's History Museum Collection in Manchester, listed in the article as: the *Electrical Trades Union (Walter Crane design)*, *The National Union General and Municipal Workers Lanes District*, the *National Union of Railmen (sic) Paddington No. 2 Branch* and the *National Union of Railmen (sic) Manchester District Council* (Macdonald et al., 2005, p. 224). To improve the interpretation of their results, the four banners were located in the National Banner Database, confirming their manufacture by the company of George Kenning & Son (Initiative, 2018).

However, three of the banners were wrongly titled in the article, their correct title being: *The National Union General and Municipal Workers Lancashire District,* the *National Union of Railwaymen Paddington No. 2 Branch* and the *National Union of Railwaymen Manchester District Council* (Initiative, 2018).

Macdonald et al. identified lead white in the ground layers of the *Electrical Trades Union banner* and the *Lancashire District banner*, with no ground layer in the other two examples. They also identified the use of red ochre, Prussian blue, chrome yellow and calcium white (calcium carbonate) as pigments for the paints, commenting that they were found to be more coarsely ground that the pigments used by Tutill (Macdonald et al., 2005, p. 227). Generally, a coarsely ground pigment suggests a manual grinding in opposition to an industrial one, but studies support that from the later part of the nineteenth century to date all pigments have been ground industrially (Sinclair, 2019). Thus, the identified variations in particle size could potentially be indicating a lower quality of the commercial paints purchased by Kenning than those purchased by Tutill.

An additional characteristic of the production, inferred from the images in the 'Supplement', is that Kenning's banners seem to have been designed individually (George Kenning and Son. Summer Number [Supplement], 1901). As it will be elaborated in Chapter 7, none of the five Kenning banners of Glasgow Museums Collection have a repeated design or size, nor does any of the other Kenning examples included in the related publications (Clark, 2001, pp. 139,205; Gorman, 1973, pp. 82,117-118; 1985, pp. 46,47). Thus, it is likely that most of Kenning's banners were bespoke designs, prepared individually for each commission. This contrasts with Tutill's production, which evidently followed a more standard approach, as depicted on the images of his workshop in the 1890's and 1930's (Gorman, 1973, pp. 60-62). Most of the banners shown in those photographs have a corresponding design with each other, which also relates to the fact that Tutill's jacquard-loom banners had the areas to be painted already woven into the silk (Emery, 1998, p. 17). Moreover, Tutill offered standard trade unions' or friendly societies' designs in his catalogues to select from, which have also been referred to as 'patter-book designs' (Emery, 1998, p. 26). Kenning's catalogues, in comparison, only showed the Masonic designs for their bannerettes.

3.3.3.5 Trimming and packing

Tutill's banners were un-stretched and taken to the top floor of the studio, where a group of women would trim them by hand (Figure 3.19). They are seen in 1899 sewing the fringes (Figure 3.20) and adding the borders (Figure 3.21) with the banners hanging from their pole loops (Lillingston, 1899, p. 324; Gorman, 1973, p. 62).

Figure 3.19 View of Tutill's top floor studio in 1899. (Image © Lillingston, 1899, p. 324).

Figure 3.20 Digital close-up showing the manual sewing of the borders.

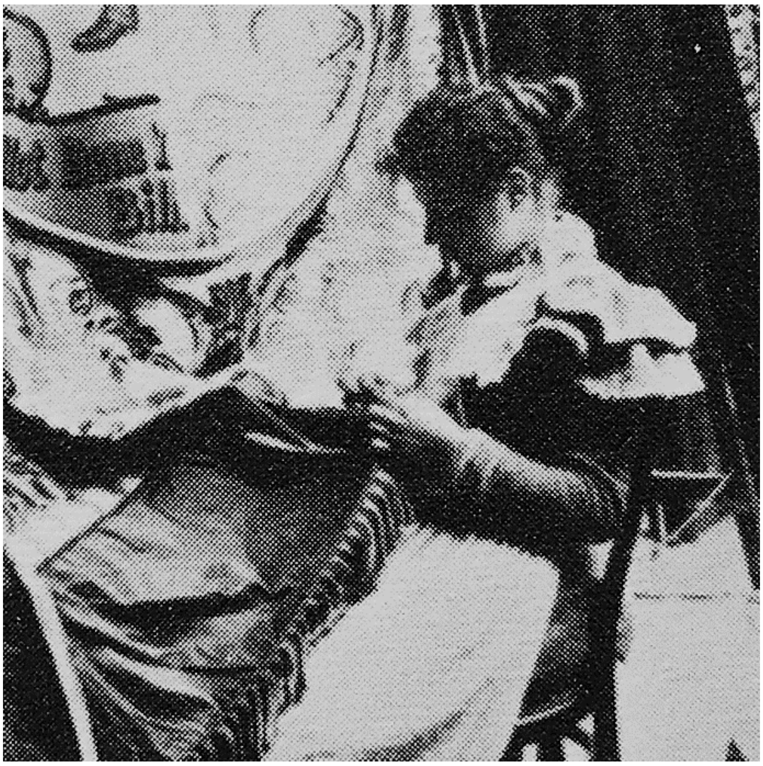


Figure 3.21 Digital close-up showing the manual sewing of the fringe.

Tutill delivered his banners rolled inside a custom-made wooden box, including the poles and ropes, which were charged additionally (Moyes, 1974, p. 44). Caring instructions were added to the box, including how to separate the packaging paper when it had become adhered to the not yet dried oil paint (Clark, 2001, p. 13). Although the primary sources do not state the time needed for their production, Tutill recommended requesting them with sufficient time in advance (Tutill, 1896), arguably to avoid the adhering and resulting damaging of their paint layers:

> "Banners painted at my leisure in the autumn and winter months are far more durable than those hurriedly executed in the busy season, because sufficient time is allowed for the general work to get thoroughly dried and properly set before the Banner is used"

Although there is no photographic evidence of the application of fringes in Kenning's banners, all of his banners collated in the National Banner Database are fringed (Initiative, 2018). There is also no indication on Kenning's company profile about the time needed for the manufacture of his banners or their type of packing. However, the minutes of the *Glasgow Typographical Society* and the *United Kingdom Society of Coachmakers, Glasgow Branch* (former name of the *National Union of Vehicle Builders, Glasgow Branch*), state that their banners took respectively 27 days (Association, 1883a, 1883b) and four months (Coachmakers, 1914a, 1914b) between their request and delivery. Additionally, two banner boxes by Kenning & Son survive: that of *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* and that of *The National Union of Railwaymen, Hither Green Branch No. 537*. Both boxes show similar metal hinges and locks, assembled with similarly shaped wooden boards, which suggest an in-house production, likely to happen in Kenning's own carpentry workshops. The box of *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* also contains the original side carrying poles, leather harnesses and ropes that were included in the banner price according to the 1878 catalogue (Kenning, 1878, p. 96), all currently kept in Glasgow Museums Collection (see Appendix I for images and further information).

In Mr Sharpe's footage, the narrator indicates that it took him up to four months to complete a banner (Pathé, 1958), which coincides with at least one of the manufacturing periods of George Kenning company.

3.4 Sources on the material characterisation of nineteenth and twentieth centuries British double-sided painted silk banners

Much of the current knowledge about the material characterisation of painted trade union banners, as acknowledged in the literature review of Thompson, Smith and Lennard, comes from few technical studies and the information gathered from the objects during their conservation (Thompson, Smith, and Lennard, 2017, p. 70).

Most of the research on the material characterisation of painted banners to date has been led by the initiative of textile conservators. However, only four studies were identified as significantly important for the present investigation. This is because they concentrated on British, commercially produced, double-sided painted silk banners, made between the 19th and 20th centuries. The two first studies were conducted by a large multidisciplinary team led by Rogerson and Lennard (2005) and MacDonald, Rogerson, Vaughan, and Wyeth (2005), as part of the holistic approach of the former Research Centre for Textile Conservation and Textile Studies, and the Textile Conservation Centre (TCC) of the University of Southampton. The third study was also conducted by a multidisciplinary team led by Smith, Thompson and Hermens (2016), at the former Centre for Textile Conservation and Technical Art History (CTC-TAH) of the University of Glasgow, successor of the TCC.[30] The fourth study is a continuation of the latter, also carried out by Smith and Thompson with the collaboration of Schmidt and Dixon (2019).

The publication of the two TCC studies (Macdonald et al., 2005; Rogerson and Lennard, 2005), followed their first annual conference in July 2004, entitled 'Scientific Analysis of Ancient and Historic Textiles: Informing preservation, display and interpretation' (Southampton, 2017). Both studies includes some of the outcomes of the conservation works conducted on painted banners at the centre, between 1985 and the year of the publication (Rogerson and Lennard, 2005, p. 15), which benefitted from the cumulative knowledge of almost 20 generations of textile conservators/textile conservation students (Foundation,

[30] Renamed as the Kelvin Centre for Conservation and Cultural Heritage Research from 2021.

2015), and the regular collaboration of conservation scientists like Nicholas Eastaugh, Paul Garside and Paul Wyeth (Frances Lennard, 2018).

Rogerson and Lennard examined the painting techniques of the two major banner makers from the 19th century, George Tutill and George Kenning, with the aim of further understanding the flexible qualities of painted banners, the layering structure of their painted regions and identifying their materials (Rogerson and Lennard, 2005, pp. 12-13). Additionally, they evaluated the past conservation treatments of two anonymous painted banners (Table 3), which will not be discussed in this review for exceeding the scope of the present research. They considered the material characterisation of an unspecified number of samples, taken from nine painted banners made by George Tutill and six painted banners by George Kenning, dating from approximately 1860 to 1918 (Rogerson and Lennard, 2005, p. 13). Two additional pairs of anonymous banners were included, giving a total of 19 painted banners studied, all from the Peoples' History Museum's collection, Manchester.

In Rogerson and Lennard's paper, all textiles were identified as silk by means of light microscopy, focusing on the main fabric as no information is given about their supplementary elements (i.e. fringe, pole loops, guides). Cross-sections from painted regions of each banner were also embedded and viewed under polarised and UV-fluorescence light microscopy, although the few images included were not properly labelled, hence limiting their usage for further comparisons.

The paint medium of all samples was analysed by gas chromatography-mass spectrometry (GC-MS) by Nicholas Eastaugh, revealing that both manufacturers used partially heat-treated linseed oil throughout the painted regions of the banners, including the ground (Rogerson and Lennard, 2005, p. 13). This relates to Gorman's suggestion that Tutill employed either old oil, or previously exposed to the atmosphere "for some time" for the preparation of his paints (Gorman, 1973, p. 50), as both types of oil would have gone through a cross-linking process either catalysed by temperature, UV radiation or oxidisation, to modify the drying time of cold-pressed linseed oil. However, no analytical data from any of the samples were included in the published work to help elucidate the results.

Five additional samples of four Tutill banners were analysed by Paul Garside to detect the presence of rubber, through attenuated total reflection (ATR) infrared spectroscopy (Rogerson and Lennard, 2005, p. 13). The identification was done against a reference spectrum of natural rubber, having matching peaks in all the samples with a reasonable degree of confidence (Garside, private communication, 2018), although no indication of functional groups is included. The finding confirming what was previously stated by Gorman (Gorman, 1973, pp. 50-51) and verified by the authors in Tutill's 1861 patent (Rogerson and Lennard, 2005, p. 13), in that Tutill used his “India rubber” preparation for a long period, between 1884 and 1914/18 according to the analysed banners (Garside, private communication, 2018).

Rogerson and Lennard stated that both manufacturers used means to ensure the flexibility of their banners, following a similarly simple layering system and flexible binders (i.e. rubber and linseed oil), which rendered their banners supple close to the time of production (Rogerson and Lennard, 2005, pp. 13-14). As part of their interpretation, they situate the production of both banner makers within the context of 19th century painting innovations, using extracts from contemporary sources by Fielding, Mérimée and Vibert (Fielding, 1839; Mérimée, 1839; Vibert, 1892) that elaborate on the flexibility needs of paintings on canvas; as well as one of the many publications by Carlyle on British 19th century painting materials (Carlyle, 2001). However, the lack of methodological description of the data and the confusion of terminology, complicate the interpretation of their results.

One of the properties repeatedly emphasised by Rogerson and Lennard is that of flexibility, particularly applied to the paint layers of the banners. They refer to a brief publication by Eastaugh (Eastaugh, 1982) for explaining that: the decrease of flexibility in the paint layer is a result of the extended drying period of the oil media, during which it becomes increasingly less flexible due to the cross-linking of their fatty acids (Rogerson and Lennard, 2005, p. 15). The knowledge on the curing and ageing of oil paints has since been significantly extended in the context of easel paintings (Erhardt, Tumosa, and Mecklenburg, 2005; van der Berg, 2002; van der Berg, van der Berg, and Boon, 1999). The main processes in the drying of oil paints have been grouped in polymerisation, hydrolysis, oxidation and metal soap formation, all responsible of producing changes in the mechanical properties of the film over a long-term period (Erhardt et al., 2005, p. 148; Izzo, 2010, pp. 8-15). Flexibility is one of the physical properties that change over the curing and ageing of oil paints, becoming more stiff or brittle as a result of their passage from a polyester to an ionomeric form (van der Berg et al., 1999, p. 249). The curing of oil paints leads to the formation of a cross-linked network, producing at first a very elastic film called linoxyn, which becomes very fragile and brittle after the rupture in the polymeric network and the formation of hydrophilic compounds (Izzo, 2010, p. 15). The change from a flexible to a stiffer oil paint film happens relatively early (within decades even), although it is also said to slow considerably as the paint ages, thus maintaining a relatively flexible film over time (Erhardt et al., 2005, p. 144). Hence, the question remains as to whether the apparent change in flexibility, or the explanation of its cause, is the key to understand the behaviour of painted banners.

In the second article, MacDonald et al. published the first systematic study dedicated to the characterisation of painted banners' pigments using Raman spectroscopy for their identification (Macdonald, Rogerson, Vaughan, and Wyeth, 2005). The study was directed at collating a spectral database of inorganic pigments in painted banners of the nineteenth and twentieth centuries, as well as to prove their preparatory process prior to painting (Macdonald et al., 2005, pp. 222-223). It is not clear whether or not such database was implemented, but after the closure of the TCC in 2009, most of the information was kept in the personal archive of one of the authors (Rogerson, personal communication, 2018).

What Macdonald et al. discovered, is that Raman analysis of the resin-embedded cross-sections was best achieved when the samples were previously prepared with a microtome, as it produced cleaner/flatter surfaces that minimised the interference caused by their otherwise dissimilar planes (Macdonald et al., 2005, p. 227). They also identified the range of pigments used by Tutill, Kenning and two anonymous manufacturers for the preparation of their grounds and paints, considered to be very limited in comparison to the variety typically found in paintings of the nineteenth and early twentieth centuries (Macdonald et al., 2005, p. 227). However, the colours and the number of banners sampled are considered too few for such comparison. They also remarked on how Kenning's examples seemed to have more coarsely grinded pigments than Tutill's, without showing any evidence or elaborating on the matter, which is important for the characterisation of their paints and the understanding of their technique. Conversely, neither the dyes nor the metal leaf/paint could be detected with the selected technique, remaining as questions for further studies.

In the third and most recent study on the characterisation of painted banners, Smith, Thompson and Hermens, identified the materials of another George Tutill banner, dating from the 1950s (Smith, Thompson and Hermens, 2016). The team analysed four samples taken from different painted sections of the banner, all clearly indicated in the text, some of which were subsequently embedded and prepared with the ion-milling technique to enhance their viewing and technical analysis (Smith, Thompson and Hermens, 2016, pp. 1,5). They followed a systematic and multi-analytical approach for the identification of the painting technique, making use of light microscopy (both normal and UV); Scanning-Electron Microscopy with Energy-Dispersive X-ray Spectroscopy (SEM-EDX); Micro Raman spectroscopy; and Fourier transform infrared spectroscopy with attenuated total reflectance (FTIR-ATR) (Smith, Thompson and Hermens, 2016, pp. 3-4).

Smith et al. positively identified almost every banner component, reporting silk for the central textile; a mixture of viscose and cotton for the fringe; lead white and calcium carbonate bound in linseed oil for the ground layer; lead white and lead red bound with linseed oil for the sampled paint layers; aluminium for the supposed metallic paint; and even shellac for the coating of the wooden pole and one of the paint samples (Smith, Thompson and Hermenes, 2016, p. 18). They also discovered that the preparation layers on the painted areas did not appear to be consistent across the banner, an important aspect that had not been detected before. Nevertheless, some misuse of terminology also confuses the interpretation of their results to an extent, particularly concerning the binding medium used for the preparation of the textile prior to painting and the translucent paint layer bound with shellac.

Similarly to Rogerson and Lennard (2005), the authors do not make a distinction between the size and the ground layer, referring to them indistinctly as "preparatory layers" (Smith, Thompson and Hermens, 2016, pp. 4,5). This is fundamental to one of their main findings, as it is the size and not the ground layer that was applied selectively, hence preventing the seeping into the textile of the white-pigmented ground, which in turn appears to be consistently applied throughout the sampled areas of the banner. There is also a misuse of the term coating/varnish when interpreting the translucent layers of colour in some parts of the banner, since they are in fact coloured glazes applied as part of the painting technique (Rodriguez, 1998; Emmerling et al, 2013). This is important because glazes have often been noticed, yet not characterised, over the metal leaf or metallic paint of similar types of banners, both as protection from oxidation and to make the substrate appear golden, as it was mentioned in a personal communication with the former senior textile conservator of the People's History Museum, Vivian Lochhead, who oversaw their banner collection between 1989 and 2016 (Lochhead, 2018).

One particular finding by Smith et al. was the detection of metal soaps with FTIR, lead carboxylates in particular. They associated their presence to an opalescent bloom on the surface of the banner, although their results were not entirely conclusive as they said to have employed a "macro FTIR" technique rather than a "micro FTIR" (Smith, Thompson and Hermens, 2016, p. 7), which did not allow imaging of the sampling area, where no other imaging technique was used (e.g. OM or SEM). While blooming has been previously reported as frequent for painted banners (Lennard and Lochhead, 2003; Lochhead, 1995; Thompson, 2010), only two studies, one of them unpublished, have linked its causes to the formation of metal soaps (Rode, 2003; Stevens, 2003).

From the painting conservation perspective, the study of metal soaps is an ongoing concern, and the state of their research as has been recently reviewed by the team of Cotte et al. (Cotte et al., 2017). Numerous publications not only explain the formation of metal soaps in oil paintings and their role in the blooming of their surface (Boon, van der Weerd, Geldof, Heeren, and Noble, 2002; Ferreira, Boon, Marone, and Stampanoni, 2011; Keune, 2005; Keune and Boon, 2007; Shimazu, 2015; van Loon, Noble, and Boon, 2011), but moreover have related their occurrence to the various pre-treatments applied to the processing of linseed oil, particularly studied for the case of British 19th century painting production (Bonaduce et al., 2012a, 2012b; Carlyle, 1999; Carlyle and Witlox, 2007). Such processes included the washing of the oil, its heating and the addition of driers at different stages of the paints' preparation, all aimed to modify their handling properties like viscosity and drying speed (Bonaduce et al., 2012a, pp. 1064-1065). These procedures can be associated with the production of commercial painted banners, as both properties are considered optimum for achieving the considerably thin layers of paint detected by Rogerson and Lennard (Rogerson and Lennard, 2005, p. 14), and to accelerate their production, as remarked by Gorman (Gorman, 1973, p. 50).

Nevertheless, the identification of paint driers and their link with the formation of metal soaps, has not yet been considered for the case of painted banners. One of the reasons might be that their identification is reportedly complicated and most of the time can only be conjectured (Cotte et al., 2017, p. 9), predominantly for the case of lead driers in the presence of another lead pigment (Noble, van Loon, and Boon, 2005; White and Kirby, 1994), as it is often the case for painted banners. Correspondingly, it has been reviewed that metal soaps can be formed likewise in the presence of lead driers and/or in the presence of lead pigments, making their interpretation all the more difficult (Cotte et al., 2017, pp. 8-10).

4 Analytical methodology for the scientific examination of five Kenning banners of Glasgow Museums Collection

4.1 Introduction

This chapter describes the analytical methodology that was followed for the scientific examination of the five Kenning banners in the Glasgow Museums Collection. To characterise the wide range of organic and inorganic materials present in the multi-layered build-up of each of such banners, a multi-analytical approach suggested by Boon and Townsend was followed (Boon and Townsend, 2012, p. 342-343). This was important for identifying the individual components of each of the banners and gain insight into the way they were built-up into a multi-layered painted banner. In this regard, multiple analytical techniques were applied to analyse different samples, according to the diagram presented in figure 4.1. The order of application considered the complexity of each analytical technique and the specificity of their respective results, going from a general to a detailed perspective. It is also worth noting that, in general, the order also considered increasing invasiveness, as this is important from an ethical sampling perspective (i.e., carry out the least invasive/destructive tests first).

Each analytical technique was chosen from the sources on the material characterisation of nineteenth and twentieth centuries British double-sided painted silk banners reviewed in section 3 of Chapter 3, to give continuity to the previous research on the subject (Rogerson and Lennard, 2005; Macdonald et al., 2005; Smith, Thompson and Hermens, 2016; Smith, Thompson, and Lennard, 2017; Thompson et al., 2017). Relevant publications on the scientific examination of painted textiles and easel paintings were also considered (Bonaduce et al., 2012a; Keune, 2005; Shimazu, 2015; van der Berg, 2002; van der Weerd, 2002). Their accuracy of identification of organic and inorganic materials, as well as how commonly these techniques were used according to the aforementioned sources influenced the choice of technical analysis, presented in Tables 4.1 and 4.2. The selection was also determined by the accessibility and availability of the most appropriate techniques reported in these sources for the present research.

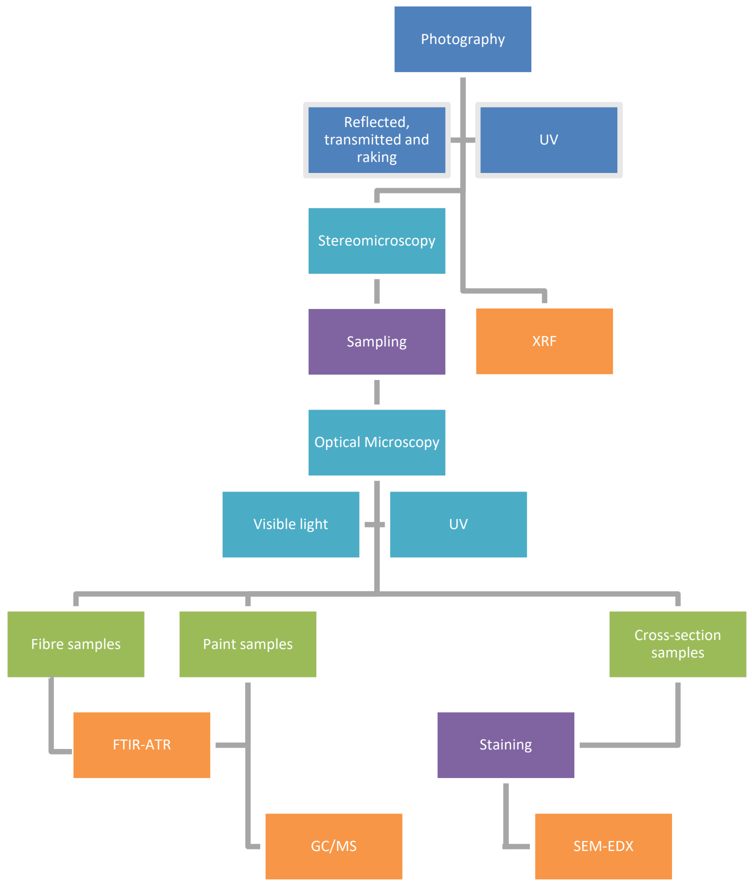


Diagram key:

- Macroscopic inspection
- Microscopic inspection
- Preparatory stages for technical analysis
- Samples selected for technical analysis
- Technical analysis

Figure 4.1. Diagram of the analytical methodology followed.

Table 4.1. Analytical techniques for the material characterisation of banners and painted textiles.

Material	Rogerson and Lennard, 2005	MacDonald et al., 2005	Smith et al., 2016	Thompson et al., 2017	Smith et al. 2017
Fibres	OM	___	OM FTIR-ATR	OM	FTIR-ATR
Dyes	___	___	n/a	___	HPLC
Binders	GC-MS FTIR-ATR	___	FTIR-ATR	OM	GC-MS SIMS
Extenders	___	___	FTIR-ATR SEM-EDX	___	SEM/EDX
Pigments	___	Raman	Raman SEM-EDX FTIR-ATR	___	Raman SEM-EDX XRF
Driers	___	___	___	___	SEM-EDX

FTIR-ATR: Fourier transform infrared spectroscopy-attenuated total reflection

GC-MS: Gas chromatography-mass spectrometry

HPLC: High performance liquid chromatography

OM: Optical microscopy

Raman: Raman spectroscopy

SEM-EDX: Scanning electron microscopy-energy dispersive X-ray spectroscopy

SIMS: Secondary ion mass spectrometry

XRF: X-ray fluorescence spectroscopy

Table 4.2. Analytical techniques for the material characterisation of easel paintings.

Material	van den Berg, 2002	van der Weerd, 2002	Keune, 2005	Bonaduce et al., 2012	Shimazu, 2015
Binders	GC-MS DTMS SIMS	DTMS FTIR	SIMS GC-MS DTMS	DE-MS TG GC-MS	GC-MS DTMS
Extenders	DTMS	FTIR	___	___	___
Pigments	___	OM SEM-EDX VIS-imaging	SIMS DTMS	___	OM FTIR SEM-EDX DTMS
Driers	OM SEM-EDX	OM SEM-EDX	___	___	___

DE-MS : Direct exposure mass spectrometry

DTMS: Direct temperature mass spectrometry

FTIR: Fourier transform infrared spectroscopy

TG: Thermogravimetric analysis

VIS-imaging: Visible light imaging micro spectroscopy

The following sections will give a brief explanation of each of the techniques, as well as a description of their limitations and the adaptations that were needed for the characterisation of the organic and inorganic materials in the five Glasgow Museums Collection banners. A summary of the techniques and their main purpose is presented in Table 4.3.

The chapter closes with a summary of the making of two historically informed reconstructions of the banner painting technique, listing the key materials and methods that are reported in full in Appendix IV Reconstructions. The reconstructions were crucial for the development of the fluorescent staining methodology of Chapter 5 and for understanding the process of banner making through experiencing it, regarded as undocumented embodied skills (Bucklow et al., 2012, p. 24). These complemented the results of the technical analysis and thorough inspection of the five banners for the interpretation of their technique.

Table 4.3. Summary of the analytical techniques and their main purpose for the material characterisation of five Kenning banners of Glasgow Museums Collection.	
Technique	Main purpose
Digital photography (with reflected, transmitted and raking illuminations)	Record of surface features, preliminary layering structure, evident underdrawings, overall condition of each banner.
UV induced fluorescence	Preliminary detection of coatings, overpaints and indication of auto-fluorescent pigments, lake pigments and binders.
Stereoscopic microscopy	Detailed record of surface features, layering structure, condition of the two types of decorations (metallic scrolls and central paintings), textile thread count, selection of sampling areas.
Optical microscopy	Preliminary identification of fibres, record of central paintings' layer structure, metallic scrolls' layer structure, measurement of layers, location and distinction of particles, selection of samples for technical analysis (FTIR-ATR, SEM-EDX, GC-MS, HPLC-PDA), identification of size layer and paint/ground medium through fluorescent staining (see Chapter 5).
Portable XRF	*In situ* elemental analysis of inorganic components (metal leaves, pigments, extenders).
FTIR-ATR	Identification of fibres, identification of the general type of binders, identification of certain pigments and extenders.
SEM-EDX	Elemental analysis and mapping of the metals associated to the metallic leaves, pigments, extenders, and other inorganic materials present in the ground and paint layers of the banners' samples.
GC-MS	Identification of binding media in ground and paint layers, identification of preparation method, identification of resin in coating or in mixture.

4.2 Digital photography

Following the approach that is routinely applied to the technical study of easel paintings (MacBeth, 2012, p. 291), the five Kenning banners of Glasgow Museums Collection were thoroughly documented by means of digital photography with reflected, transmitted, and raking illuminations. This range of photographic techniques was important for this research to relate the results to the technical studies of easel paintings besides textiles. The equipment used for this purpose was a digital camera Lumix DMC-LX5 with 10 megapixels and CCD sensor, its integrated flash for reflected illumination and a custom-made lightbox with four 70 W fluorescent batten lights (property of GMRC) for transmitted and ranking illumination.

Due to the large dimensions and fragile condition of the five selected banners, all the inspection, sampling, and documentation had to be conducted with the banners laid out horizontally on a working table. This restricted the access and acquisition of photographs mostly to the peripheral areas, which could be reached without having to lean or rest onto the fragile objects. The general photographs of sides A and B of each of the banners were previously taken and provided by Glasgow Museums' photographer Iona Shepherd. All other images (unless otherwise stated) were obtained by the author. All image files were stored as part of the approved data management plan, to be handed to Glasgow Museums at the end of the research for their final safekeeping. A selection of representative images per banner are included in their documentation sheets in Appendix I, Banners documentation.

4.2.1 Reflected light illumination

Reflected light inspection and photography helps to indicate the presence of any surface materials that have shine or gloss. Carried out with the built-in flash of the camera in areas limited to its reach (measuring 10 × 10 cm), this method allowed the location of glossy areas in the banners that could relate to potential varnishes and glazes, either general or local, potential previous interventions of repair/conservation and metallic components. Limitations of this technique are related to the area illuminated by the flash, object size and the possibility not encountering specular reflectance, all of which were experienced during the inspection and photographing of the five Kenning banners of Glasgow Museums Collection.

4.2.2 Transmitted light illumination

Transmitted light inspection and photography offer indication of the varied materials on canvas painting (or painted textile) in relation to their opacity (Buzzegoli and Keller, p. 2009, 196). This qualitative technique highlights the non-homogeneities of the object's constitutive layers, producing information about the different thicknesses of the pictorial layers, the textile and any damages permeating both. Each banner was examined using a light box, mainly the top and bottom of the banners. This showed aspects of their construction (e.g., potential size layer applied to the textile) and condition issues (e.g., abraded textile and paint, holes, splits, and tears). The limitations of this technique are closely related to the objects condition and opacity, given that low or no transmission occurs in areas of thick and opaque layers and excessive transmission occurs with thin and severely damaged objects. In the case of the banners the fragile condition of the whole and the high opacity of the painted/silvered decorations produced areas of excessive contrast, reducing the amount of good images acquired.

4.2.3 Raking light illumination

The raking light inspection and photography allows the highlighting of surface irregularities through the directed casting of their shadows with a light source. In the case of the banners, this was carried out with a small torch in areas limited to its spot (about 15 cm wide). It evidenced the surface features of their construction such as the texture of the weave and the relief of the brushstrokes of the applied paints, as well as condition issues like distortions of the textile and painting and unstable craquelures of the paint layer (i.e., cupping, tenting), which are otherwise unnoticed (MacBeth, 2012, p. 291-294; Kirsh and Levenson, 2002, p. 72).

4.3 UV induced fluorescence

UV fluorescence examination and photography were carried out using a Reskolux UV 365 handheld lamp (device emits high intensity UV light of 365nm +/-5, UV-A), wearing UV filtered goggles as protective equipment. A 365nm wavelength is recommended to achieve the best response of fluorescent materials (Cosentino, 2015, pp. 54-55). Fluorescence is the visible result of the excitation of electrons within an atom as they are promoted to higher shells and then fall back, emitting the excess energy as electromagnetic radiation of a longer wavelength than the source (Johnston-Feller, 2001, 205). Fluorescence only occurs whilst the material is being illuminated with the UV source, more visible in a total darkness environment. [31]

[31] Although it is recommended to do the inspection and photography in complete darkness, the large size and fragile condition of the banners restricted their access to the research room of Glasgow Museums Resource Centre, which unfortunately lacks such possibility. The partial images were acquired with the banners laid out horizontally by means of a blackout hood.

The inspection and detailed photography provided valuable insights into the variety of materials on the surface of each banner, illustrated by the varied fluorescence, typical of certain materials observed (Cosentino, 2015, pp. 53-62). Materials reported in the literature were preliminarily indicated or ruled out with this method, including: natural and synthetic resins, specific pigments like lead white, zinc white, titanium white and madder lake, as well as other organic materials like animal glue, some kinds of waxes and shellac, were preliminarily indicated or ruled out with this method (Conservation, 2017; MacBeth, 2012, pp. 294-296; Stuart, 2007, pp. 76-77).

4.4 Stereomicroscopy

Digital surface microscopy was performed *in situ* using a portable USB microscope DinoLite model AM4113T at a magnification range between 10x and 20x. By means of digital zoom and fibre optic epi-illumination, this technique allowed for the distinction of features about the banners' technique and their materials, and condition, and previous repairs or renovations, equiparable to those listed by Eastaugh and Walsh for easel paintings (Eastaugh and Walsh, 2012, p. 310). Additional features documented were details of the textile construction of the banners, the application of the metallic leaves and their surface damages. The most representative micrographs obtained were included in the documentation sheets of each banner(see Appendix I, Banners documentation), and all the acquired images will be handed to Glasgow Museums for their safekeeping and attachment to the objects' files. Additionally, this technique enabled the highlighting of the type of weave and acquisition of the average thread count of the banners' main textile components (three separate measurements were done per banner for obtaining the average thread count). Furthermore, the location of the potential sampling points that were required for the other analytical techniques were selected. The limitation of this technique, particularly when used for digital imaging rather than direct observation, was the the limited focus range which hindered the quality of the acquired images. Likewise with the macro photography, the acquisition of images was restricted to the accessible areas of the horizontally-laid banners.

4.5 Optical microscopy

Optical microscopy is a useful analytical technique that can employ both visible and ultra-violet illumination (the latter to achieve fluorescence imaging), and is commonly applied to the scientific examination of painting samples (Mazzeo, Prati and Sandu, 2009, p. 179; Eastaugh and Walsh, 2012, p. 306).[32] Using a system of lenses, filters, and reflected or transmitted illumination sources, the morphology of fibres and paint samples from the five banners could be observed and documented in detail. With a magnification range between 10x and 200x, features like colour, thickness, size, and shape, as well as auto-fluorescent materials within were registered. Two different microscopes and digital cameras were used for this purpose at the former CTC-TAH Centre (now Kelvin Centre for Conservation and Cultural Heritage Research):

- For the textile fibres, a Zeiss Axiolab microscope with Polarised Light Microscopy. Images were acquired with an AxioCam ICc1 colour digital camera with 0.5x c-mount and Zen Lite imaging software.

- For the paint samples and cross-sections, an Olympus BX41 polarising microscope with a built-in Olympus CCD camera of 2.5 million pixels and a U-LH100HG 100-Watt Pressure Mercury Arc Lamp Housing for UV epi-illumination. For detection of auto-fluorescent materials UV fluorescence filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm) was used. All images were processed with Olympus Stream Basic version 1.9.3 software.

Given the translucent nature of the textile fibres, their inspection and micrographic documentation were conducted under transmitted illumination, whilst the opaque nature of the paint and cross-section samples required reflected illumination. Both types of samples were inspected and documented in dark field with crossed polarising filters as suggested in the literature (Mazzeo, Prati and Sandu, 2009, p. 180; Eastaugh and Walsh, 2012, p. 310-313; Mayer, 2012, p. 319-320). Dark field illumination allows a better distinction of the

[32] The information on the fluorescence microscopy is described in Chapter 5.

peripheral features of the samples, as well as a greater colour contrast useful in recognising their defining features.

The paint cross-section samples were prepared by mounting them in the commercial resin Technovit 2000 LC (Heraeus Kulzer, Germany), a 1-component methacrylate that polymerizes under blue light. After preliminary grinding with silicon carbide (SiC) paper, the surfaces were dry polished with Micro-Mesh® cloths containing both silicon carbide and aluminium oxide (Al_2O_3), using grades 1800 through to 12000, similarly described in Richter (2013, p. 85) and Smith, Thompson and Hermens (2016, p. 3).

In addition to the documentation of the banners, which is included in their documentation sheets in Appendix I, the micrographs of the cross-section samples were used to identify individual particles to be analysed with SEM-EDX.

The limitations of the optical microscopy were to do with the need of sampling, given that is not possible to obtain such high magnification *in situ*. Furthermore, the quality of the images is directly related to the evenness of the sample as only a limited focal plane could be captured at any one time, unless stacking was used, which was not the case due to the alteration of the original image. The particularities of this technique for carrying out fluorescent staining of the cross-sections are described in detail in Chapter 5.

4.6 Sampling methodology for optical microscopy and micro-invasive analytical techniques

Samples were obtained from previously damaged areas, avoiding any aesthetic focal points of the objects as well as any structural areas, as described by Plesters (Plesters, 1956), or in the case of the textile, any positions vital to structural integrity. The methodology also considered the *Ethical Sampling Guidance* of the Institute of Conservation of the UK (Icon) (Quye and Strlic, 2019) to justify the need for sampling and to decide, with involvement of the owner/custodian of the objects Glasgow Museums, their average size and maximum number of samples, as is illustrated in a sampling agreement that included all parties involved.[33] All sampling areas were previously selected and methodically located, labelled and photographed, according to a sampling protocol specifically designed for the five Kenning banners of Glasgow Museums Collection (see Appendix II, Sampling Protocols). The number of banner samples required, was determined based on the number needed to cover the material identification of their fibres (main fabric warp, main fabric weft, main sewing thread, hanging loop warp, hanging loop weft, fringe core and fringe coat); the material identification of their metallic scrolls (size layer, ground layer, metal leaf, coatings); the material identification of their central paintings (size layer, ground layer, paint layers, varnish); and the material identification of their pigment palette, by means of the selected techniques that were available to the research.

Five types of samples were obtained for the following purposes:

- Textile fibres: collection of yarns measuring an average length of 1mm for analysis with microscopy and FTIR-ATR. Samples were taken with tweezers and a scalpel from previously frayed sections of the banners.

- Textile fibres large: collection of yarns from each of the five banners main fabric (warp of weft) and three from a faded section of *The Glasgow Typographical Society* banner's fringe, measuring a maximum length of 5mm for dye analysis with HPLC-PDA.[34]

- Paint samples: shavings of paint and ground, paint and metal leaf, and paint only, measuring a maximum size of $1mm^2$ for microscopic inspection

[33] Such agreement remains in the archive of Glasgow Museums and on the OneDrive assigned to my student number at the University of Glasgow, as part of the approved data management plan. All samples remained in custody of the author until completion of the thesis, to be returned to their owner/custodian Glasgow Museums in a labelled box. The box will be archived with the banners and attached to their documentation in their database. All remaining samples have the potential of being further studied in the future.

[34] Although the initial planning considered the acquisition of these samples for their dye analysis with HPLC-PDA at the University of Delaware, they had to be left aside due to unforeseen circumstances that made the agreement void, as well as further access restrictions related to the COVID19 pandemic. However, they remain in custody of Glasgow Museums with the possibility of being analysed in such way in the future.

and analysis with FTIR-ATR and SEM-EDX. Samples were taken with a micro-scalpel from previously damaged areas.

- Paint samples (large): one shaving of paint and ground from each of the five banners, measuring a maximum size of 2mm^2 for binding media analysis with GC-MS.

- Samples for cross-sections: transversal cut-outs including all the banner stratigraphy on both sides A and B, taken from the two representative decorations of each banner, metallic scrolls, and central paintings, with a maximum size of 1mm^3 for microscopic inspection and SEM-EDX analysis. These samples were cut through the banner adjacent to areas with previous punctures or holes, as the samples required to have both sides A and B for the understanding of their layering sequence. Their location is given in detail in Appendix II.

4.7 Portable X-Ray Fluorescence Spectroscopy (Portable XRF)

Portable XRF is an elemental analysis technique that can be used *in situ* for the study of cultural objects in a non-invasive, non-destructive way. It is based on the characteristic emission of X-rays from the materials, caused by the irradiation of the sample with a high-energy beam of either X-rays or gamma rays (Dran and Laval, 2009, p.210). The fluorescence phenomenon occurs when energy from the radiation source is absorbed by an atom, leading to the ejection of an inner orbital electron and destabilising the electronic structure; when an outer orbital electron 'falls' into the resulting inner orbital gap, restoring the electronic structure, its excess energy is lost as an emitted X-ray of characteristic energy (and this emission is always of lower energy than the incident radiation). The technique only identifies elements present in the materials and does not provide any information on the chemical state. It is better suited for heavy elements identification as the lighter elements yield a low fluorescent response and tend to overlap as their characteristic peaks are very close to each other (Dran and Laval, 2009, p.212-13). Another highlighted issue is that the emission from the lightest elements is very easily absorbed by the environment, so are simply not detected at all.

The equipment used was a Thermo Scientific Niton XL3t XRF analyser, with an Ag anode (6-50 kV, 0-200 µA max), a geometrically optimised large area drift detector (GOLDD) of a resolution <185 eV @ 60,000 cps @ 4µ sec shaping time, and three filters for wide detection of elements (Main Filter 40 keV – Ag; High Filter 50 keV– Mo; Low Filter 20 keV – Fe/Cu; and Light Filter 8 keV – no filter). The equipment was set in mining mode, considered the best for this study because of the potential presence of heavy metals within the sampling points. Each point was analysed twice, under conditions for main range analysis and under conditions for low range analysis. Data was collected for 30 seconds. All the spectra were compiled using MATLAB software version R2021a, to conduct peak identification by assignment of principal X emission lines (L-, K-, M-) according to the *Principal X-ray Emission Spectra of the Chemical Elements* chart (Harwell, 1974).

Due to budgetary constraints and accessibility restrictions related to the COVID-19 emergency, the equipment could only be used for one of the banners, *The Glasgow Typographical Society*, selected to do XRF for being the oldest example of the five Glasgow Museums Collection banners, manufactured in 1883, and the first George Kenning banner to be technically analysed (as the other technically studied banners are all by George Kenning & Son's company). Like the other techniques applied to the banners *in situ*, portable XRF was conducted with the banner laid out horizontally over a working table. Thus, background measurements of the isolated table and of the unpainted textile were taken to determine their composition and to subtract their peaks from the interpretation of the painting sampling points.

The multi-layered structure of the banners complicate the interpretation of the XRF data the depth of penetration achieved by the XRF technique can mean that potentially multiple layers at a single position can be observed (McGlinchey, 2013, p. 136-139). Therefore, even though a preliminary indication could be made based on the XRF data, the positive identification of pigments required further analysis with SEM-EDX which allowed for the specific analysis of pigment particles within the paint layers (Carlyle, 2001; Eastaugh et al., 2008).

4.8 Fourier Transform Infrared spectroscopy (FTIR) with Attenuated Total Reflectance (ATR)

Infrared spectroscopy is an analytical technique that is used for the chemical characterisation of organic and inorganic materials that might present in cultural objects like the banners included in this research, such as binding media, varnishes, adhesives, coatings, pigments, corrosion products, salts, etc (Galeotti et al., 2009, p. 151). The spectrometer produces a beam of infrared radiation (frequency range of 4000-400 cm^{-1}) that interacts with the functional groups of the sample molecules and produces a second beam characteristic of each one. What is observed, however, is not a second beam but the primary beam with some frequencies attenuated due to their interaction with the sample. These are compared by the detector and their difference gives the frequencies of vibration functional group bonds analysed in the sample, which in the case of FTIR is processed with a particular mathematical algorithm that is Fourier transform (Derrick et al., 1999, p. 4).[35] The result is an infrared spectrum where the percentage of transmission/absorbance of the sample is plotted against the wavenumbers (cm^{-1}) (Galeotti et al., 2009, p. 151). Reflection mode is reportedly used for the analysis of heterogeneous samples like the banners' samples, using ATR technique for measuring the IR spectra based on the internal reflection of its crystal (Galeotti et al., 2009, p. 152), not requiring additional sample preparation (Derrick et al., 1999, p. 79). However, in order for the technique to produce an IR spectrum, the analyser must be in direct physical contact with the object or samples taken from the object. Therefore, ATR-FTIR falls within the group of the micro-invasive analytical techniques.

The equipment used was located at the former Centre for Textile Conservation and Technical Art History of the University of Glasgow (now Kelvin Centre for Conservation and Cultural Heritage Research). It was a Perkin Elmer Spectrum One FTIR Spectrometer with Spectrum software version 5.0.1 and fitted with a Universal ATR Sampling Accessory. The ATR crystal used was a diamond/thallium-bromoiodide (C/KRS-5) with a penetration depth of up to

[35] Fourier transform is a mathematical equation that decomposes functions depending on space or time into functions depending on spatial frequency or temporal frequency (Derrick et al., 1999, p. 4).

2μm. A total of 32 scans were taken for each sample at a resolution of 8cm-1 and with an average gauge force of 30N.

Given that the equipment available at the former CTC-TAH was unable to perform FTIR Imaging, which has been suggested as the ideal technique for locating the different materials in similar painted banners (Smith, Thompson and Hermens, 2016, p.8), for the identification of oil paints (Mazzeo, et al., 2008) and coloured glazes on metal leaf (Emmerling et al., 2013), the methodology for analysing the banners samples with FTIR-ATR was adapted to each of their materials. For the textile samples, the fibres were scanned as they fell on the ATR crystal, not distinguishing between their front or back as they were often too small to flip for doing separate scans. Considering the 2μm depth of penetration of the analyser (Smith, Thompson and Hermens, 2016, p. 3), the unembedded paint samples were selected for their small number of layers, preferably only two: ground (back of the sample) and paint (front of the sample). The samples selected contained: three layers for the metallic scroll samples (ground-metal leaf-coating) and two for the central paintings (ground-paint). Samples with less layers were also selected when possible, such as one-layered paint samples or one-layer coloured coating (glaze) samples, as well as two-layered metallic scroll samples (metal leaf-coating). To allow the comparison of FTIR results per layer, these samples were analysed on both sides (front and back). Cross-sections and other paint samples with more than one paint layer were not considered for FTIR, as they cannot be analysed with macro FTIR but micro, which was not available to this research.

Each spectrum was compared against selected standards of the materials most likely to be found in nineteenth and twentieth century British double-sided painted banners on silk, based on the results of the previous research (Rogerson and Lennard, 2004; Macdonald et al., 2004; Smith, Thompson and Hermens, 2016). Other standards were used for identifying materials not previously reported on such type of painted banners but suggested in the historical sources reviewed in Chapter 3, all of which are included in Appendix III, Analytical results.

The chemical similarities between some of the targeted compounds (i.e., silk fibres and proteinaceous size layers), required further processing of the acquired spectra for better interpretation.

4.9 Scanning Electron Microscopy (SEM) with Energy-dispersive X-ray microanalysis (EDX)

Scanning electron microscopy (SEM) with energy-dispersive X-ray spectroscopy (EDX) is a micro-invasive technique that is frequently used for imaging and microanalysis of samples from cultural objects at a magnification of up to 300,000 x (Joosten and Spring, 2009, p. 191). The SEM is a type of electron microscope that generates an image of the sample by scanning its surface with a high-energy beam of electrons, focused with a set of electromagnets. Back-scattered electron images are monochrome/greyscale produced by the difference in density of each of the materials present (white for denser materials, black for lighter and grey for densities in between). Secondary electrons transmit the information on the topography of the sample, while backscattered electrons give information on its chemical composition. The EDX is a coupled X-ray analysis that detects the emission of characteristic X-rays from the chemical elements contained in the sample, with a detection limit of ca. 10% by volume (Townsend and Boon, 2012, p. 345). To prevent the charging and heating of non-conductive specimens during the electron bombarding under vacuum (Joonsten and Spring, 2009, p. 191), the cross-section samples were carbon coated.

The analysis and carbon coating were performed by Mr Peter Chung at the Imaging Spectroscopy and Analysis Centre (ISAC) of the University of Glasgow. The equipment was a Carl Zeiss Sigma Variable Pressure Analytical SEM with Oxford Microanalysis. With a Schottky thermal field emitter electron source; accelerating voltage range of 2.0 to 30 kV; with a current range of 4pA to 20nA; variable pressure range of 2-133 Pa; with a resolution at 1kV/15 kV of 2.8 nm/ 1.5nm; and an Energy-dispersive X-ray analysis (EDX) with an 80 mm silicon-drift detector. A total of 99 frames were analysed at 4min/frame at an augment of 1200 x (800 x for samples MG10 and MG26), with a working distance of 8.5mm. Due to COVID-19 restrictions, data was remotely processed with AZtec® software, montaging all the individual maps, applying TrueMap to every sample for elemental mapping, and using Point ID for identification of selected areas and particles of interest at the scanned resolution. Unfortunately, the remote processing of data only allowed spot analysis of individual particles that were distinguishable at that resolution. Smaller particles were still mapped as single element maps but were unable to be zoomed-in for point identification, this being the biggest limitation of the technique for the present research.

Although similar to XRF analysis in that it only identifies elements, the advantage of EDX is the mapping possibility, which allows a more accurate interpretation of the results highlighting the particles that have more than one identifiable element in their composition (e.g., calcium and sulphur of calcium sulphate). It also enables the analysis of a single particle and the detection of elements in that one particle. Yet it fails in providing information on the chemical configuration, to which complementary techniques like FTIR need to be used in conjunction. For the present research, two cross-section samples per banner were analysed by this technique (10 in total), representing the two types of decoration seen, metallic scrolls and central paintings. Their results were contrasted with equivalent samples analysed by other techniques, aiding in the interpretation of the latter.

4.10 Gas Chromatography-Mass Spectrometry (GC-MS)

Gas chromatography (GC) is a chemical separation technique used for volatile organic mixtures such as resins and paint media. It is based on the differences between the chemical attraction of the volatilised sample injected into a solid stationary phase and that of the moving phase (inert gas) (Boon and Townsend, 2012, p. 350). Samples are dissolved and injected into the end of the column at a set temperature and the separated compounds come out at characteristic times and are detected by specific devices generating chromatograms (Bonaduce et al., 2009, p. 159). It is a micro-invasive and destructive technique.

Mass spectrometry (MS) is a coupled technique that gives in addition information on the structure of each separated compound. The spectrometer has an ion source chamber into which a chromatographic column is inserted. Molecules are ionised inside this chamber and their ions separated according to mass-to-charge ratio, producing a specific mass spectrum that is used to identify the known or unknown compound (Bonaduce et al., 2009, p.159-160).

This analysis was performed in London by *Art, Analysis & Research* (AA&R) (see Appendix III, Analytical results §GC/MS). Each sample was dissolved in 3-(Trifluoromethyl) phenyl trimethylammonium hydroxide (TMTFTH) (20 µl), heated at 70 °C for four hours and then vortex-mixed. Samples were individually injected (1 µl each) into a Varian 450-GC gas chromatograph coupled with a Varian 320-MS mass spectrometer. An VF-5ms capillary column (30 m length x 0.25 mm internal diameter x 0.25 µm film thickness) was used to provide separation of the components under a constant flow of helium gas (1.0 ml/min). The GC injector temperature was set at 270 °C. The analysis was performed in split less mode with chromatographic conditions as follows: initial temperature 80 °C held for 2 min, increased at 10 °C/min to 200 °C, held for 3 min, increased at 7 °C/min to 280 °C, held for 3 min, then increased at 20 °C/min to 300 °C, held for 20 min. There was a 5-minute solvent delay. The transfer line was set to 280 °C, with the MS source temperature as 200 °C. Mass spectra were recorded under electron impact ionisation (70 eV) in the range of m/z 45 to 650.

Four large paint samples were selected for binding media identification with GC-MS: TS19, GU29, VB30 and SM31 (Figure 31) (see Appendix V Sampling Protocols for location). Sample GU29 was additionally divided into two, due to the possibility of physically separating the paint with a scalpel (i.e., GU29_A from the ground layer, GU29_B from the paint layer) in an attempt to identify the binder of each layer separately.

The preliminary preparation of the sample can impede the detection of materials if these react with the solvents used. In the case of the banner samples, rubber or tempera components were discarded for not being reported in the previous George Kenning study; tempera for not being mentioned as adequate for banner painting in the sources reviewed in Chapter 3 and rubber for only being historically mentioned by Kelly (1911) for the company of George Tutill. Such materials are unable to be detected with the same solvent mixture used for the targeted compounds: drying oils, waxes, and resins.

4.11 Historically informed reconstructions of double-sided painted banners on silk

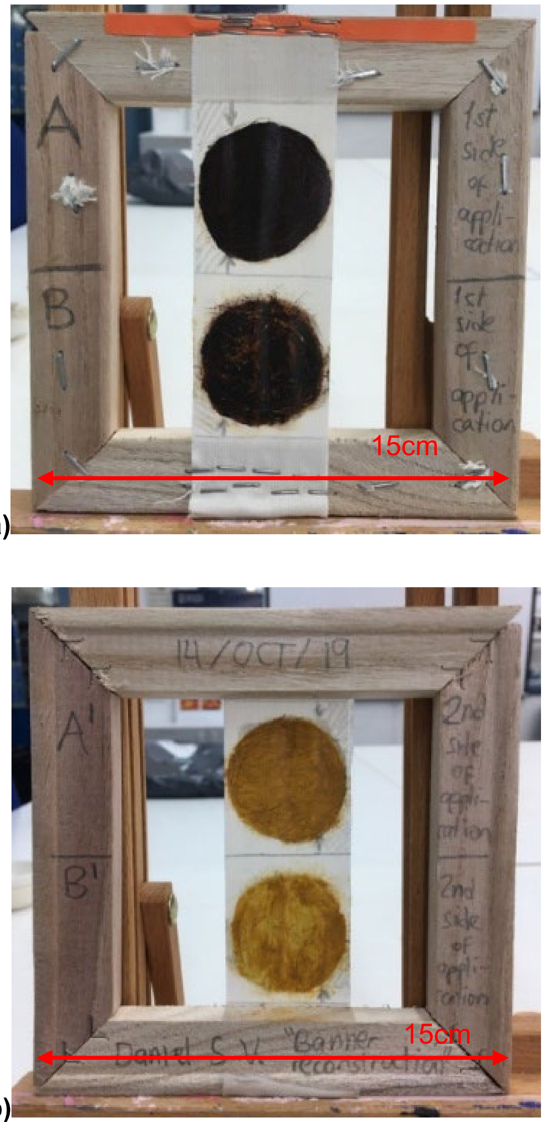
4.11.1 Reconstruction 1

A small historically informed reconstruction of a double-sided painted silk banner was prepared to test if the localisation of their size and paint layers could be achieved with SYPRO® Ruby and Nile Red.[36] The reconstruction was divided in 4 sections to allow the testing of different materials as explained in the following paragraph. Its making considered the preliminary results gathered through FTIR-ATR, along with the technical information extracted from the source on banner painting that had more resemblance to the technique observed in the five banners of Glasgow Museums Collection (Kelly, 1911, pp. 105-110), and the historical photographs of the two commercial British banner makers discussed in Chapter 3, section 2.

Reconstruction 1 was made on a stretched silk rib textile (Silk faille, Broadwick Silks), the most similar to the textile of the five Kenning banners of Glasgow Museums Collection. It was selectively sized on both sides with 1:10 w/v rabbit skin glue at 60ºC (No. LC27485J, L. Cornelissen & Son) (Figure 4.2), the same proteinaceous material used for size in Smith and Thompson's banner reconstructions (see Chapter 5 for details). On each side a ground layer was applied of 1:1 v/v lead white and chalk (No. LC18004H and No. LC23165J, L. Cornelissen & Son) mixed dry and then bound with one of the two types of linseed oil selected for their contrasting handling and drying properties (Raw linseed oil No. 73054 and Stand linseed oil No. 73200, Kremer Pigmente). A different colour of paint was applied to side A, raw umber, and to side B yellow ochre (No. LC16071C and No. LC16141C, L. Cornelissen & Son). The pigments were selected for being present in the five Kenning banners of Glasgow Museums Collection and they were bound in the type of linseed oil also used for the ground (raw and stand) for consistency and ease of comparison (see details in Appendix IV, Reconstructions). All grounds were applied with a spatula and all paints were applied with a flat bristle brush, on a vertically positioned easel to

[36] The importance of fluorescent staining to the study of the five Kenning banners of Glasgow Museums collection is described in Chapter 5.

emulate the original manufacturing process seen in the historical photographs presented in Chapter 3.



a) b)

Figure 4.2. Double-sided painted silk banner *Reconstruction 1*; a) front, b) back. Sections indicated as A, A' correspond with raw linseed oil preparations and B, B' with stand linseed oil (both ground and paint).

The reconstruction was left to naturally dry for 50 days before sampling. The time-lapse considered the production time of *The Glasgow Typographical Society* banner of 27 days (see Chapter 2), plus 23 more days decided personally to further increase the drying of the linseed oil-containing layers. The individual drying times per process are listed in Appendix IV. A short interval of time of the main processes is presented in Figure 4.3 for side A, a-d, and side B, e-h of the reconstruction.

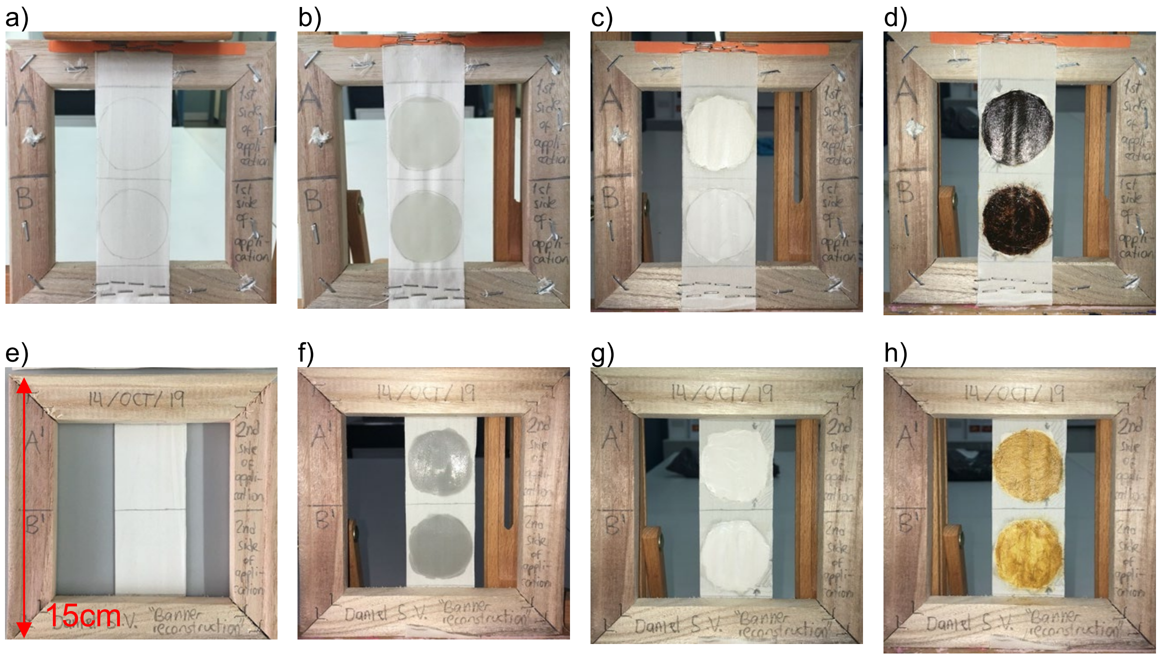


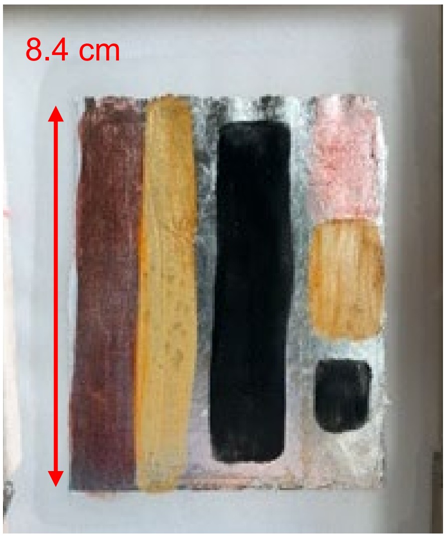
Figure 4.3 Short interval of time of the main processes applied in *Reconstruction 1* on sides A and B: a,e) stretching and pencil drawing of the areas to be painted; b,f) application of hot size layer, shown when wet for added emphasis; c,g) application of ground layers with raw linseed oil (top) and stand linseed oil (bottom); d,h) application of paint layers with raw linseed oil (top) and stand linseed oil (bottom).

4.11.2 Reconstruction 2

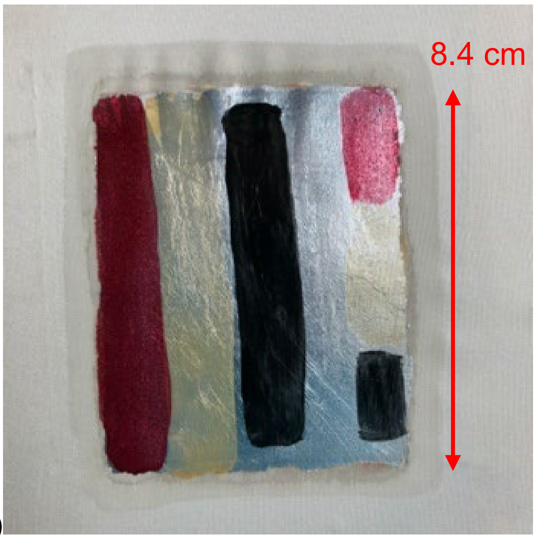
A larger historically informed reconstruction of the identified Kenning banner technique was prepared to test the application of the painted and metallic decorations, their drying times, and the handling of the object after finished, aiming to better understand the surface changes and damages seen during the inspection of the five Kenning banners of Glasgow Museums Collection. Its making considered the results of the first reconstruction and the recommendations laid out by Kelly (1911) for the stretching of the silk, the application of the size, the application of the ground and its usage as gold-size for the adhesion of metallic leaves, plus other recommended materials for adhesion of metallic leaves over dry ground/paint layer, the application of coloured glazes, the application of tube oil paint and the final lettering, all discussed in Chapter 3.

Reconstruction 2 was made on the same silk rib textile (Silk faille, Broadwick Silks) but this time stretched taut on its four sides as recommended by Kelly (1911). It was selectively sized on both sides with 1:10 w/v rabbit skin glue at 60ºC (No. LC27485J, L. Cornelissen & Son), applied 0.5mm beyond the pencil drawn forms, as indicated by Kelly (1911). Once dried, each side was worked separately until completion, on a vertically positioned easel to emulate the original manufacturing process as with the small reconstruction. The grounds were a mixture of 1:1 v/v lead white and chalk (No. LC18004H and No. LC23165J, L. Cornelissen & Son) mixed dry and then bound with raw linseed oil (No. 73054, Kremer Pigmente), applied with a spatula. Each side had two sections marked, an upper rectangle for the application of metallic leaf over the mordant ground layer and a halved oval section for the application over dry-to-touch ground layer of tube oil paint (Michael Harding artists oil colours) and metallic leaves with Japan gold-size (3-hour Japan Gold Size, Wrights of Lymm Ltd.). All the drying times were checked by hand whilst wearing latex gloves to prevent lead contamination, annotating the times accordingly as minutes, hours, and days (see Appendix IV).

Side A of the reconstruction had transfer silver leaf applied and side B had aluminium leaf (Gold Leaf Supplies, UK), to test both types of metallic leaves found in the five Kenning banners of Glasgow Museums Collection. Additionally, both sides had 24k gold leaf (Gold Leaf Supplies, UK) applied to their halved-oval sections with Japan gold-size, potential method of applying the golden metal leaf in the examples from Glasgow Museums Collection that contained it. Following Kelly's recommendations and the preliminary results seen in the fluorescent staining of the banner samples (see Chapter 5), a diluted layer of rabbit skin glue was immediately applied with a soft-hair brush after the application of both leaves, leaving a control area without coating in each case for comparison (1:5 w/v rabbit skin glue at 60ºC, No. LC27485J, L. Cornelissen & Son). The rectangular sections were subsequently glazed in two colours bound with Japan gold-size (Figure 4.4, a, b), choosing madder lake (pigment, prepared by Clara Gonzalez as part of the Technical Art History course 2019-20) and yellow ochre paint (Michael Harding artists oil colours) for side A, plus alizarin crimson (pigment, Kremer Pigmente) and yellow ochre paint for side B. They were also used for testing the lettering, selecting ivory black (pigment, L. Cornelissen & Son, London) for side A, and lamp black (pigment PBK 7.77266/47250, TAH pigment collection) for side B, both bound with Japan Gold-Size.



a)



b)

Figure 4.4. Silvered and glazed areas of *Reconstruction 2*; a) Side A b) Side B.

Two sets of paints were selected for each side, Indian red and yellow ochre for side A, and ultramarine blue and *terre verte* green for side B, both applied straight from the tube and with the addition of 50% volume of lead white paint

(Michael Harding artists oil paints, specially fabricated for Christina Young), mixed in palette before applying. Both sides had a layer of each paint applied directly to the dried-to-touch ground and a subsequent paint layer applied on top of the latter, in an alternated way that would have every colour mixture applied on top of each one (Figures 4.5 and 4.6). All paints and glazes were applied with an angled brush of natural hair, similar to those used by sign painters, directly from the tube, meaning no dilution with solvent nor medium took place. A single layer of each paint/glaze was applied in all cases.

a)

Figure 4.5. Painted and gilded areas of *Reconstruction 2*, side A.

b)

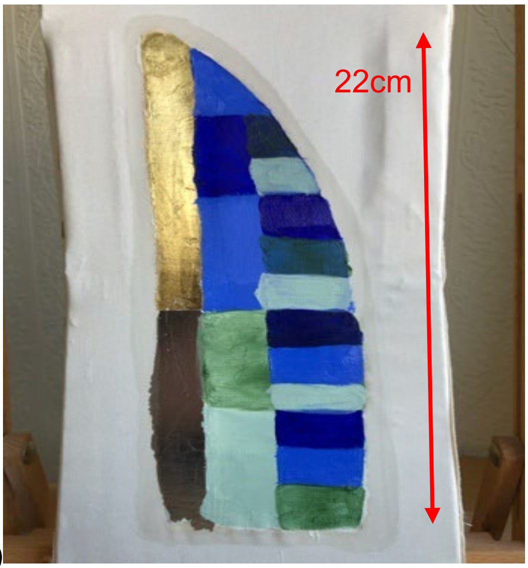


Figure 4.6. Painted and gilded areas of *Reconstruction 2*, side B.

A short interval of time of the main processes applied to side A and side B of the reconstruction is presented in Figures 4.7 and 4.8. The observations and drying time results of every step are listed in full in Appendix IV.

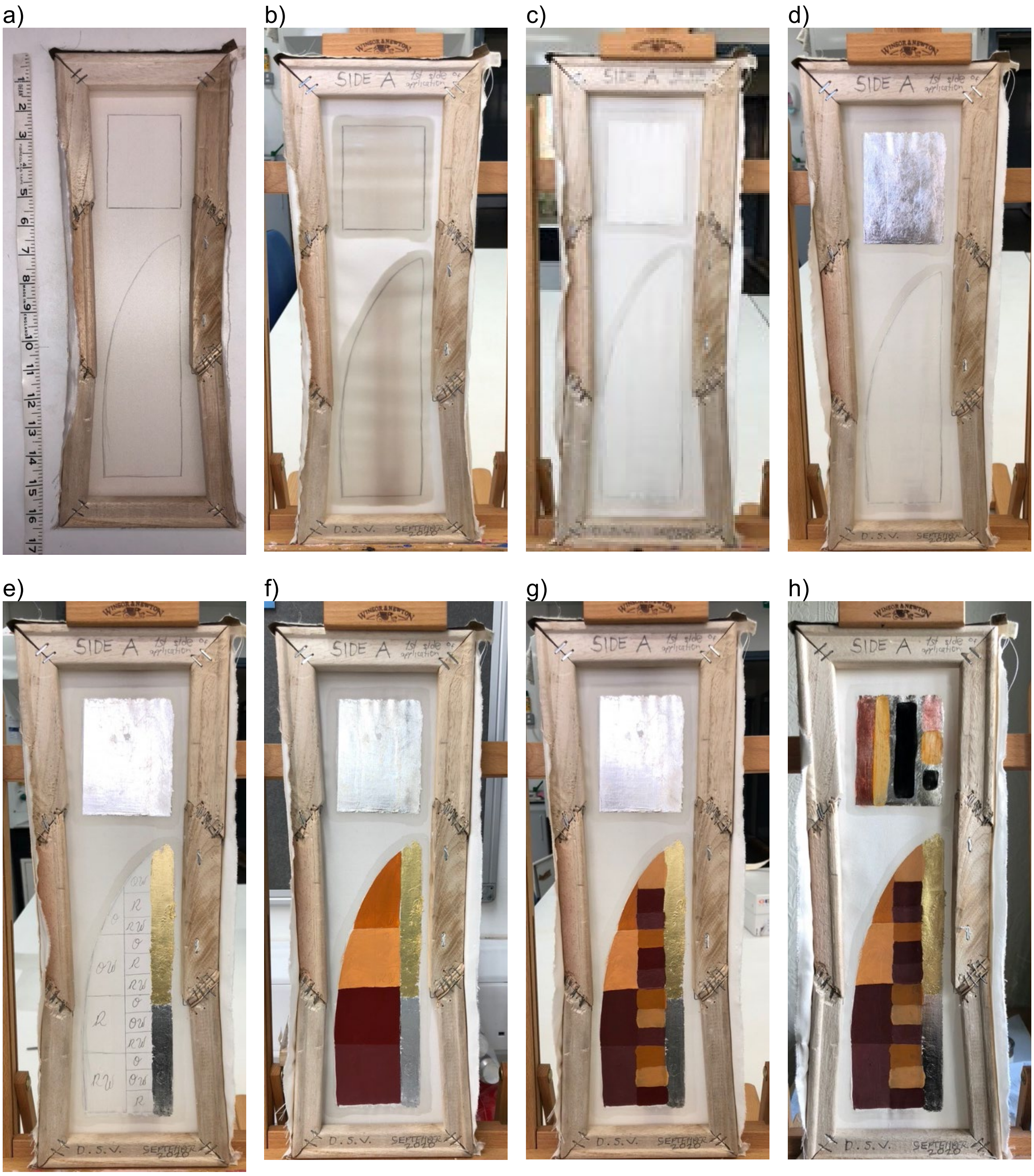


Figure 4.7 Short interval of time of the main processes applied in *Reconstruction 2*, sides A: a) stretching and pencil drawing of the areas to be painted; b,) application of hot size layer, shown when wet for added emphasis; c) application of ground layers with raw linseed oil; d) application of transfer-silver leaf on top square whilst the ground was mordant; e) application of gold and silver leaf over Japan gold size and marking of painted areas; f) application of first layer of paints; g) application of second layer of paints; h) application of glazes and lettering.

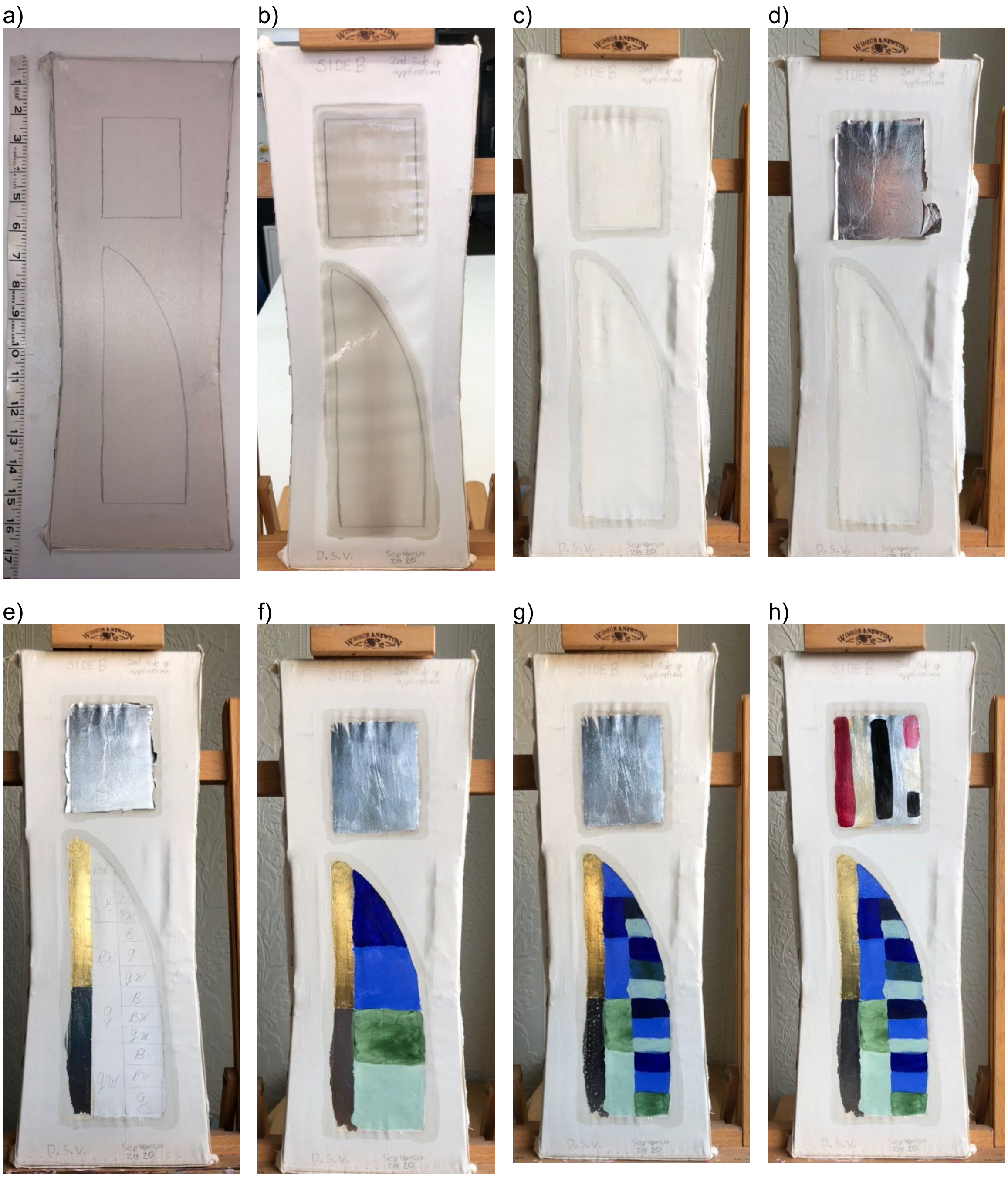


Figure 4.8. Short interval of time of the main processes applied in *Reconstruction 2*, sides B: a) stretching and pencil drawing of the areas to be painted; b,) application of hot size layer, shown when wet for added emphasis; c) application of ground layers with raw linseed oil; d) application of transfer-aluminium leaf on top square whilst the ground was mordant; e) application of gold and aluminium leaf over Japan gold size and marking of painted areas; f) application of first layer of paints; g) application of second layer of paints; h) application of glazes and lettering.

Once both sides were dry to touch, the reconstruction was released from its stretcher and trimmed by hand emulating the process seen in the historical photographs of Tutill’s manufacturing (Gorman, 1973, p. 58-65). The left, right and bottom sides were finished with a hemmed edge by means of a running stitch and the top side was finished with a reinforced running stitch for attaching the pole loops, which were folded inside the hemmed edge as seen in most of the five Kenning banners of Glasgow Museums Collection. Finally, a fringe was attached also by means of a running stitch to the bottom hemmed edge of the reconstruction (Figures 4.9 and 4.10). This added weight at the bottom of the banner which helped it stretch and drape.

a)

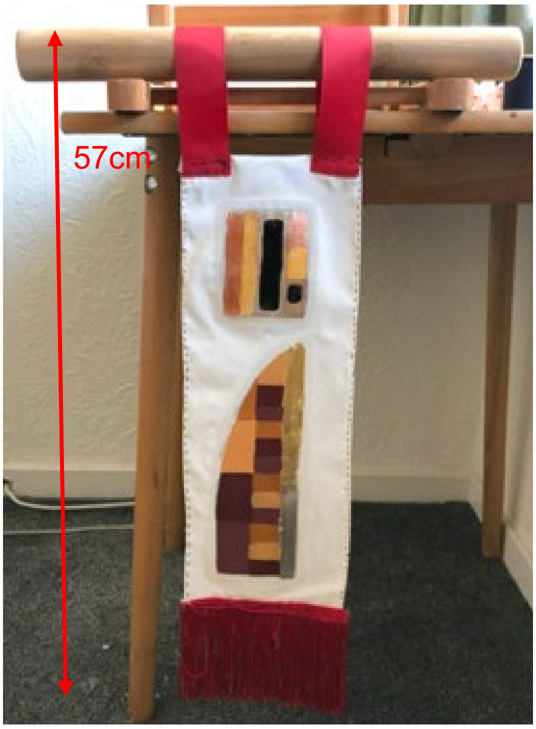


Figure 4.9. Double-sided painted silk banner *Reconstruction 2*, side A.

b)

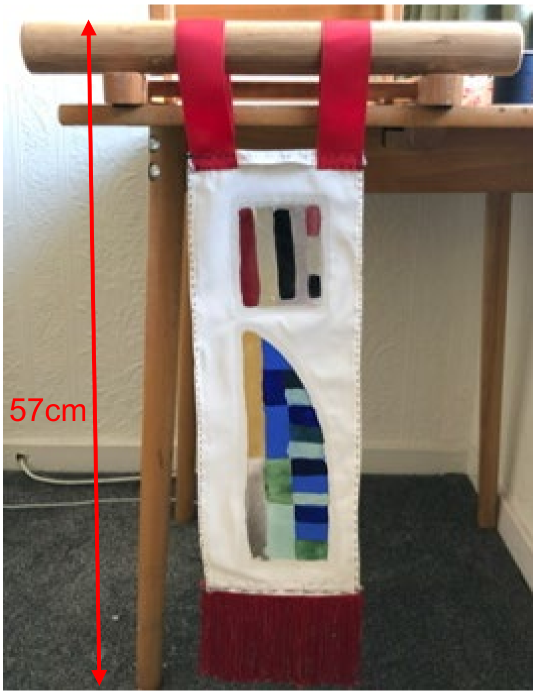


Figure 4.10. Double-sided painted silk banner reconstruction 2, side B.

The resulting banner was rolled within a similarly thick wooden pole of 3.8 cm diameter like the original banners; packed in a similarly sized box (made of carboard instead of the original wooden box due to budgetary constraints) and left as that for further 5 days, the reported maximum length of a trip from London to Glasgow in 1914 (Bartholomew, 1914, p. 86). After that time, the reconstruction was unpacked, unrolled, and evaluated, with the observations included in Appendix IV. Overall, the whole process of the reconstruction replicated the 27 days that were calculated as the shortest manufacturing length, from request to delivery, of the banner of *The Glasgow Typographical Society* by George Kenning.

5 Fluorescent staining methodology for the identification and localisation of proteinaceous and lipidic binders in double-sided painted silk banners

5.1 Introduction

This chapter presents the fluorescent staining methodology adapted for the localisation of proteinaceous and lipidic binders within cross-sections of painted silk banners. The fluorescent staining of proteinaceous and lipidic binders within paint cross-sections has been shown to be a valuable alternative to conventional staining for their identification and localisation (Wolbers, Buck and Olley, 2012, p. 327). Previous published research on painted banners has highlighted the importance of locating and identifying the material used as a size layer for a more comprehensive understanding of their technique (Rogerson and Lennard, 2004, p. 13-14; Smith, Thompson and Hermens, 2016, p. 8, 13,15). Therefore, this was a main aim in the material characterisation of the five Kenning banners of Glasgow Museums Collection, which led to some important results in this study.

5.2 Overview of the use of staining for the study of paint-cross-sections

Staining is one of the more established methods to help identify binders and coatings using paint cross-sections. It is used every day in most science conservation laboratories alongside other techniques. Nevertheless, there is acknowledgement that it is not totally reliable, which has sparked a recent discussion in the field of conservation (Motz and Fuhrmann, 2018; Lude and Schultz, 2018). The method was introduced into the field of conservation by Joyce Plesters, who used non-fluorescent stains for the examination of media, including Acid Fuchsine and Amido Black for proteins and Nile Blue for drying oils (Plesters, 1954, pp. 97-101; 1956, pp. 129-130). Non-fluorescent stains or diachromes are coloured chemical compounds that bind selectively and, in most cases, permanently to organic materials like proteins, carbohydrates and lipids, making them distinguishable during microscopic inspection and documentation. Other diachromes such as Sudan Black for drying oils or Ponceau S and Coomassie

250 for proteins were later advocated as options (Johnson and Packard, 1971; Martin, 1977; Gay, 1978). However, these stains have the disadvantage of being coloured and maintaining their colour after having stained, thus they are not practical when the paint layer has a similar or darker colour than the dye. Additionally, there are toxicity issues associated with some of these stains.[37]

Fluorescent stains or fluorochromes were introduced to the conservation field in the late eighties to overcome the difficulties detected in the microscopy identification and localisation of binding media within paint cross-sections (Wolbers and Landrey, 1987). This type of stain can either be coloured or uncoloured chemical compounds that bind selectively to organic materials like proteins, carbohydrates and lipids. Fluorochromes have since been successfully applied to the study of paintings and polychrome sculptures (Emmerling et al., 2013; Sandu, Schäfer, Magrini, Bracci, and Roque, 2012; Wolbers, 2000; Wolbers, Buck, and Olley, 2012), as well as painted banners (Smith, Thompson, and Hermens, 2016). The main advantages of these stains in comparison with the non-fluorescent ones is the relative ease of interpretation of the results, as the stained layers emit a fluorescence when excited by the incident light, which only occurs when interacting with the functional groups or molecular structures targeted (Greenspan, Mayer, and Fowler, 1985; Schäfer, 2013; Wolbers et al., 2012). The specificity of fluorescent staining has been highlighted as particularly useful by Sandu et al. for identifying proteinaceous media within cross-sections in the absence of analytical techniques like Micro-Fourier Transform Infrared Spectroscopy mapping (μFTIR) (Sandu, Roque, et al., 2012, p. 323). A disadvantage of FTIR is the interference of acrylic embedding resins which makes the interpretation complex. This can be mitigated by embedding in an infrared transparent salt (KBr) or by the expensive ion polishing method to enhance findings further when using mapping spectroscopic techniques (Mazzeo, Joseph, Prati, and Millemaggi, 2007, pp. 116-117; Prati et al., 2012, p. 88; Smith, Schmidt, Thompson, and Dixon, 2019, pp. 1-3).

Of all the fluorescent stains reported in the conservation literature, two were selected for the present study: the commercially produced SYPRO® Ruby protein blot stain (Invitrogen) for the staining of proteins and the reagent Nile Red for

[37] Dr Margaret Smith, personal communication, April 2021.

the staining of lipids. SYPRO® Ruby blot stain was selected for the reported advantages of its use and positive results published, being the most recently researched fluorescent stain for proteinaceous binders (Carlyle, 2005; Emmerling et al., 2013; Magrini et al., 2013; Motz and Fuhrmann, 2018; Lude and Schultz, 2018). It is also one of the methods currently used at the former Centre for Textile Conservation and Technical Art History (CTCTAH) of the University of Glasgow (now Kelvin Centre for Conservation and Cultural Heritage Research) for the routine microscopy analysis of cross-sections So there is familiarity with the technique. Nile Red was selected for having also been included in recent publications in the field (Sandu, Schäfer, et al., 2012; Wolbers et al., 2012; Schäfer, 2008; Schäfer, 1997) and for its affordability in comparison to other fluorescent stains for lipids.

5.3 Chemical and Physical properties of the selected stains

5.3.1 SYPRO® Ruby protein blot stain

SYPRO® Ruby stains are registered trademarks and exclusive formulations of Invitrogen (formerly Molecular Probes Inc., Eugene Oregon), reported to have been used in the proteomics field since the late 1990s (Berggren et al., 1999, p. 129; Sandu, Roque, et al., 2012, p. 319; Schäfer, 2013, p. 710). SYPRO® Ruby protein blot stain (Thermo-Fisher, 2015) has given more consistent results than the other formulations of SYPRO® Ruby in cross-section staining (Schäfer, 2013, p. 710), thus it is only the Invitrogen stain that will be referred to as SYPRO® Ruby henceforth. It is a ready-to-use luminescent metal chelate stain containing ruthenium II tris (bathophenanthrolinedisulfonate) as an organic transition metal complex. This is the main protein binding component and produces the emission colour on interaction (Figure 5.1). The solution contains an unrevealed buffer that judging by its strong smell and pH of 4 (Thermo-Fisher, 2015, p. 5) is acetic acid based (Schäfer, 2013, p. 711). SYPRO® Ruby allows sensitive fluorescence detection of proteins in an acid medium, without covalent bonding with the proteins' free amino groups (Berggren et al., 1999, pp. 129-130; Wolbers et al., 2012, p. 329). As explained by Yarmoluk et al., the ruthenium ion and inorganic ligands bind primarily to basic (free) amino acid residues by electrostatic interaction of its sulfonate groups (Figure 5.2a). Secondarily, the ruthenium ion binds to the polypeptide backbone of the protein molecule through a coordination bond (Figure 5.2b) (Yarmoluk, Kovalska, and Volkova, 2011, p. 181).

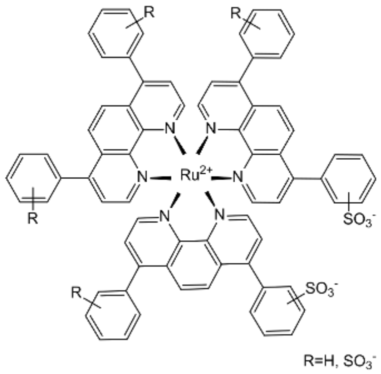


Figure 5.1. Known structure of SYPRO© Ruby fluorescent stain. (Image © Ghilt, distributed under a CC-BY 2.0 license.

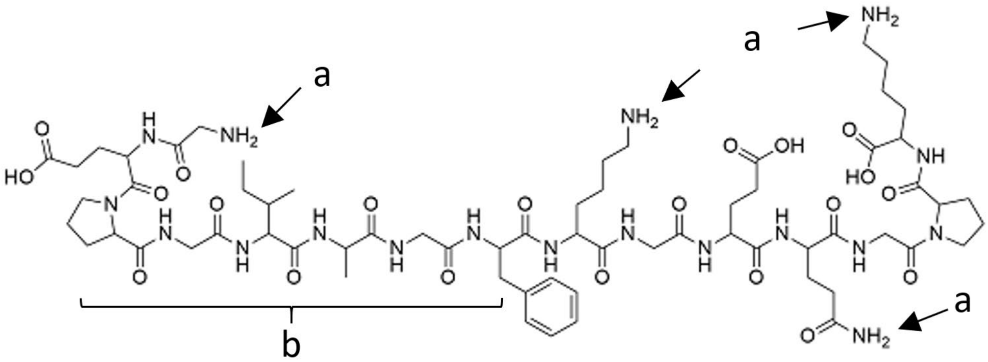
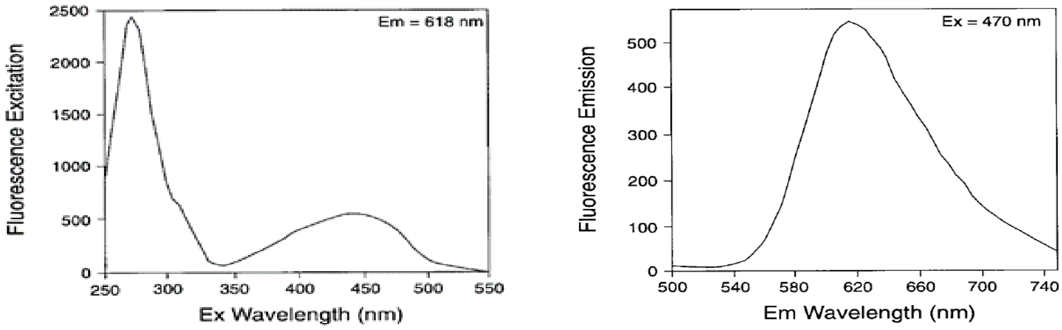


Figure 5.2. Structure of a collagen type II molecule with indication of the amino groups (a) and polypeptide backbone (b) binding areas. (Image © distributed under a CC-BY 2.0 license, modified by the author).

SYPRO® Ruby is colourless and non-fluorescent in solution (and dried), only becoming fluorescent upon protein interaction (Schäfer, 2013, p. 710). The fluorescence spectra of proteins stained with SYPRO® Ruby has two excitation maxima at 275 nm (ultraviolet light) and 440 nm (blue light), with an emission maximum at 618 nm (Figure 5.3), which makes it compatible with available excitation filters of 302 nm, 470 nm and similar (Berggren et al., 1999, p. 133-134). This means that with an excitation set at 470 nm, which is the preferred setting in the revised publications (Berggren et al., 1999; Carlyle, 2005; Emmerling et al., 2013; Sandu, Roque, et al., 2012; Sandu, Schäfer, et al., 2012; Schäfer, 2013), the positive stain is seen as an intense orange colour fluorescence caused by a large 'Stokes' shift (difference between the absorption and emission maxima) towards the orange wavelength (618 nm) of the visible light spectrum.



a) b)

Figure 5.3. Fluorescence spectra of SYPRO Ruby protein blot stain based on Berggren et al. (Berggren et al., 1999, p. 133); a) excitation maxima at 275 and 445 nm approximately, b) emission maximum at 618 nm with excitation set at 470 nm.

In the field of proteomics it is reported that SYPRO© Ruby is an ultra-sensitive stain with detection sensitivity of 0.25-1 ng protein/mm^2, superior to that of Amido Black and Coomassie Blue (Berggren et al., 1999, p. 129). But it also is not protein selective, staining most classes of proteins including glycoproteins, phosphoproteins, lipoproteins, calcium binding proteins, fibrillar proteins and even proteins considered difficult to stain by traditional methods (Yarmoluk et al., 2011, p. 181). Recent studies in the conservation and technical art history fields have also shown that SYPRO® Ruby positively stains most of the proteinaceous materials found in works of art, including mammalian and fish glues (collagen), whole egg (albumin), egg yolk, egg white and casein (Sandu, Roque, et al., 2012, p. 323; Sandu, Schäfer, et al., 2012, p. 868). The proteinaceous fibre silk, mostly formed of fibroin (Luxford, Thickett and Wyeth, 2009, p. 152), has only been previously considered by Smith et al. with regards to whether it is stained with SYPRO® Ruby (Smith, Thompson and Hermens, 2016) and is part of ongoing research.

Although SYPRO© Ruby's fluorescence colour is said to differ from the autofluorescence of paintings' binding media (Schäfer, 2013, p. 710), typically falling around 500 nm (Pronti, Felici, Ménager, Vieillescazes, and Piacentini, 2017, p. 4), a study has reported interference with the autofluorescence of synthetic pigments containing alizarin, suggesting that other colorants used in paintings (lake pigments) like madder or textile dyes containing Eosin could also mask the results (Sandu, Roque, et al., 2012, p. 321). Eosin is one of the early synthetic dyestuffs used in the period of 1850-1900, constituted of tetra brominated fluorescein (van Bommel, Berghe, Wallert, Boitelle, and Wouters, 2007, p. 261, 263).

Table 5.1. Materials that could mask the fluorescence of SYPRO© Ruby protein blot stain

Pigment/dye	Excitation λ	Emission λ	Authors
14 alizarin-based lakes (including madder)	365 nm	596-626 nm	Pronti et al. (2018)
Alizarin	458 nm	630-660 nm	Grazia et al. (2011)
Purpurin	458 nm	561-600 nm	Grazia et al. (2011)
Eosin (early synthetic dye)	320-345 nm / 445 nm	600 nm	van Bommel et al. (2007)

Autofluorescence is the natural fluorescence occurring in substances and minerals when excited with ultraviolet light, also known as primary fluorescence (Rost, 2017, 629). In this regard, Pronti et al. have reported the emission maxima wavelengths of fourteen alizarin-based lakes (including madder) all falling within the orange-red region (Pronti et al., 2018, p. 18), while Grazia et al. have indicated the emission wavelengths of both alizarin and purpurin (Table 5.1) (Grazia, Clementi, Miliani,and Romani, 2011, p. 1252). A similar finding for early synthetic dyes indicates the maximum emission wavelength of Eosin approaching the same region as SYPRO® Ruby (van Bommel, Berghe, Wallert, Boitelle, and Wouters, 2007, p. 264). In addition to that, it is reported that shellac and its variations, another binding medium potentially present in painted banners, also has an autofluorescence colour of an orange hue under UV light (Delaware, 2018). These findings highlight a potential problem of interpretation in painted silk banners, which could have been dyed or contain similar auto-fluorescent compounds. Additionally, it has been reported that SYPRO® Ruby can positively stain other materials such as polysaccharides, due to their proteinaceous content in the form of glycoproteins (Motz and Fuhrmann, 2018;

174-181; Lude and Schultz, 2018, p. 201-212). Summarised in Table 5.2, these materials could potentially be present in banners as previous repair/restoration treatments.

Table 5.2. Materials that can be stained with SYPRO© Ruby protein blot stain

Polysaccharides	Proteinaceous content	Source
Gum Arabic	2% glycoproteins	Lude and Schultz (2018)
Gum tragacanth	3% glycoproteins	
Wheat starch	10-15% protein (depending on type of grain and production process)	
Methyl cellulose	glycoproteins (percentage not specified)	

5.3.2 Nile Red lipid probe

Nile Red (9-diethylamino-5H-benzo[α]phenoxazine-5-one) is a red coloured benzo-phenoxazone dye (Greenspan and Fowler, 1985, p. 783; Greenspan, Mayer and Fowler, 1985, p. 967). It has been reported as commonly used in the field of microbiology since the late eighties for staining intracellular neutral lipid droplets (Greenspan and Fowler, 1985; Tamminga, Hengstmann, and Fischer, 2016) and it is listed as one of the most common fluorochrome dyes for localising and identifying lipids within cross-sections of easel paintings and polychrome sculptures (Sandu, Schäfer, et al., 2012; Schäfer, 2008; Wolbers et al., 2012). Nile Red is a fluorogenic dye (Fam, Klymchenko, and Collot, 2018, p. 3), which means that it is a latent fluorophore, or fluorescent chemical compound, capable of reemitting light upon excitation at a longer wavelength in response to environmental changes, interactions with analytes or specific chemical reactions (Chyan and Raines, 2018, p. 1810). In the case of Nile Red, these changes and interactions are said to be related to the polarity of the solvents it is dissolved in or the substances it is intended to stain (Greenspan, Mayer and Fowler, 1985, p. 972), although a more recent study correlates such behaviour to an increase in the Young's modulus of the substrate (Jee, Park, Kwon, and Lee, 2009). Nile Red is an uncharged heterocyclic molecule (Figure 5.4) highly soluble in organic solvents and lipids, yet relatively insoluble in water, acting as a fluorescent hydrophobic probe (Fowler and Greenspan, 1985, p. 833). Lipids are similarly defined as compounds that are soluble in organic solvents but insoluble in water and in terms of the fluorescent staining of painted objects (banners included), drying oils such as linseed oil are considered within that definition (Figure 5.4) (Schäfer, 1997, p. 57).

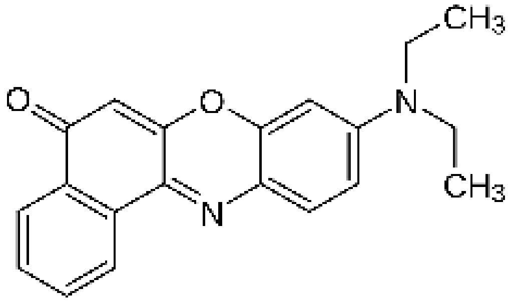


Figure 5.4. Nile red structure. (Image © public domain).

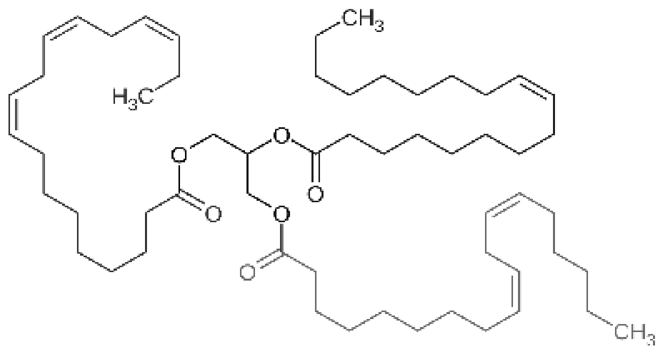


Figure 5.5. Representative triglyceride structure found in linseed oil, derived of linoleic acid, alpha-linolenic acid, and oleic acid. (Image © Public domain).

Fluorescent staining of lipids is mainly accomplished by the interaction between the substrate and the stain through secondary forces and is therefore governed by their affinity (Schäfer, 1997, p. 57). Although the process could appear random as there are no specific bonding forces involved (i.e. binding to specific functional group), lipid-stain selectivity can be increased through the incorporation of water into the carrier solvent, acting as a repulsive barrier for its preferred uptake by hydrophilic materials (i.e. proteins and polysaccharides) and for minimising the dissolution of lipids by the carrier solvent (Schäfer, 1997, p. 58). Furthermore, Nile Red has a high octanol-water partition coefficient (log P = 5.1), which gives it high affinity towards lipids and poor affinity towards hydrophilic substances (Schäfer, 1997, p. 59).

Nile Red also exhibits solvatochromatism, a phenomenon that causes colour variations in the intense fluorescence of the dye depending on the hydrophobicity of the surrounding environment (Figure 5.6). This means that in an increasingly polar medium, Nile Red's fluorescence colour shifts towards the red region of the visible light spectrum (positive solvatochromatism or bathochromatic shift). Such effect has been highlighted appropriate for evaluating oil-media polarity within paintings cross-sections (Wolbers et al., 2012, p. 330) and has only been tested and described by Schäfer for two unidentified multi-layered painting samples (Schäfer, 1997, pp. 62, 86).

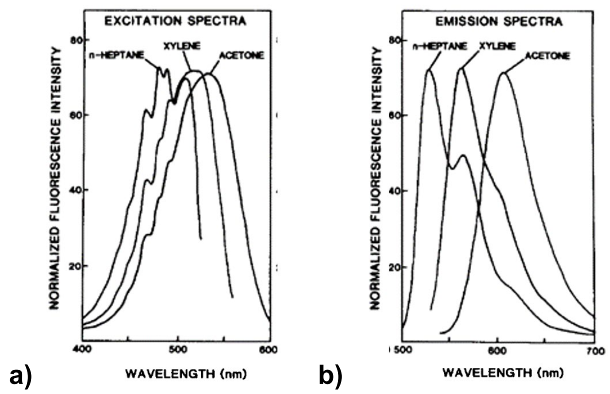


Figure 5.6. Fluorescence spectra of Nile Red dissolved in n-heptane, xylene and acetone based on Greenspan, Mayer and Fowler (1985, p. 967); a) excitation maxima at 484 nm, 523 nm and 536 nm, b) emission maxima at 529 nm (green), 565 nm (green-yellow) and 608 nm (orange-red) with excitation set at 487-489 nm and 530-550 nm.

Nile Red's fluorescence can be excited at different wavelengths from 484 nm to 559nm (blue and green light respectively), with an emission between 529 nm and up to 629 nm (Greenspan and Fowler, 1985, pp. 785-786).

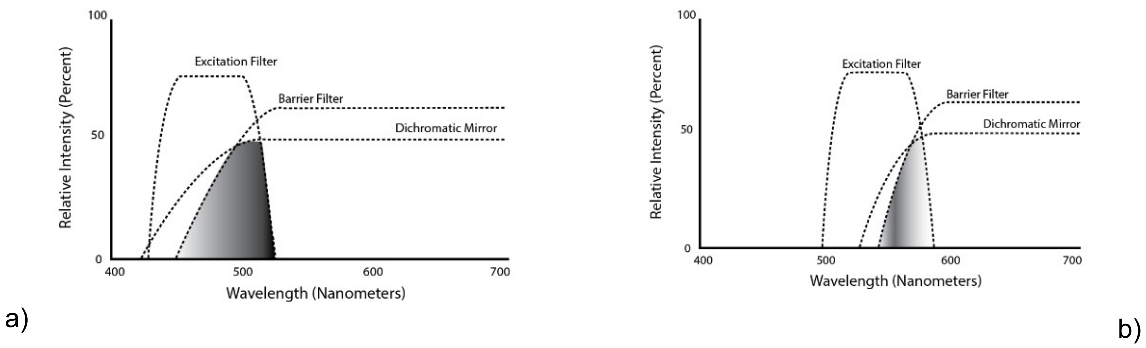


Figure 5.7. Fluorescence filter spectra of settings suggested by Fowler and Greenspan for a) fluorescein, b) rhodamine. Grey-scale areas show only the wavelengths passed through the barrier filter. Graphs originally plotted with Olympus Interactive Java Tutorials (Olympus, 2020).

The positive stain indicated by Greenspan and Fowler is a yellow-gold colour for neutral lipids (i.e. triacylglycerols, cholesterol, cholesteryl esters) and a red colour for amphipathic lipids (i.e. phospholipids) (Fowler and Greenspan, 1985, p. 835). The yellow-gold fluorescence can be examined under blue light and filter set for fluorescein fluorescence[38] (450-500 nm band pass filter, 510 nm centre wavelength chromatic beam splitter and 528 nm long pass barrier filter) (Figure 5.7a); the red fluorescence is seen under green light and filter set for rhodamine fluorescence[39] (515-560 nm band pass excitation filter, 580 nm centre wavelength chromatic beam splitter and 590 nm long pass barrier filter) (Figure 5.7b) (Fowler and Greenspan, 1985, p. 835).

However, it is reported that for paint cross-section microscopy and fluorescent staining, the excitation wavelength of Nile Red is 535 nm and its emission 580 nm, giving a positive stain colour of red under a green light with an excitation filter of 546/10 nm and a long pass barrier filter of 590 nm (Wolbers et al., 2012, p. 332). According to Schäfer, Nile Red is recommended for the staining of moderately-aged oil films of paint cross-sections (Schäfer, 1997, p. 59), appropriate for the five selected banners not reaching the 150 years given to higher hydrolysis (matured) oil paints (van den Berg, van den Berg and Boon, 1999, 251).

5.4 Staining methodology

Besides the study of Smith et al. in which SYPRO® Ruby was used to detect a proteinaceous coating over a 'silver paint' sample from a Tutill banner (Smith, Thompson and Hermens, 2016, pp. 4,8), there are no other publications on the use of SYPRO® Ruby on painted silk textiles. In the case of Nile Red, one publication describes how a positive stain appears in two paint cross-sections containing oil paint layers (Schäfer, 1997, p. 86), but it has not yet been applied to the study of painted textiles. This supposed the need of testing both stains before applying them to the historical banners' samples.

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[38] Fluorescein is the general name of fluorescein isothiocyanate (FITC), a common fluorophore used in microscopy for labelling proteins since 1960 (Wolbers et al., 2012, p. 328).

[39] Rhodamine is the general name of rhodamine B, a fluorescent stain for lipids extensively used in biotechnology applications (Wolbers et al., 2012, p. 330).

Furthermore, the scarcity of publications concerning cross-sections of double-sided painted banners on silk in comparison with traditional easel paintings, required the preparation of reference standards to aid with the correct interpretation of the fluorescent staining results. Therefore, the following staining methodology was developed for the characterisation of painted silk banners based on recommended procedures for SYPRO® Ruby and Nile Red as follows.

5.4.1 Staining protocols

The method of application of SYPRO® Ruby stain followed was that detailed by Schäfer (2013). The embedded and exposed samples were fixed overnight in a saturated vapour chamber of formaldehyde (37% by weight); left to ventilate for 5 hours to allow full volatilisation and further polished to remove swollen areas with Micro®Mesh polishing cloths grits 4000, 6000 and 8000.[40] Vapour phase fixation with formaldehyde causes minor swelling of the paint layers due to mild cross-linking of proteinaceous and lipidic binders yet it is needed to convert the soluble target material (i.e. proteins) into insoluble and resistant networks (Schäfer, 2013, p. 711). A drop of the stain was applied with an Eppendorf pipette over each cross-section individually, left to react for 2 minutes as recommended by Richter for traditional paint cross-sections (Richter, 2019), and the remaining stain was absorbed with a disposable wipe. Although the recommended time worked well with the cross-sections of this study, it is generally not possible to develop a standard protocol for SYPRO Ruby® due to the variability of painting materials in each object (e.g., solubility, thickness, concentration). Thus, the reaction time should be carefully tested for different types of painted textiles by starting with 15-20 seconds and gradually increasing the staining time if no reaction takes place, within a range of 10 seconds and 5 minutes (Motz and Fuhrmann, 2018, p. 174-181). The reaction is observed as the dissolution of the stain into the substrate, which depending on the composition of the paint could show some effervescence due to the acidic pH (i.e., when calcium carbonate is present in the mixture). Gloves were worn to avoid contamination. Each sample was then left to dry for a further 9 minutes, all

[40] Dr Mark Richter suggested the further polishing of the samples with MicroMesh® up to the grit 8000, explaining that the cross-sections take up the stain much better if the surface is not perfectly polished up to the grit 12000 (M. Richter, personal communication, 2019).

under a black-out hood or in a dark room to ensure total darkness. Maintaining darkness is important due to the light sensitivity of the stain.

The method of application of Nile Red was adapted from those published by Fowler and Greenspan (1985) and Prata et al. (2019), following further recommendations published by Schäfer (1997) and the solution suggested by Wolbers et al. (2012, p. 332). A solution of 0.02% in water/isopropanol (15:85 v/v) was prepared (0.1 mg of Nile Red in 5 ml of solvent mixture) and stored in a dark glass vial until use. A drop of the stain was applied with an Eppendorf pipette over the cross-section without touching the sample to avoid damage or contamination, left to react for 5 minutes, and washed with a solvent mixture of water/isopropanol 15:85 v/v using a venting wash bottle; excess liquid was immediately absorbed with a disposable wipe without touching the sample which was left to dry for further 15 minutes. All done in total darkness due to the light sensitivity of the stain, achieved either with a black-out hood or in a dark room.

5.4.2 Instrumentation

All samples were inspected with aid of an Olympus BX41 polarising microscope with a built-in Olympus CCD camera of 2.5 million pixels and a U-LH100HG 100-Watt Pressure Mercury Arc Lamp Housing for UV epi-illumination. Images of before and after staining were acquired under bright field-no filter, dark field-crossed polarisers, fluorescent filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm) (Figure 5.8 a) and fluorescent filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm) (Figure 5.8 b), all processed with Olympus Stream Basic version 1.9.3 software.[41]

Nine selected samples were additionally inspected through a Zeiss Axioskop optical microscope with an attached AxioCam MRc Zeiss camera of 2.5 million pixels and an HBO 100 Mercury Lamp unit for UV epi-illumination. Images of before and after staining were acquired under fluorescent filter set for fluorescein (BP 450-490nm, FT 510nm, BP 515-565nm) (Figure 5.9 a) and for

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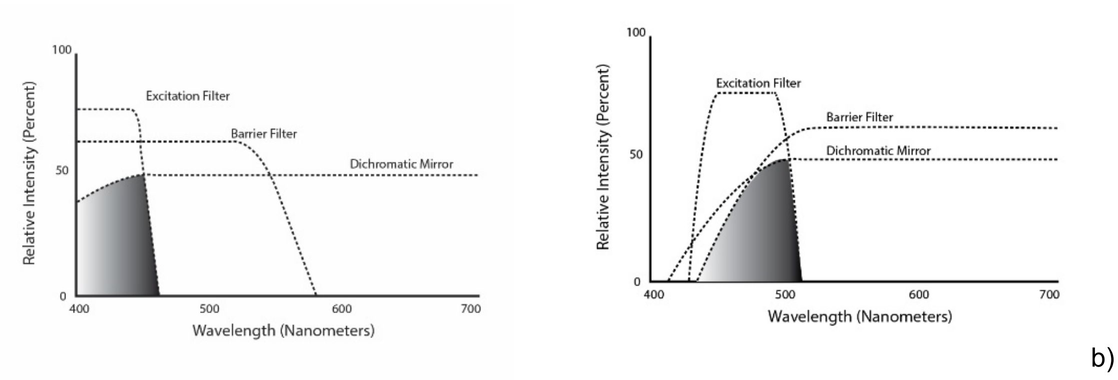
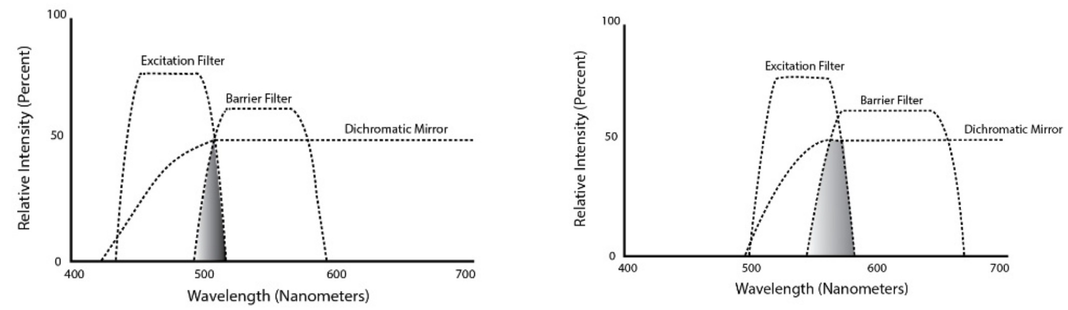
[41] Although documentation of cross-sections was acquired with all four settings, only the images acquired with the fluorescent filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm) were included. The fluorescence registered with the filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm) and UV light was too inconsistent for evaluating the results of the selected stains.

rhodamine (BP 446/12nm, FT 560nm, BP 575-640nm) (Figure 5.9 b), all processed with Axiovision V4.8 software.



a) b)

Figure 5.8. Fluorescence filter spectra of a) U-M11011v2, b) U-MWB2 settings. Grey-scale areas show only the wavelengths passed through the barrier filter. Graphs adapted from the originals plotted with Olympus Interactive Java Tutorials (Olympus, 2020).



a) b)

Figure 5.9. Fluorescence filter spectra of Zeiss Axioskop settings for a) fluorescein, b) rhodamine. Grey-scale areas show only the wavelengths passed through the barrier filter. Graphs adapted from the originals plotted with Olympus Interactive Java Tutorials (Olympus, 2020).

5.5 Samples rationale

5.5.1 Isolated materials (SYPRO® Ruby, Nile Red, rabbit skin glue, and linseed oil)

To aid with the interpretation of the fluorescent staining results of SYPRO® Ruby and Nile Red, each of the stains and their targeted products: rabbit skin glue and linseed oil, were prepared for observation (Table 5.3). A solution of rabbit skin glue (No. LC27485J: L. Cornelissen & Son) was prepared at a concentration of

10% w/v at a temperature of 60º C; an uncontaminated glass slide was dipped into it and left to dry horizontally. Another uncontaminated glass slide was dipped directly into raw linseed oil (No. 73054 Kremer Pigmente) and left to dry horizontally. The samples formed a dry film and they were both placed by the laboratory window with a Plexiglas cover that allowed light entry and ventilation but prevented the deposit of dust. Samples were removed and used after 250 days because of COVID-19 restrictions. Both slides were subsequently halved with a glass cutter, preparing two of the halves with formaldehyde fixation and two without for comparison. The stains were applied following the protocols of section 5.4.1 without the polishing step.

Nile Red samples were also prepared to be seen under the same filtering conditions on uncontaminated glass slides, both as a powder and as a solution of 0.02% in water/isopropanol (15:85 v/v), left to dry before inspection under total darkness. The intention of preparing these samples was to document the autofluorescence of the dry coloured stain, because it has only been documented in solution (Schäfer, 1997). Given that SYPRO Ruby® has no autofluorescence on its own, no comparative sample was prepared.

Table 5.3. Samples of isolated materials for SYPRO® Ruby and Nile Red staining tests.

Material	Non fixed	Formaldehyde fixed
Rabbit skin glue	FR01	FR02
Raw linseed oil	FO01	FO02

* Sample code: (F) indicates film sample, (R) indicates rabbit skin glue, (O) indicates linseed oil and numbers indicate non fixed (01) and formaldehyde fixed (02).

The environmental conditions in the CTCTAH laboratory during preparation and inspection of all samples in this chapter were registered at an average 20.7°C temperature and 50.3 % relative humidity, obtained from the total of 64 days worked. The measurements were made with an analogue thermohydrometer located in the laboratory.

5.5.2 One-sided mock-up samples

Two one sided mock-ups of painted textiles were provided by Dr Margaret Smith and Karen Thompson (staff at University of Glasgow) to test the fluorescent stains of the present study.[42] These mock-ups had been prepared in February 2016 in the CTCTAH, as part of their ongoing research on painted textiles. Each mock-up had identical sampling areas with painting materials most frequently found in painted textiles according to their previous research (Smith, Thompson, and Lennard, 2017; Thompson, Smith, and Lennard, 2017). Silk textile was selected because of the banners' main fabric and cotton textile was additionally selected for comparison, because it was expected to present non proteinaceous fibre to potentially give a negative stain with SYPRO® Ruby. Each mock-up had 15 similarly prepared areas plus the untreated textile (Figure 5.10):

- 5 different size layers: rabbit skin glue 1:100 w/v, rabbit skin glue 1:10 w/v, polyurethane, egg white, egg yolk.

- 5 different size layers plus 1 white ground layer: mixture of 10.15 g of zinc white (L. Cornelissen & Son) and q.s. (exact quantity was not disclosed by Smith and Thompson) of stand linseed oil (Winsor & Newton).

- 5 different size layers plus 1 white ground layer plus 2 paint layers: Chrome yellow oil paint (Hue 623 – Georgian range, Daler Rowney) and Vermilion oil paint (Hue 588 – Oil range, Daler Rowney).

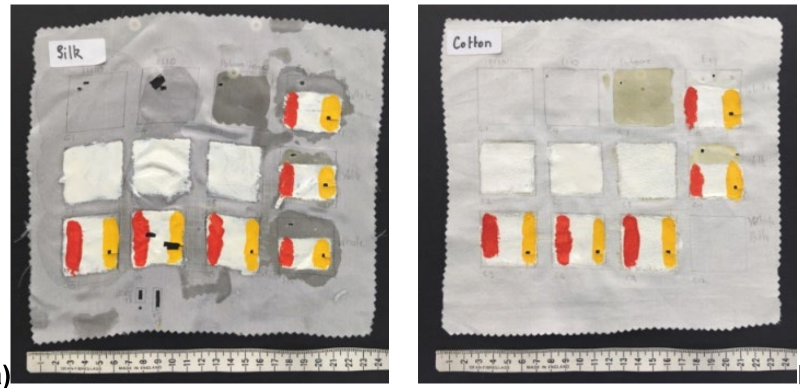
a)  b)

Figure 5.10. Mock-ups of one-sided sized and painted textiles; a) silk, b) cotton.

[42] Dr Margaret Smith is affiliate researcher at the Kelvin Centre for Conservation and Cultural Heritage Research of the School of Culture & Creative Arts. Mrs Karen Thompson is senior lecturer (History of Art) for the MPhil Textile Conservation course at the at the Kelvin Centre for Conservation and Cultural Heritage Research of the School of Culture & Creative Arts. They have jointly researched commercially produced British painted banners since 2015.

Additional one-sided mock-ups were prepared for testing other materials, which are indicated in the corresponding section.

5.5.2.1 Size samples

Eight textile cross-sections were taken from Smith and Thompson's mock-ups, three from the silk fabric and five from the cotton fabric (Table 5.4). Samples included four of the different sizes previously listed as well as the unsized textiles.

The aim was to test the effect of SYPRO® Ruby on the two selected fabrics and see if its fluorescence could be distinguished from that reported for rabbit skin glue and egg white (Sandu, Roque, et al., 2012, p. 320-321). Polyurethane was additionally selected as another amino-containing polymer that could be stained with SYPRO® Ruby, having been identified by Smith and Thompson in some modern paint formulations.[43]

A second set of samples from the two textiles was impregnated in a solution of cyclododecane and white spirit 30:40 v/v (Rowe and Rozeik, 2008, p. 20) before being embedded and left to volatilise for 20 days after exposure by dry-polishing before staining. The aim was to detect if better results could be achieved by preventing the penetration of the mounting resin into the fibres. While the treatment enabled a better-preserved structure of the textile samples, having acted as a temporary consolidant while curing and polishing took place (Martin de Fonjaudran, Nevin, Piqué, and Cather, 2008), there are possible residues of cyclododecane within the cross-sections particularly in the cotton samples, which add an unnecessary variable to the interpretation. Nevertheless, the results after the SYPRO® Ruby staining were equivalent in both set of samples but appearing more evident in the cyclododecane impregnated samples than in the un-impregnated ones.

[43] Smith, personal communication, 2019.

Table 5.4. Textile mock-ups samples for SYPRO® Ruby staining		
Sample code*	Fibre	Size
PS13	Silk	No size
PS16	Silk	Rabbit skin glue 1:100 w/v
PS15	Silk	Rabbit skin glue 1:10 w/v
C0	Cotton	No size
C1	Cotton	Rabbit skin glue 1:100 w/v
C4	Cotton	Rabbit skin glue 1:10 w/v
C7	Cotton	Polyurethane
C10	Cotton	Egg white
*Silk samples were assigned a different code than that originally given by Smith and Thompson (S), indicating a plain weave silk textile (PS). Cotton samples maintained their original coding (C).		

5.5.2.2 Paint and size samples

Another five cross-sections from Smith and Thompson's mock-ups were taken from the silk textile section containing rabbit skin glue 1:10 w/v, ground layer of zinc white with stand linseed oil, and chrome yellow paint layer (Figure 5.10a, bottom row, second square from the left). (Table 5.5 and Figure 5.10a). The aim was to test the selected stains in the added ground and paint layers. Two other samples prepared by Smith in March 2014 were also provided for comparing the staining results of SYPRO® Ruby on an un-sized painted silk textile, as well as to compare the results of Nile Red on a dried lead white oil paint (Table 5.5, sample code Pb1 and Pb2).

Table 5.5. Painted textile samples for SYPRO® Ruby and Nile Red staining				
Sample code*	Fibre	Size	Paint	Stain
S6	Silk	Rabbit skin glue 1:10 w/v	Oil	SYPRO® Ruby
RS1	Silk	Rabbit skin glue 1:10 w/v	Oil	SYPRO® Ruby
RS2	Silk	Rabbit skin glue 1:10 w/v	Oil	SYPRO® Ruby
Pb1	Silk	No size	Oil (Lead white)	SYPRO® Ruby
RN1	Silk	Rabbit skin glue 1:10 w/v	Oil	Nile Red
RN2	Silk	Rabbit skin glue 1:10 w/v	Oil	Nile Red
RN3	Linen	Rabbit skin glue 1:10 w/v	Acrylic	Nile Red
RN4	Linen	Rabbit skin glue 1:10 w/v	Acrylic	Nile Red
Pb2	Silk (dyed)	No size	Oil (Lead white)	Nile Red
*Sample S6 maintained Smith and Thompson's coding. Samples taken for staining tests were labelled as reconstruction SYPRO (RS) or reconstruction NILE (RN). Unsized samples with lead paint were labelled with chemical symbol (Pb).				

Additionally, an acrylic paint mock-up was prepared by using a plain weave linen canvas sized on one side with 1:10 w/v rabbit skin glue (No. LC27485J: L. Cornelissen & Son), titanium white acrylic paint and synthetic ultramarine blue acrylic paint (both paints Crawford & Black) (Table 5.5, sample code RN3 and RN4). The intention of this last mock-up was to potentially serve as a negative stain example for Nile Red, given that its composition was not lipidic. Acrylic paint was also selected for being the preferred paint used by modern banner makers (Thompson et al., 2017, p. 71) and for the possibility of having been used in historical banners as part of a later treatment of repair or restoration.

5.5.3 Two-sided paint and size mock-ups

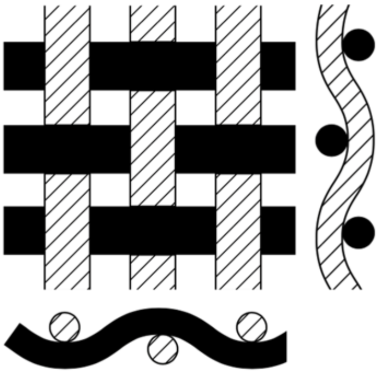
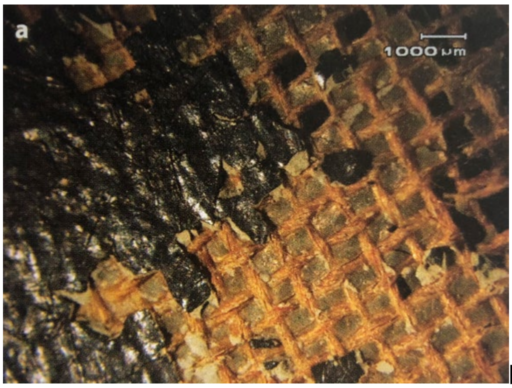
To test the potential of SYPRO® Ruby to determine different concentrations of proteinaceous size on double-sided painted silk banners, four additional mock-ups were made. They were prepared using an uncontaminated section of silk rib fabric (Silk faille, Broadwick Silks) like the original weave of the five selected banners, with three dilutions (2.5% w/v, 5% w/v and 10% w/v) of rabbit skin glue in distilled water (No. LC27485J, L. Cornelissen & Son), applied with a brush at 60ºC and left to dry. One layer of white acrylic paint (Titanium white acrylic, Crawford & Black) was applied by brush on each side and left to dry. The size layer had to be enclosed between a paint layer to mimic a double-sided painted banner. Acrylic paint was selected due to its fastest drying compared to the oil paints commonly found on banners. A fourth mock-up without any size was also prepared for comparison.

Table 5.6. Double-sided painted silk mock-ups for SYPRO® Ruby staining

Sample code*	Size	Paint
RS00_1	None	Titanium white acrylic (Crawford & Black)
RS00_2	None	
RS02_1	Rabbit skin glue 2.5% w/v	
RS02_2	Rabbit skin glue 2.5% w/v	
RS05_1	Rabbit skin glue 5% w/v	
RS05_2	Rabbit skin glue 5% w/v	
RS10_1	Rabbit skin glue 10% w/v	
RS10_2	Rabbit skin glue 10% w/v	

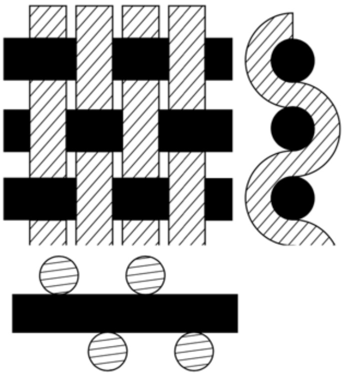
*(R) indicates rabbit skin glue, (S) indicates size samples, (00, 02, 05, 10) indicates size concentration, (_1) indicates the weave direction seen from the wefts, (_2) indicates the weave direction seen from the warps.

A total of eight cross-sections, one from each of the two weave directions of the four different mock-ups, were taken and embedded (Table 5.6). The samples were acquired in pairs to evidence the two possible aspects of a double-sided painted silk banner cross-section. Unlike traditional easel paintings, frequently painted onto a plain weave textile with equal alternation of warps and wefts (1:1) with comparable thicknesses (Figure 5.11), these types of banners are usually painted onto rib fabrics with unequal alternation of warps and wefts and significantly different thicknesses (wefts frequently twice as thick as the warps). This results in a different appearance of their cross-section views depending on the weave direction from where they were sampled (Figure 5.12).


a)


b)

Figure 5.11. Tabby or plain weave fabric: a) plan view with warp (streaked) and weft (black) cross-sections, based on Gandhi and Sondhelm (2016, p. 65); b) Detail of a paint loss from a 1901 portrait on a commercially prepared French canvas published by Carlyle (2017, p. 25).


a)

b)

Figure 5.12. Rib or warp-faced plain weave: a) Fabric's plan view with warp (streaked) and weft (black) cross-sections, based on Gandhi and Sondhelm (2016, p. 65); b) Microphotograph of the painted rib textile of the Glasgow Upholsterers Society banner, DinoLite model AM4113T, normal light, 10 x.

5.5.4 Double-sided painted banner reconstruction samples

A total of four cross-sections from the *Reconstruction 1* described in Chapter 4, section 4.10.1, one per weave direction of each reconstruction, were cut-out with a scalpel and embedded (Table 5.7).

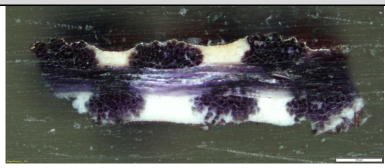
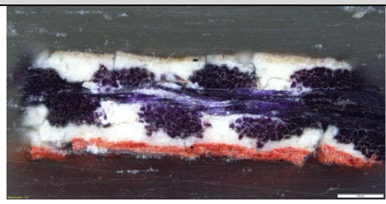
The four cross-sections were prepared in pairs to test the viability of applying both stains separately and simultaneously, as an experimental crossed staining method (Table 5.7, sample code RA2 and RB1).

Table 5.7. Double-sided painted silk banner reconstructions' samples for SYPRO® Ruby and Nile Red staining			
Sample code*	Size	Paint	Stain(s)
RA1	Rabbit skin glue 1:10 w/v	Raw linseed oil	Nile Red
RA2	Rabbit skin glue 1:10 w/v	Raw linseed oil	SYPRO® Ruby / Nile Red
RB1	Rabbit skin glue 1:10 w/v	Stand linseed oil	SYPRO® Ruby / Nile Red
RB2	Rabbit skin glue 1:10 w/v	Stand linseed oil	Nile Red
*Letters indicate banner reconstructions prepared with raw linseed oil (RA) and stand linseed oil (RB). Numbers indicate the weave direction from where the samples were taken and embedded, seen from the wefts (1), seen from the warps (2).			

5.5.5 Cross-sections from the banner of *The Glasgow Typographical Society* by George Kenning.

To test the viability of this fluorescent staining methodology in cross-sections of naturally aged painted silk banners, two embedded samples from one of the five banners were selected and tested as representative examples of the two motifs found in their design: metallic scrolls and central paintings.

Due to the thickness of the samples, which would allow repolishing in case the results were inadequate, the two examples from the banner of *The Glasgow Typographical Society* were selected to test the staining methodologies (Table 5.8) (see Chapter 4, section 4.5 for embedding details and Appendix II for localisation).

Table 5.8. Cross-sections from a George Kenning banner, seen under Olympus BX41 microscope at 100x magnification, normal light, dark field, crossed polarisers.		
Title and year of making	Silvered scroll section	Central painting section
The Glasgow Typographical Society (1883)	 TS08	 TS40

As previously noticed by Rogerson and Lennard (2004) and Smith, Thompson and Hermens (2016), there was no visual evidence of a size layer in the cross-sections, other than the restricted penetration of the white ground layer into the fibres.

Like the double-sided painted banner reconstruction samples, both cross-sections were firstly treated with SYPRO® Ruby but only sample TS40 was subsequently crossed stained with Nile Red.

5.6 Staining tests

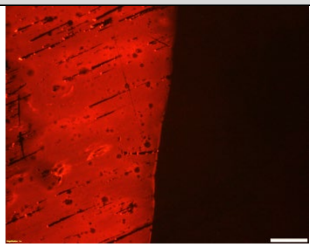
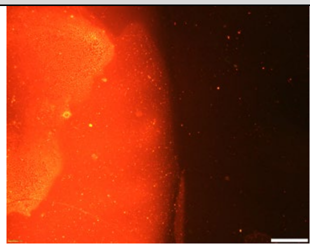
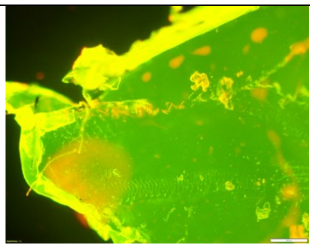
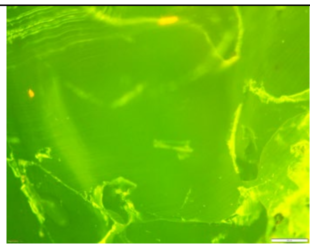
5.6.1 SYPRO® Ruby protein blot stain

The tests of the SYPRO® Ruby staining of film samples of rabbit skin glue and raw linseed oil confirmed its specificity for proteinaceous materials only (Table 5.9). They additionally showed the influence that formaldehyde fixation has on the uptake of the fluorescent stain and the physical solidity of the proteinaceous sample. While both rabbit skin glue films were positively stained with the reagent, sample FR02 showed a significantly higher fluorescence than sample FR01. Additionally, sample FR01 remained significantly more sensitive to abrasion than sample FR02, as the touch of a paper towel to remove airborne particles left marks on the first but not on the second.

Protein fixation was originally developed by the field of histology, not only to reduce their solubility as Schäfer explains (Schäfer, 2013), but to harden and preserve the tissues intended for study (Eltoum, Fredenburgh, et al., 2001). This explains the significantly higher resistance to abrasion seen on sample FR02. Formaldehyde fixation is considered the most common fixative used in diagnostic pathology, a type of non-coagulant or cross-linking fixative (Eltoum, Fredenburgh, et al., 2001). As the type indicates, the mechanism triggered by the exposure to formaldehyde either as liquid or gas (vapour), is the cross-linkage of the protein molecules. In the case of collagen, the main component of rabbit skin glue, this cross-linking is primarily caused by the hydrogen bonds forming within the helical structure of its high hydroxyproline content (Heidemann, 1982). This complex process also known as tanning, has been reported to increase the spacing between collagen chains from 10 to 17Å

(Gustavson, 1956). Although not stated in the literature, it appears that the higher uptake of SYPRO® Ruby on the fixed sample FR02 can be due to such increased spacing, allowing the fluorescent stain to bind with more sections of the polypeptide backbone in addition to the free amino groups.

Table 5.9 SYPRO® Ruby staining of isolated binder films, seen through Olympus BX41 optical microscope, 50 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm)

Material	Non fixed	Formaldehyde fixed
Rabbit skin glue (10% w/v)	 FR01	 FR02
Raw linseed oil	 FO01	 FO02

*Sample codes are indicated under each image. **Rabbit skin glue samples show interface between stained and non-stained areas of the same film. Linseed oil samples are not segmented due to lack of stain's fluorescence.

SYPRO® Ruby also positively stained all the undyed silk fabric samples, both with and without rabbit skin glue size. Although predominantly composed of fibroin (Figure 5.14), silk is not fully crystalline, but has some accessible amorphous content where the stain seems able to bind. The positive stain was seen through an Olympus BX41 microscope with U-MWB2 filter conditions as a homogeneous orange tone with a similar intensity in all the undyed silk samples (Figure 5.15 a, b, c).

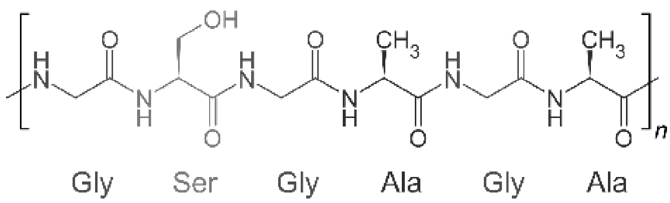


Figure 5.14. Structure of a fibroin unit with indication of amino acids glycine (Gly), serine (Ser) and alanine (Ala) in the sequence. (Image © Public domain).

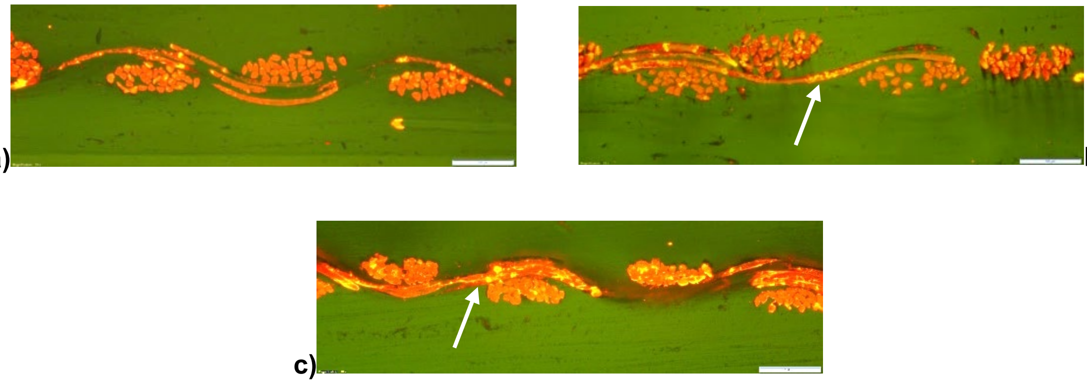


Figure 5.15. SYPRO® Ruby staining of silk textile samples, seen through Olympus BX41 optical microscope, 100 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm); a) PS13 after staining, b) PS16 after staining, c) PS15 after staining. White arrows indicate the detection of a continuous line of size (bright yellow) on side of application.

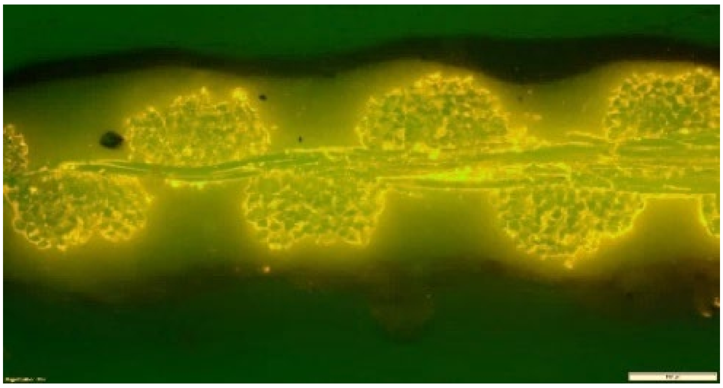
Tests for checking the possibility of distinction between the fluorescence of the proteinaceous sizes and silk varied depending on the type of size and concentration. All silk samples prepared with the highest concentration of rabbit skin glue size (1:10) showed a higher fluorescence intensity, registered as an intense yellow due to the over-exposure of the camera sensor (Figures 5.15 c; 5.16 a, b; 5.22 a). In all those samples the collagen-based size was seen as a continuous yellow line over the side of application, interpreted as the formation of a proteinaceous film on top of the textile substrate. This can be explained by the higher uptake of SYPRO® Ruby onto the amorphous protein collagen, caused by the multiple free amino groups in addition to the polypeptide backbone chain (Figure 5.2 b).

To discard a possible higher intake of SYPRO® Ruby by residual sericin in the textile, two fibres from the reconstruction silk, warp and weft, were analysed with FTIR-ATR by Dr Paul Garside. He estimated the proportions according to Zhang and Wyeth (2010, pp. 626-631) as follows:

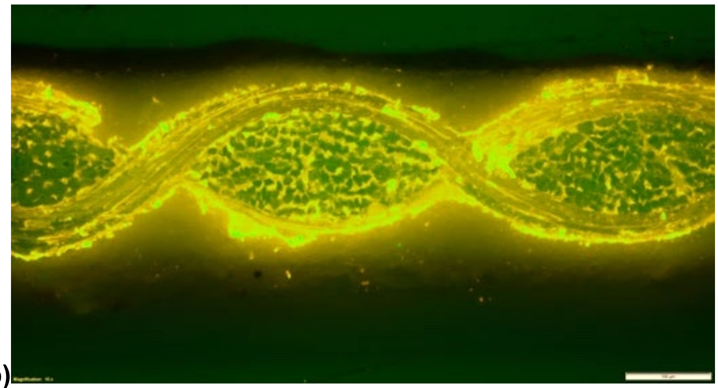
Warp:
$I_{1650}/I_{1625} = 0.68$
$I_{1400}/I_{1445} = 0.28$
$I_{1070}/I_{1165} = 0.85$

Weft:
$I_{1650}/I_{1625} = 0.61$
$I_{1400}/I_{1445} = 0.31$
$I_{1070}/I_{1165} = 0.96$

According to Zhang and Wyeth, these values are close to the observed ones for 0% residual sericin (Zhang and Wyeth, 2010, pp. 629), thus the higher intake can only be attributed to the added collagen content of the rabbit skin glue size.



a)



b)

Figure 5.16. SYPRO® Ruby staining of double-sided painted banner reconstructions, seen through Olympus BX41 optical microscope, 100 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm); a) sample RA2 (10% w/v rabbit skin glue) after staining, b) sample RB1 (10% w/v rabbit skin glue) after staining.

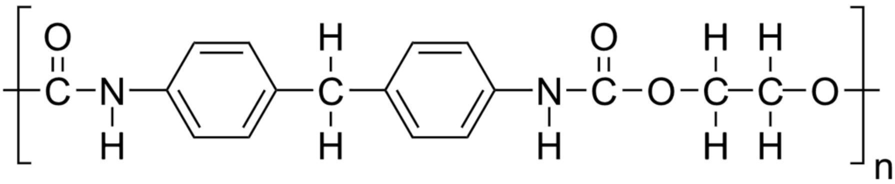


Figure 5.17. Structure of a polyurethane unit. (Image © Hbf878 distributed under a CC-BY 2.0 license).

The staining tests of the different types of proteinaceous sizes, showed SYPRO® Ruby stained positively for both mammalian glue (rabbit skin glue) and egg white sizes (Figure 5.18), corroborating the results of Sandu et al. (Sandu, Roque, et al., 2012). However, SYPRO® Ruby did not stain the other nitrogen-containing polymer polyurethane. This is probably due to the absence of free amino groups in its molecule, as well as the lack of a polypeptide backbone chain (Figure 5.17), confirming the specificity of such fluorescent stain for proteinaceous materials only.

The lower concentration of glue size (1:100) and the egg white size, showed a slightly more intense orange colour than the un-sized silk, but unfortunately not enough to make a distinction from the un-sized silk fibroin (Figures 5.15 a; 18 b, e). This confirms two other results reported by Sandu et al., in that SYPRO® Ruby intensity variations indicate different protein concentrations depending on its fluorescence intensity but does not have a specific response for different proteinaceous binders (egg and animal/fish glues) (Sandu, Roque, et al., 2012, pp. 320-321; Lude and Schultz, 2018, p. 201-212).

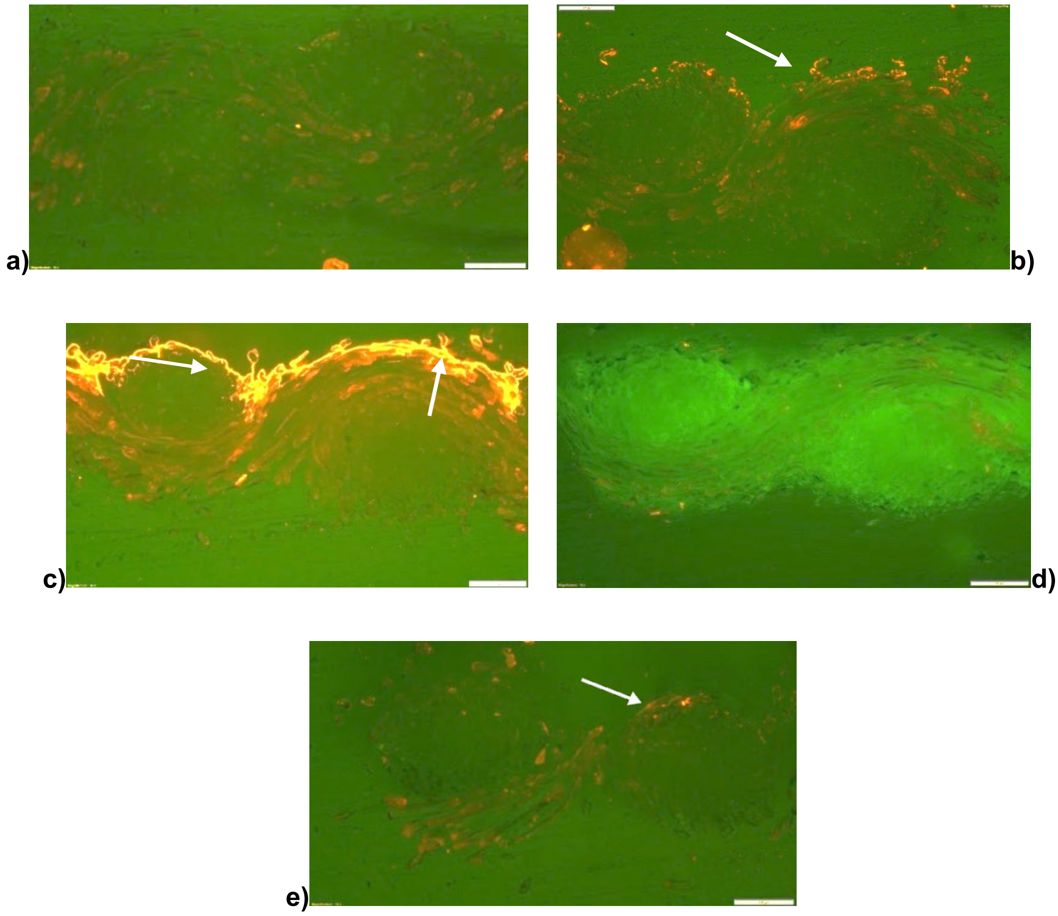


Figure 5.18. SYPRO® Ruby staining of cotton textile samples, seen through Olympus BX41 optical microscope, 100 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm); a)C0 after staining, b)C1 after staining, c)C4 after staining, d)C7 after staining and e)C10 after staining. White arrows indicate the detection of a continuous line of size (bright yellow) on side of application, better evidenced in c).

The possibility of detecting the side of application of the size was also tested. In particular for cotton textile samples C1, C4 and C10, as well as the one-sided painted silk mock-ups (Figures 5.18 b, c, e; 5.20 a). For these cases, an accumulation of the applied proteinaceous material was made evident with

SYPRO® Ruby, which registered as yellow in the 1:10 concentrations and as a slightly more intense orange than the silk fibres in the 1:100 and egg white samples.

Additionally, undyed cotton fibres of samples C0, C1, C4, C7 and C10 were partially stained regardless of having been sized or not, seen as scattered blots of a pale-translucent orange hue (Figure 5.18 a-e).

To test this apparent affinity of SYPRO® Ruby to cotton fibres, a set of four cotton duck samples was additionally embedded and prepared in the same way, to be stained with the reagent. Two of the samples were embedded as sent by the manufacturer to potentially detect a proteinaceous size residue that could cause the positive staining seen in samples C0, C1, C4, C7 and C10. Two other samples were previously scoured by submitting it to two full washing cycles (four hours in total) at 60° Celsius without the use of detergent, to try to eliminate any potential proteinaceous residue. It is possible that a small residue was still present, thus affecting the results. Nevertheless, the tests were deemed as inconclusive due to the limited number of samples for comparison and the added variables of fibre damaging (temperature, humidity, and abrasion), similar positive staining was detected in areas, regardless of the preparation method. This indicates that cotton fibres have a proteinaceous content that is made evident with SYPRO® Ruby.

Whilst cotton is considered as ‘the purest form of cellulose available in nature’ (Dochia, Sirghie et al., 2012, p. 12), their fibres are composed by a multi-layered structure made of different chemical compounds. From outer to inner they comprise of a: cuticle, primary wall, winding layer, secondary wall and lumen (Figure 5.19).

The secondary wall of cotton fibres is formed by crystalline cellulose. Due to its high crystallinity and its thickness, the secondary cell wall predominates in terms of physical properties and longer-term ageing properties. The outer cell walls have a significant influence on interactions with the local environment such as moisture sorption and dye uptake, as well as with immediate/short term reactivity and degradative changes due to their more amorphous structure and greater accessibility. The outer cell walls are formed by a mixture of waxes, amorphous cellulose, pectins, minerals and most importantly for this research, proteins. It is reported that the chemical composition of a cotton fibre has a typical protein content of 1.3%, with a minimum of 1.1% and a maximum of 1.9% on a dry basis (Kanchagar, 2003). Thus, the positive staining seen in all cotton samples are consistent with the previously reported high sensitivity of SYPRO® Ruby for protein detection (Berggren et al., 1999; Magrini et al., 2013; Schäfer, 2013; Motz and Furmann, 2018) and the reported possibility of staining glycoproteins in polysaccharides (Lude and Schultz, 2018).

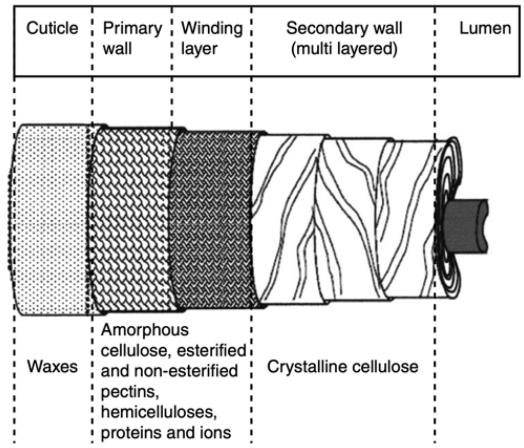


Figure 5.19. Layered representation of a cotton fibre as published by Dochia, Sirghie et al. (2012, p. 15).

A problem of interpretation occurred between the registered fluorescence of the one-sided painted silk samples with 1:10 size (S6, RS1, RS2, RA2 and RB1) and the one-sided painted silk sample without size (Pb1), which could be interpreted as a false positive with SYPRO® Ruby. Both types of one-sided painted samples registered a yellow fluorescence colour in the interface between paint and textile, alongside the homogenous orange colour of the silk fibres (Figure 5.20 a, b). However, the yellow fluorescence registered in samples RS1and RS2, [44] indicated the presence of the collagen-based size applied onto one side of the textile, while in sample Pb1, intentionally left un-sized for comparison, the yellow could indicate a higher SYPRO® Ruby uptake by the silk fibre due to abrasion or possible handling contamination. During the live inspection of both samples, only an orange fluorescence was detected, varying in the intensity of

[44] The word registered is used here to distinguish between the digital image acquired by the camera and the live inspection observed under the microscope.

fluorescent emission. Such variations in intensity cause the digital camera to register yellow, as a consequence of the over-exposure of the orange fluorescence colour after the automatic light adjustment of the image acquisition software. Thus, the silk is shown in orange and the size in yellow.


a)

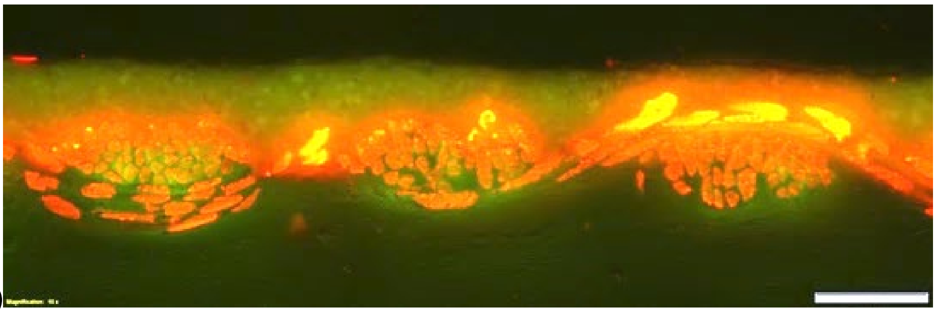

b)

Figure 5.20. Comparisons of SYPRO® Ruby staining of one-sided painted silk mock-ups with and without size, seen through Olympus BX41 optical microscope, 100 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm); a) RS1 (10% w/v rabbit skin glue) after staining, b) Pb1 (no size) after staining.

To complement the interpretation of SYPRO® Ruby results, sample RA2 from the double-sided banner reconstructions was additionally inspected under a Zeiss Axioscop microscope with filtering settings for fluorescein and rhodamine fluorescence (Figure 5.9 a, b). Although the settings limited the range of colours seen to either green or red (Figure 5.21 a-d), the stained proteinaceous size was increasingly recognisable as a neat line surrounding the yarns, with the advantage of not being tainted with the reflected orange colour coming from the SYPRO® Ruby-stained silk or having a colour variation between the live inspection and the image registered by the camera. This occurred due to the increased wavelength restriction of the Zeiss Axioscop filter settings compared to the Olympus BX41 filter settings (Figure 5.8 a, b), which significantly reduced the excitation/emission of the original auto-fluorescence of the proteinaceous materials and enhanced the excitation/emission of the fluorescent stain occurring at 470 nm and 618 nm respectively.

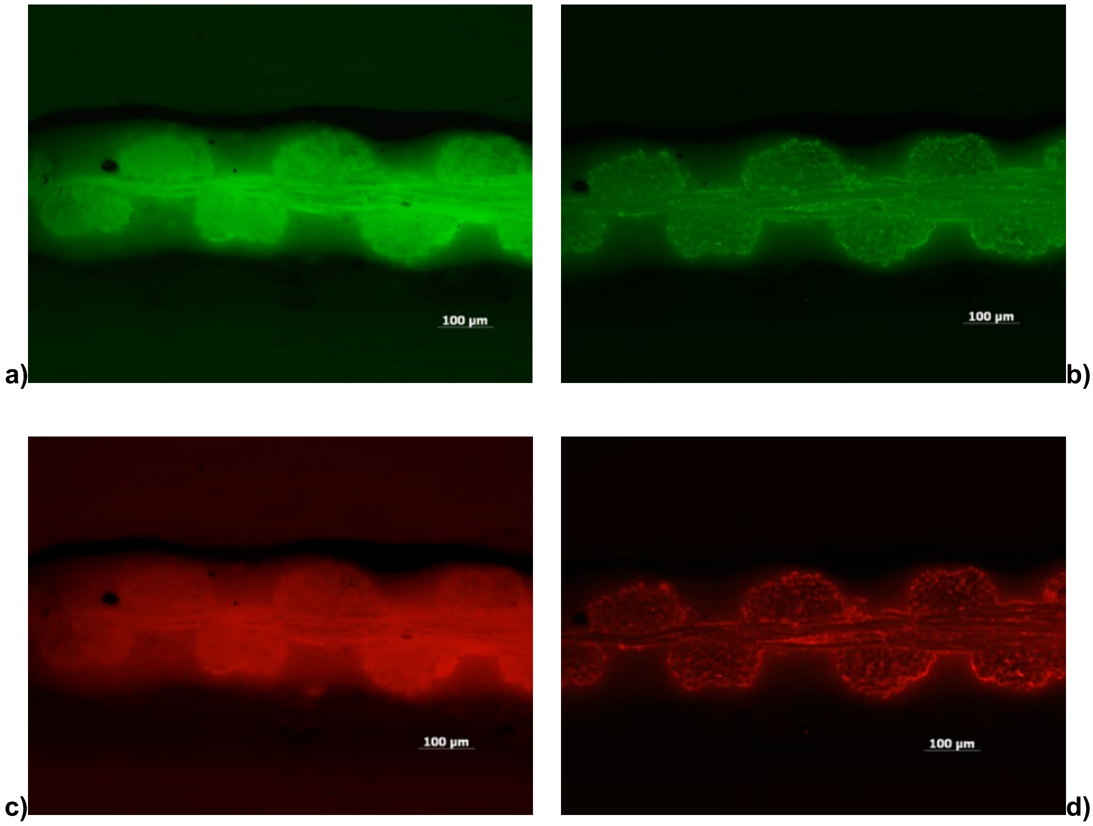
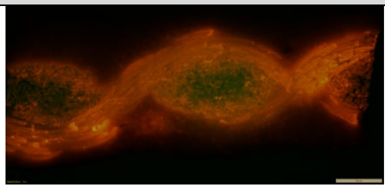
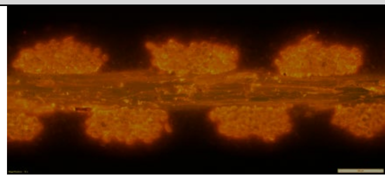
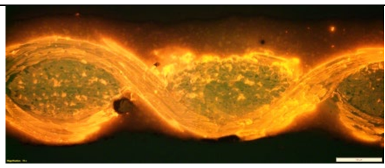
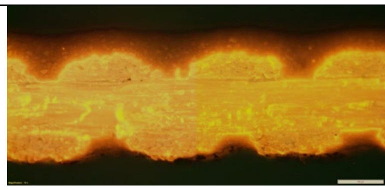
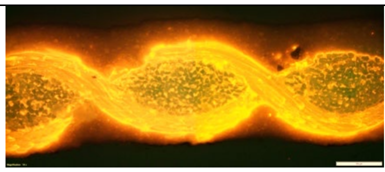


Figure 5.21. SYPRO® Ruby staining of sample RA2 (10% w/v rabbit skin glue) under Zeiss Axioscop optical microscope at 100x magnification, with a) fluorescein settings (BP 450-490nm, FT 510nm, BP 515-565nm) before, b) fluorescein settings after, c) rhodamine settings (BP 446/12nm, FT 560nm, BP 575-640nm) before, d) rhodamine settings after.

The staining tests of the double-sided painted silk mock-ups, aimed to testing the viability of SYPRO® Ruby for distinguishing different size concentrations, were satisfactory (Table 5.10). As seen in Table 5.10, the fluorescence increased with each size concentration, even allowing the distinction of unsized silk textile. However, more research is required to make this a reliable method particularly onto aged samples, as it is not possible to compare this set with naturally aged banner samples due to the added variables affecting the materials' fluorescence.

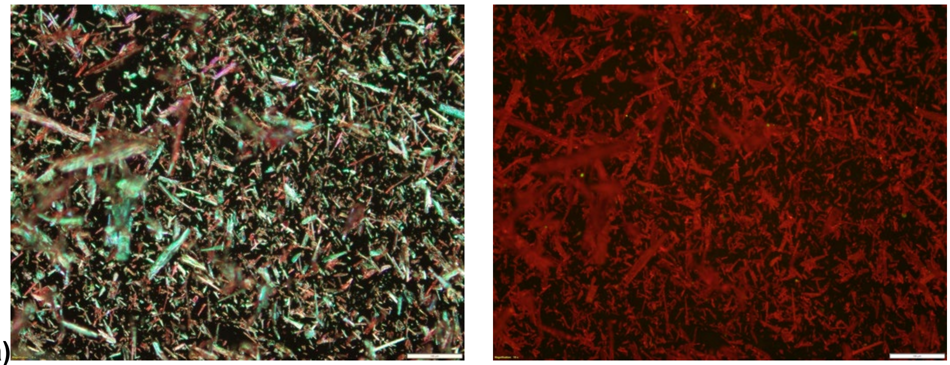
Table 5.10 SYPRO® Ruby staining of double-sided painted silk mock-ups at different size concentrations, seen through Olympus BX41 optical microscope, 100 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm)

Concentration	Weft direction	Warp direction
No size	 RS00_1	 RS00_2
2.5% w/v	 RS02_1	 RS02_2
5% w/v	 RS05_1	 RS05_2
10% w/v	 RS10_1	 RS10_2

*Sample codes are indicated under each image.

5.6.2 Nile Red lipid probe

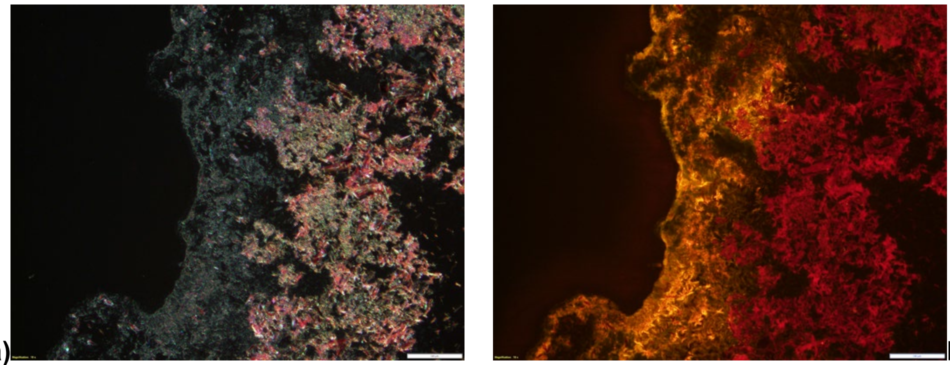
Nile Red isolated dry stain was seen under normal light, as clusters of acicular shaped particles with a streaked texture, an iridescent colour changing from green to pink colour and a metallic lustre (Figure 5.22 a). Under filtering conditions U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm) (Figure 5.22 b), the dry stain fluoresced in an orange-red hue with a medium to low intensity depending on the exposure settings of the image software.



a) b)

Figure 5.22. Nile Red appearance under Olympus BX41 optical microscope, 100 x magnification; a) Normal light, dark field, crossed polarisers; b) fluorescence filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm).

The isolated dried staining solution was then inspected under normal light, detecting a significant decrease in particle size than the dry stain, as well as a grey sediment towards the edge of the drying halo (Figure 5.23 a). Under the filtering conditions U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm), two different fluorescence colours were detected dependant of particle size (Figure 5.23 b): an orange-red colour, similar to that seen on the dry powder, was seen in the larger particles with a higher intensity, and a bright yellow-orange colour was seen in the powder-like particles towards the edges. This suggests that the solvent mixture of water/isopropanol was able to partially dissolve Nile Red, leaving behind a sediment with a different fluorescence colour and a potentially different structure as it dried. However, the phenomenon is complex and would require further research to be explained, which surpasses the objectives and specialty of this study.

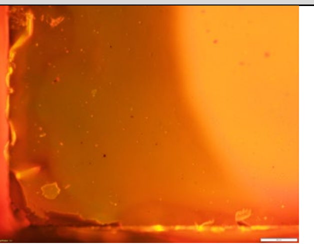
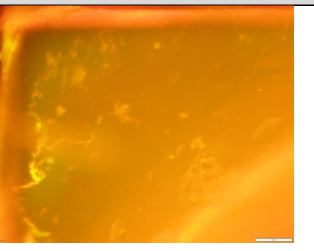
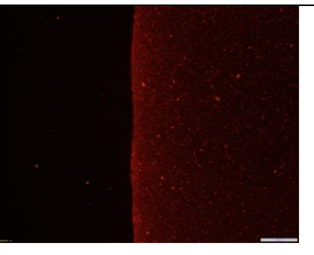
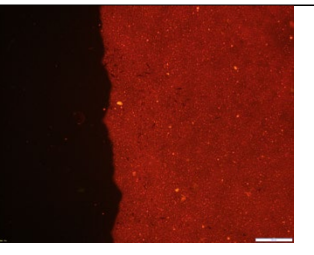


a) b)

Figure 5.23. Appearance of Nile Red solution in water/isopropanol after dried under Olympus BX41 optical microscope, 100 x magnification; a) Normal light, dark field, crossed polarisers; b) fluorescence filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm).

Nile Red positively stained the isolated films of raw linseed oil both fixed and non-fixed (Table 5.11, raw linseed oil). The positive colour was seen as a very bright orange-yellow fluorescence, so bright that it precluded the comparison with the un-stained section of the sample. Such sections maintained the same bright green colour as seen in the negatively stained samples with SYPRO® Ruby (Table 5.9, raw linseed oil). However, an unexpected result was seen on the film samples of rabbit skin glue, where a potential false positive was detected (Table 5.11, rabbit skin glue). While sample FR01 showed the deposition of small red fluorescent particles on the surface, corresponding with the auto-fluorescence colour of Nile Red in dry form (Figures 5.22b and 5.23b), sample FR02 additionally showed bright-red fluorescence throughout the film that indicated a positive stain (Table 5.11, rabbit skin glue, formaldehyde fixed).

To understand such positive stain of the formaldehyde-fixed rabbit skin glue film with Nile Red, a relation was found in the fields of histochemistry and biochemistry to suggest a possible cause. According to Sackett and Wolff, Nile Red binds to some proteins, particularly those with hydrophobic character (Sackett and Wolff, 1987, p. 231). Some hydrophobic binding sites are said to be formed on proteins as a consequence of partial denaturation, exposing the hydrophobic residues normally found in the interior of the proteins (Sackett & Wolff, 1987, p. 232). In this regard, Nile Red has been successfully used for the fluorescent staining of protein aggregates (Demeule, Gurny and Arvinte T., 2007, p. 37-45). In pharmaceutical manufacturing, protein aggregates can be formed during protein unfolding or in processes such as ligand-protein binding, when the hydrophilic exterior of the proteins is susceptible to interact with each other and clump in aggregates, exposing their otherwise hydrophobic interior (Demeule, Gurny and Arvinte T., 2007, p. 38). This is considered a type of irreversible protein degradation and it is said to be related, among other aspects, to the retention of the secondary structures between protein monomers (Roberts, 2006, p. 18). Correspondingly, it has been reported that formaldehyde fixation “locks in” the secondary structure of proteins as a consequence of cross-linking (Mason and O’Leary, 1991, 225). Hence, the positive stain seen on the rabbit skin glue sample FR02, previously fixed with formaldehyde vapour, is potentially indicating the locking of collagen’s secondary structure, a possible aggregate formation and an overall increased hydrophobicity of the proteinaceous material made evident with Nile Red.[45] However, this is only one interpretation that requires further research to confirm it, which is beyond the scope of this research.

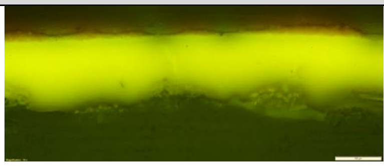
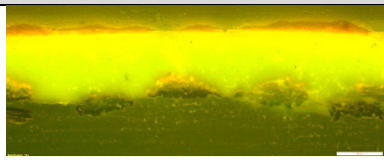
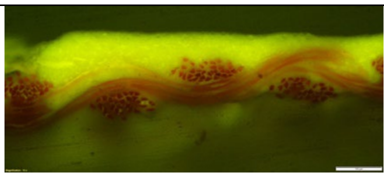
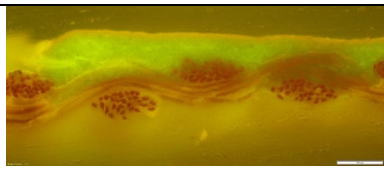
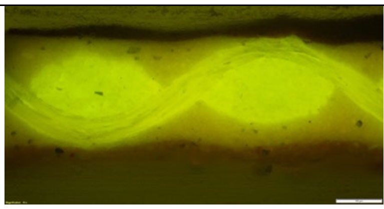
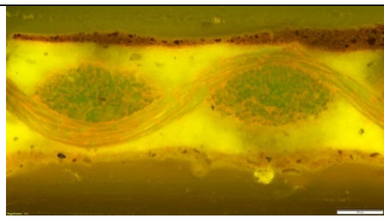
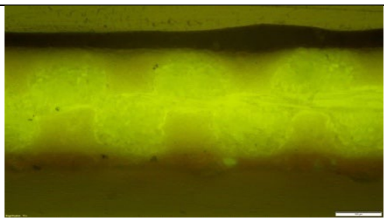
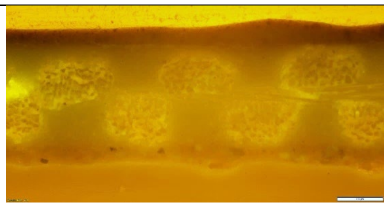
Table 5.11 Nile Red staining of isolated binder films, seen through Olympus BX41 optical microscope, 50 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm).		
Material	Non fixed	Formaldehyde fixed
Raw linseed oil	 FO01	 FO02
Rabbit skin glue (10% w/v)	 FR01	 FR02
*Sample codes are indicated under each image. **Linseed oil samples are not segmented due to excessive fluorescence after staining. Rabbit skin glue samples show interface between stained and non-stained areas of the same film.		

Nile Red positively stained both oil-containing layers (ground and paint) of the one-sided paint mock-ups and double-sided banner reconstruction cross-sections. Samples inspected through the U-MWB2 filter settings showed a positive stain of a yellow-golden hue, similar to that reported by Fowler and Greenspan for the detection of neutral lipids (Fowler and Greenspan, 1985, p. 835). The level of staining of Nile Red under the U-MWB2 filter settings, showed a significant variation from sample to sample and within different parts of the cross-sections. They either showed a different fluorescence colour in the outer part of the paint layer (Table 5.12 sample Pb2 after staining), or a more intense yellow glow (Table 5.12 samples RN1, RN4, RA1 and RB2 after staining). Schäfer correlated the variation of fluorescence colours (solvatochromatism) of Nile Red in a

[45] High temperatures can also cause the denaturalisation of rabbit skin glue, hence the maximum temperature used for the preparation of the material for this research was 60° C.

positively stained paint cross-section with the varying polarity of the oil-paint layers (Schäfer, 1997, pp. 61-62, 86). Similarly, Greenspan, Fowler and Mayer reported a yellow-golden colour in hydrophobic lipid droplets and a red colour in amphipathic phospholipids (Greenspan, Fowler and Mayer, 1985, p. 835). This evidences the previously highlighted potential of Nile Red for estimating oil-media polarity in paint cross-sections (Wolbers et al., 2012, p. 330).

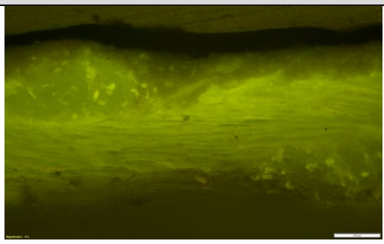
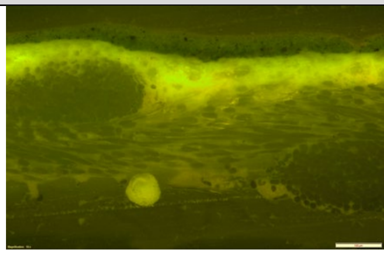
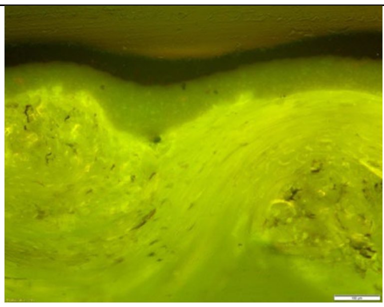
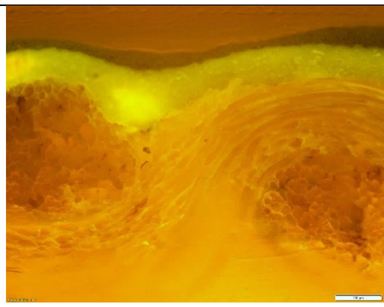
Table 5.12 Comparison of Nile Red staining of painted samples, seen through Olympus BX41 optical microscope, 100 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm)

Sample code	Before staining	After staining
RN1		
Pb2		
RA1		
RB2		

However, an unexpected problem of interpretation was noticed in sample RN1 containing zinc white (Table 5.12, sample RN1 after staining). The pigment's autofluorescence when mixed with linseed oil fell within the same region as Nile Red's emission maxima (around 580 nm) (Pronti, Felici, Ménager, Vieillescazes, and Piacentini, 2017, p. 4). This was interpreted as a false negative, given that it did show an intense yellow fluorescence in its also oil-containing chrome yellow paint layer under the U-MWB2 filter. However, a second evaluation detected a similarity with the greenish fluorescence colour registered in the lead white containing sample Pb2 (Table 5.12, sample Pb2 after staining). This could potentially indicate a decrease in polarity in the oil binder of both samples, given that a green fluorescence colour is reported for Nile Red when dissolved in heptane (Schäfer, 1997, p. 86).

Another unexpected finding was the positive stain of the acrylic paint samples with Nile Red. This was seen as a yellow-golden glow in the acrylic paint samples RN3 and RN4 (Table 5.13) and in the embedding resin of all Nile Red samples (Table 5.12).

Table 5.13 Comparison of Nile Red staining of painted samples, seen through Olympus BX41 optical microscope, 100 x magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm)

Sample code	Before staining	After staining
RN3		
RN4		

To understand these staining tests, an additional literature review showed that Nile Red has been recently proved useful for the detection of polymers and microplastics in the field of environmental science (Jee et al., 2009; Prata et al., 2019; Shim, Song, Hong, and Jang, 2016; Tamminga et al., 2016). Shim et al. defined plastics as hydrocarbon molecules derived from petroleum, natural gas or biomass and considered them just as hydrophobic as lipids (Shim et al., 2016, p. 469). Nile Red has been correspondingly defined as a hydrophobic probe (Fowler and Greenspan, 1985, p. 833) and it has been proved to be an effective stain for polymers like polyethylene terephthalate (PET), polyethylene (PE), polypropylene (PP) and polystyrene (PS) (Prata et al., 2019, p. 1279). It has also been proved useful for the staining of polyacrylic acid (PAA) and polymethyl methacrylate (PMMA), reporting a high fluorescence lifetime for these two acrylic-based polymers directly related to their higher Young modulus (Jee et al., 2009, p. 115). This theoretically explains the positive stain of both acrylic paint and embedding resin and it is an interesting finding which could lead to complications in the use of Nile Red for embedded cross-sections of objects that may have both oil and acrylic paints present. To stress such finding, further staining tests were conducted on another type of embedding resin for comparison: Araldite® 2020 epoxy resin. The commercial resin was selected for its preference in recent studies in the field of analysis of museum objects (Wu, Lombardo et al., 2020a; 2020b). Additionally, epoxy resins have the advantage of not emitting autofluorescence and have good transparency in the IR spectral range, making it useful for μFTIR mapping (Vagnini et al., 2008, pp. 59-60).

Epoxy resins theoretically show a more hydrophilic configuration in their basic molecule than acrylic resins, due to the presence of multiple hydroxyl groups (OH) (Figure 5.24). Contrarily, acrylic resins show a more hydrophobic configuration due to multiple carboxyl groups (CH_2) (Figure 5.25), similar to the basic molecular structure of linseed oil (Figure 5.5).

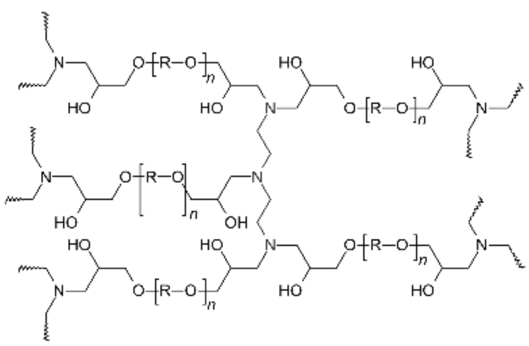


Figure 5.24. Structure of an epoxy resin. (Image © Roland.chem distributed under a CC-BY 2.0 license).

Thus, two new blocks were prepared separately, one of Technovit 2000 LC resin and one of Araldite® 2020 epoxy resin, subsequently stained and observed under the same filtering conditions reported in section 5.4.2. Both resin blocks were always handled wearing nitrile gloves and were stained without further polishing to prevent any possible contamination (Table 5.14).

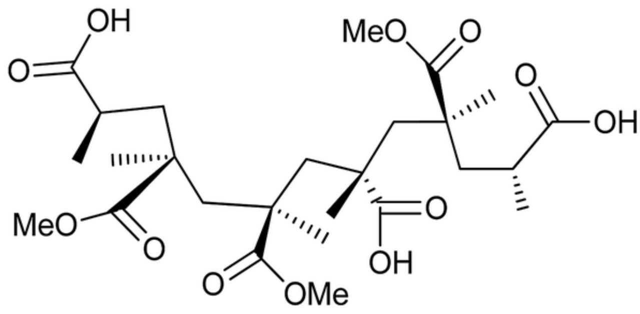


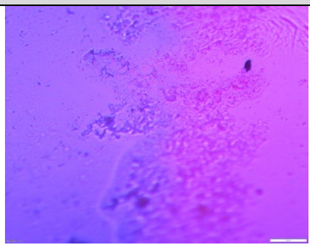
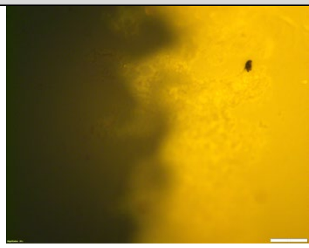
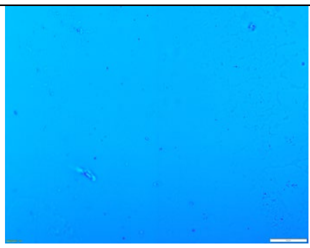
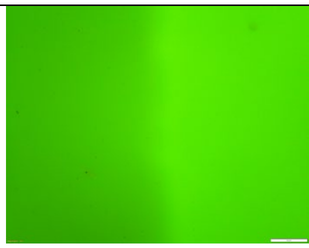
Figure 5.25. Structure of a polymethylmethacrylate polymer. 'Me' indicates the carboxyl groups. (Image © Gyurova et al., 2017, p. 13373).

Table 5.14 Samples of embedding resins for Nile Red staining tests.		
Material	Technovit 2000 LC	Araldite 2020
Sample code*	ER01	ER02
*ER stands for embedding resin, numbers distinguish the two types.		

Nile Red positively stained block ER01 of acrylic resin Technovit 2000 LC, seen as a bright pink fluorescence colour under filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm) and as a bright yellow-golden fluorescence colour under filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm) (Table 5.15, acrylic). The non-stained section or auto-fluorescence colours of the sample remained blue under filter U-M11011v2 and dark green under filter U-MWB2. Contrastingly, block ER02 of Araldite® 2020 epoxy resin did not change its initial auto-fluorescence colours under either of the same filtering conditions (Table 5.15, epoxy). Although a slight increase in fluorescence intensity was detected after staining with filter U-MWB2, the colour remained in the same green hue.

To consolidate the interpretation of the Nile Red staining results, oil paint samples RN1, RN2, RA1, RB2 and acrylic paint samples RN3, RN4, were selected to be additionally inspected and registered with the settings for fluorescein and rhodamine fluorescence recommended by Fowler and Greenspan (Figure 5.7), with the comparable settings of the Zeiss Axioscop microscope (Figure 5.9). Samples RB2 and RN4 were additionally submitted to a longer staining time of 30 minutes recommended by Prata et al. to check the repeatability of the fluorescence increase (Prata et al., 2019). This led to an amplified yellow-golden staining of their embedding resin (Table 5.15, samples RN4 and Table 5.14 sample RB2 after staining), and to an intensification in the fluorescence of the acrylic paint in sample RN4, confirming Schäfer's findings regarding the changes of specificity in lipid stains with longer times (Schäfer, 1997, p. 58). However, both samples showed evidence of dissolution of their paint and ground layers, which made it unsuitable for testing on the historical samples.

Table 5.15 Comparative staining results of Nile Red in the two types of embedding resins, seen under Olympus BX41 optical microscope with two filtering conditions, 50 X magnification.

Type of resin	Filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)	Filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm)
Acrylic	 ER01	 ER01
Epoxy	 ER02	 ER02

*Sample codes under each image. ** All segmented images show stain side on the right and un-stained auto-fluorescence on the left side.

Under the Zeiss Axioscope microscope, Nile Red's positive stain was seen as an intense green glow under filter settings for fluorescein, which during the live inspection was perceived as if the layers were "glowing from within" on both oil (Figure 5.26 b) and acrylic paint cross-sections (Figure 5.27 b). As the uptake of Nile Red happens preferably into the hydrophobic molecules of both oil and acrylic, the fluorescence emitted illuminated the particles of pigments and fillers bound therein. This response was found to be slightly dependent on the colour of the pigment, as the darker raw umber and ultramarine blue paints were not seen as illuminated as those containing ochre and chrome yellow. Nevertheless, the positive stain in all dark-pigmented layers still allowed the distinction of particles not discernible before Nile Red staining.

Nile Red’s positive stain under filter settings for rhodamine was seen as a red glow, perceived similarly in both oil and acrylic paint samples throughout the matrix of paint and ground layers but with less intensity (Figures 5.26 d, 5.27 d).

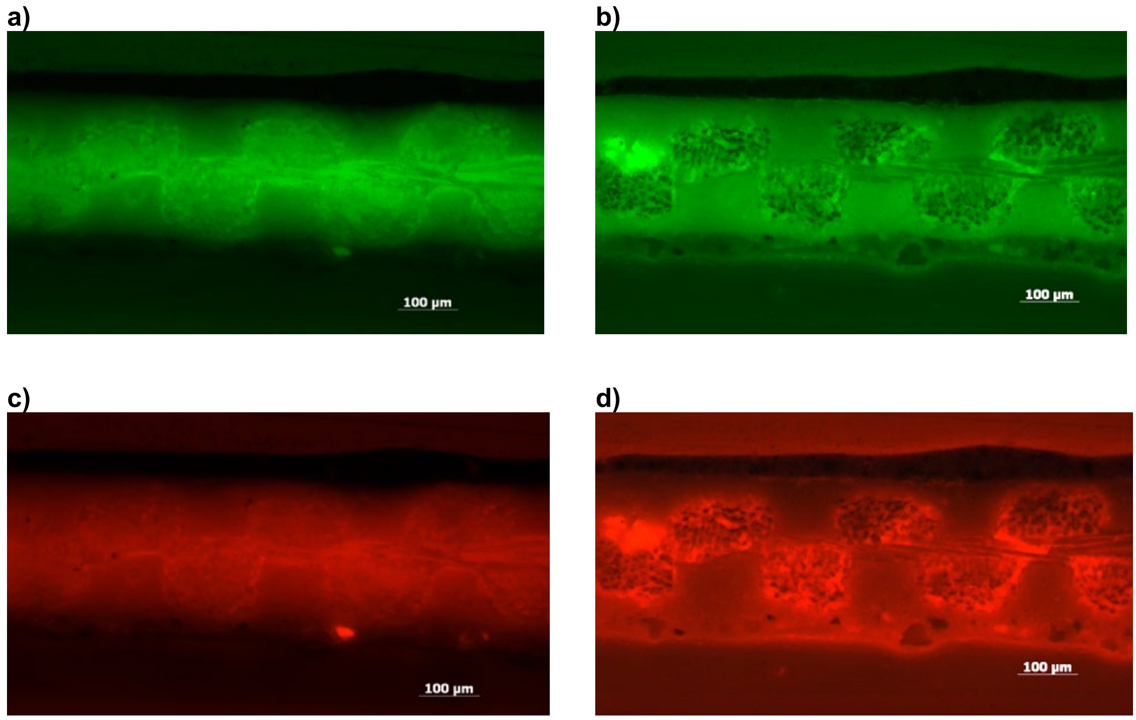


Figure 5.26. Nile Red staining of oil paint sample RB2 under Zeiss Axioscop optical microscope at 100x magnification, with a) fluorescein settings (BP 450-490nm, FT 510nm, BP 515-565nm) before, b) fluorescein settings after, c) rhodamine settings (BP 446/12nm, FT 560nm, BP 575-640nm) before, d) rhodamine settings after.

Under both filtering conditions, the intense autofluorescence coming from the rabbit skin glue size (Figures 5.26 a, c; 5.27 a, c) was quenched after the staining with Nile Red. In both types of samples, the individual silk yarns of the oil-paint examples and the linen of the acrylic examples, were easily distinguished for lacking any fluorescence (Figures 5.26 b, d: 5.27 b, d). Given that Nile Red has no fluorescence whilst dissolved in water (Greenspan, Fowler and Mayer, 1985, p. 967), the results suggest that the same happens to the stain when bound onto hydrophilic materials such as natural fibres and rabbit skin glue size. Thus, the non-fluorescence of the hydrophilic materials corroborates the positive staining of its surrounding hydrophobic media.

It also confirms that adding water to the carrier solvent, as suggested by Schäfer (1997, p. 58), enhances the specificity and uptake of the stain into the hydrophobic molecules, in this case oil and acrylic paints.

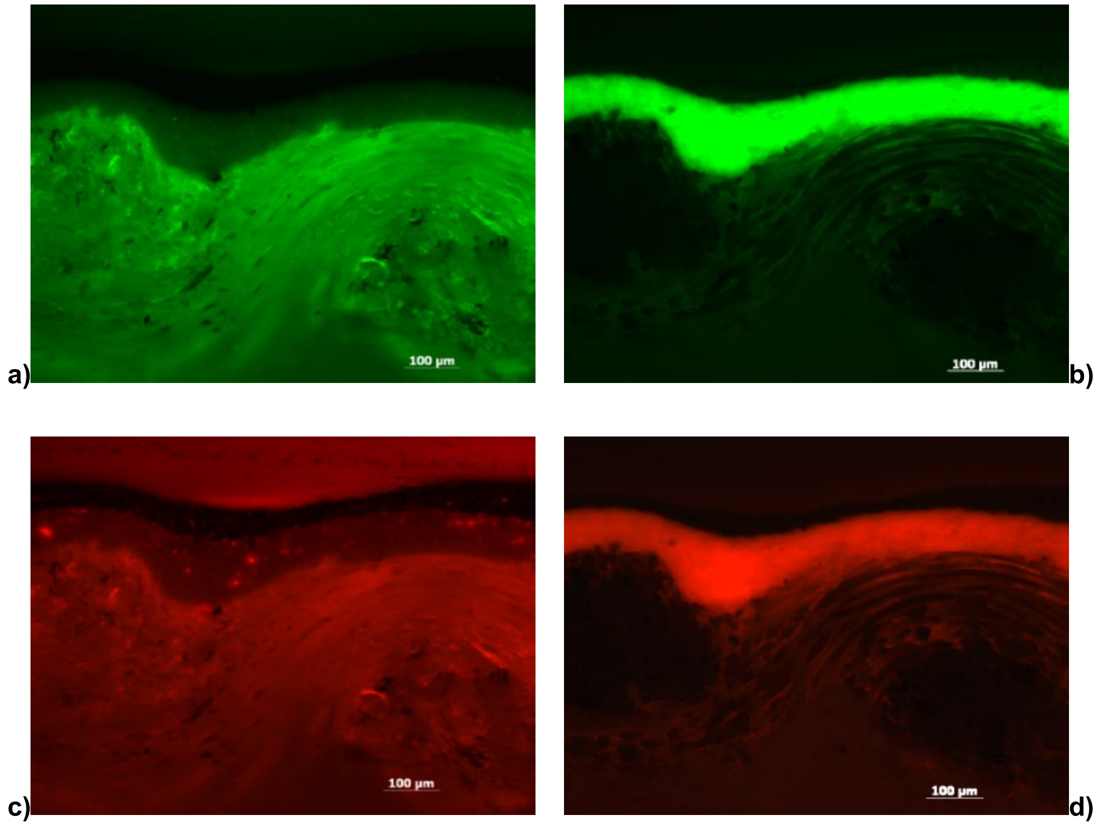
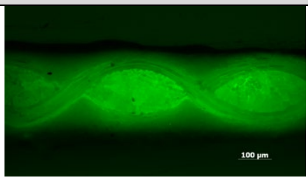
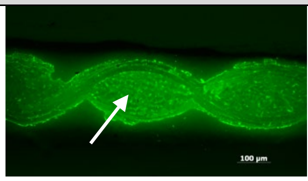
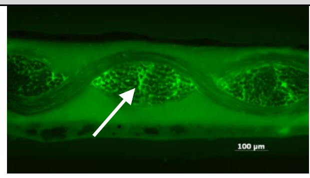
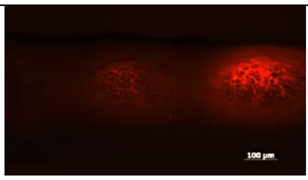
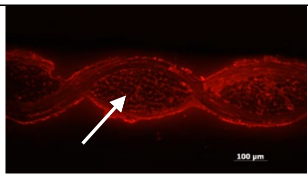
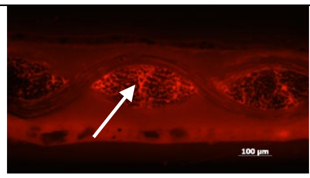
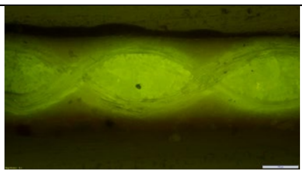
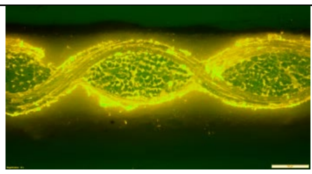
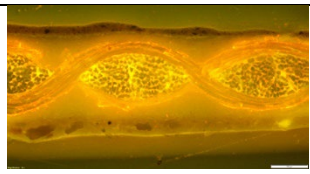


Figure 5.27. Nile Red staining of acrylic paint sample RN4 under Zeiss Axioscop optical microscope at 100 x magnification, with a) fluorescein settings (BP 450-490nm, FT 510nm, BP 515-565nm) before, b) fluorescein settings after, c) rhodamine settings (BP 446/12nm, FT 560nm, BP 575-640nm) before, d) rhodamine settings after.

5.6.3 Crossed staining with SYPRO® Ruby and Nile Red

An experimental cross-staining protocol was applied to the banner reconstruction samples RA2 and RB1, to see the viability of the method to simultaneously localise both proteinaceous and lipidic binders within a single cross-section. However, the swelling caused by the fixation process of SYPRO® Ruby and its subsequent polishing, made it only possible to apply Nile Red afterwards.

Table 5.16 Example of cross-staining on sample RB1 with SYPRO® Ruby and Nile Red, seen under Zeiss Axioscop microscope at 100x magnification with settings for fluorescein and rhodamine; and Olympus BX41 microscope with filter U-MWB2. White arrows indicate the supposed staining of seeped oil with Nile Red and their equivalent unstained areas with SYPRO® Ruby.

Filter set	Before staining	After SYPRO® Ruby	After Nile Red
F			
R			
U			

* F (fluorescein), R (rhodamine), U (U-MWB2)

The tests of both samples under the Zeiss Axioscop microscope clearly showed the uptake of SYPRO® Ruby along the film formed by the rabbit skin glue size (Figure 5.21 b,d; Table 5.16 filter sets F and R after SYPRO® Ruby). Likewise, both samples showed Nile Red's positive stain as an overall luminosity coming from the ground and paint layers of the cross-section, highlighting details that were not visible before staining nor after SYPRO® Ruby. Additionally, sample RB1 showed a possible seeping of the stand linseed oil into the wefts of the weave, which appeared positively stained with Nile Red in bright green/red depending on the settings, yet negatively stained with SYPRO® Ruby (Table 5.16, filter sets F and R). An important finding from these tests was that SYPRO® Ruby's fluorescence was indiscernible from Nile Red's under the Zeiss Axioscop microscope but remained discernible under the Olympus BX41. Even though the emission maxima of both stains are close (618 nm for SYPRO® Ruby and 608 nm for Nile Red), it was still possible to distinguish the characteristic orange fluorescence of SYPRO® Ruby from the yellow fluorescence of Nile Red under the U-MWB2 filter settings (Table 5.16, filter set U after Nile Red). Interestingly, the individual detection of the silk yarns happened after the application of both stains, yet indistinguishable before staining.

5.6.3.1 Crossed staining of cross-sections from the banner of *The Glasgow Typographical Society*

After the clear results of the experimental samples, the same crossed staining methodology was applied to two historical cross-sections from the banner of *The Glasgow Typographical Society*: samples TS08 (silvered section) and TS40 (central painting). However, an unexpected autofluorescence of the same colour as SYPRO® Ruby was observed in the silk fibres of both samples before staining under filtering conditions U-MWB2, changing from the dark-blue colour detected under normal light to a bright orange tone (Figures 5.28 and 5.29).

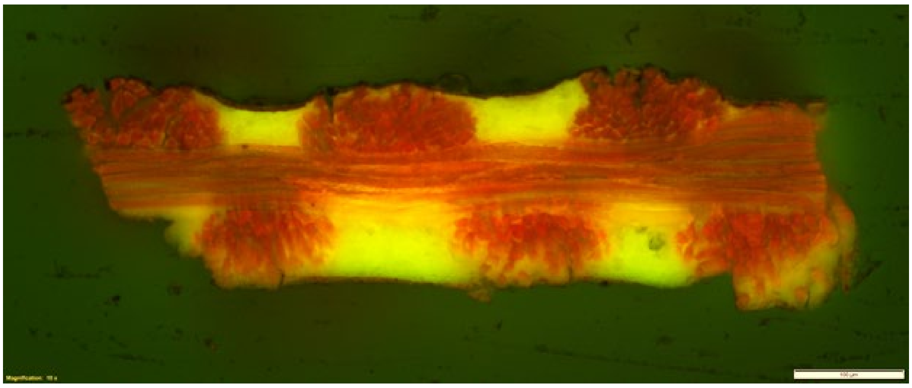


Figure 5.28. Sample TS40 seen under Olympus BX41 optical microscope, 100 X magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm), before staining.

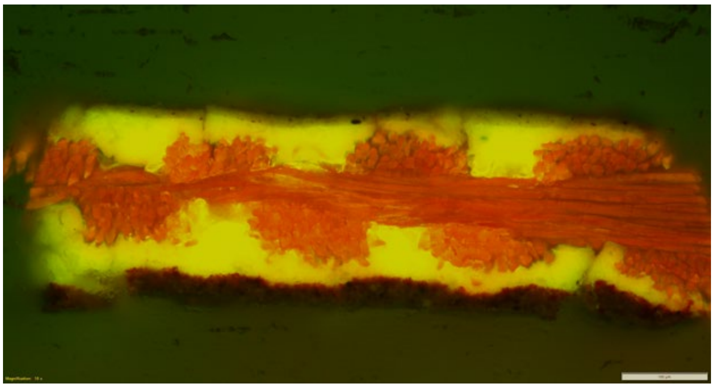


Figure 5.29. Sample TS40 seen under Olympus BX41 optical microscope, 100 X magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm), before staining.

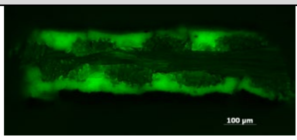
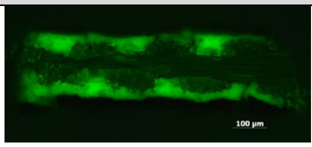
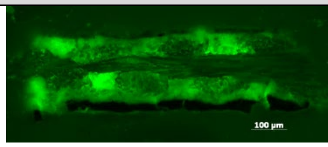
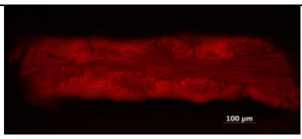
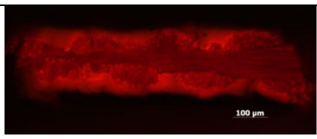
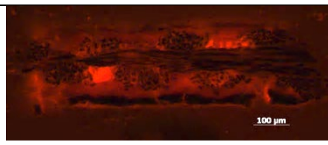
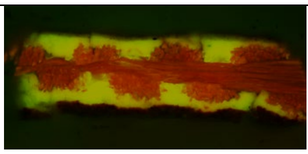
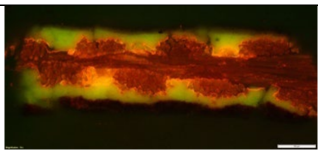
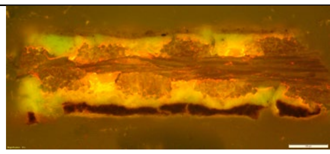
Clarke has reported that natural dyes are typically not fluorescent, in contrast with most synthetic dyes (Clarke, 1999, p. 1421-1436). This suggests the use of a synthetic dye for the dyeing of the Typographers' fabric, having a clearly definable fluorescence similar to the materials reported by the authors in Table 5.1 of this chapter.

Despite not being able to distinguish the positive orange staining of the silk with SYPRO® Ruby from the orange autofluorescence of the dye, there was a positive and unmistakeable staining of what was thus identified as a proteinaceous size layer. This was observed as a continuous thin orange line surrounding the yarns in the weft and warp directions of both samples, similarly to the double-sided reconstruction samples. A proteinaceous coating was also stained over the metal leaf of sample TS08. This result is consistent with the findings of Smith, Thompson and Hermens (2016) in a similar banner, and those of Emmerling et al. in a group of coloured glazes on metal leaf from the Baroque and Rococo period (Emmerling, et al., 2013).

The fluorescence staining of the two historical samples seen under the Olympus BX41 microscope after SYPRO® Ruby were equivalent to the experimental samples, but with a weaker fluorescence intensity. This has been previously ascribed by Sandu et al. to the oxidisation of proteins as part of their ageing (Sandu, Roque, et al., 2012, p. 321), which diminishes the uptake and subsequent fluorescence of the stain. The result contrasts with the autofluorescence of naturally aged materials, which has been reported to increase or even start happening after ageing has taken place (de la Rie, 1982, p. 65-69).

Following the same methodology as section 5.6.3, sample TS40 was additionally selected for the experimental crossed staining protocol with Nile Red. The results under the Zeiss Axioscop microscope similarly showed how Nile Red's positive stain is seen as an overall green or red glow, depending on the filtering conditions, throughout the layers of the cross-section.

Table 5.17 Example of cross-staining on sample TS40 with SYPRO® Ruby and Nile Red, seen under Zeiss Axioscop microscope at 100x magnification with settings for fluorescein and rhodamine; and Olympus BX41 microscope with filter U-MWB2.

Filter set	Before staining	After SYPRO® Ruby	After Nile Red
F			
R			
U			

* F (fluorescein), R (rhodamine), U (U-MWB2)

Nile Red increasingly highlighted the paint layers on either side (sides A and B of the banner), which were not visible before staining nor after SYPRO® Ruby (Table 5.17, filter sets for fluorescein and rhodamine after Nile Red). It also suggests the heterogeneity in the polarity of the oxidised oil and a possible accumulation of oil that sank at the bottom of the ground layers, appearing as blotches of bright green/red colour depending on the settings. Consistent with reconstruction sample RB1, SYPRO® Ruby's fluorescence was surpassed by Nile Red's under the Zeiss Axioscop microscope but remained discernible under the Olympus BX41 (Table 5.17, filter set U-MWB2) due to the much wider range of wavelengths passed through its barrier filter (see section 5.4.2, Figures 5.8 and 5.9). Nile Red stain quenched the autofluorescence colour of the dyed silk yarns, seen as a complete absence of fluorescence under the Zeiss Axioscop microscope and as a blue-grey tone under the Olympus BX41 microscope. Like the experimental samples, the fluorescence quenching of proteinaceous materials caused by Nile Red's uptake confirmed their hydrophilic nature and distinguished them from the surrounding hydrophobic oil binder of the paint and ground layers.

The fluorescent staining results were particularly useful for mapping and identifying the original size layer and proteinaceous coating in samples TS08 and TS40 from the banner of *The Glasgow Typographical Society*. Additionally, the visual similarities with *Reconstruction 1* sample RA2 suggested a similar size application on both sides of the fabric and potentially a similar concentration as that used in the reconstruction (1:10 w/v) (Figure 5.30). These findings contributed to understanding one of the stages of the manufacturing technique used by George Kenning's company by identifying a protein layer different from the silk fibre. This builds on previous work by Smith, Thompson and Hermens (Smith et al., 2014). However, identification of the specific type of protein used as a size was not achieved due to lack of sensitivity of the analytical techniques chosen.

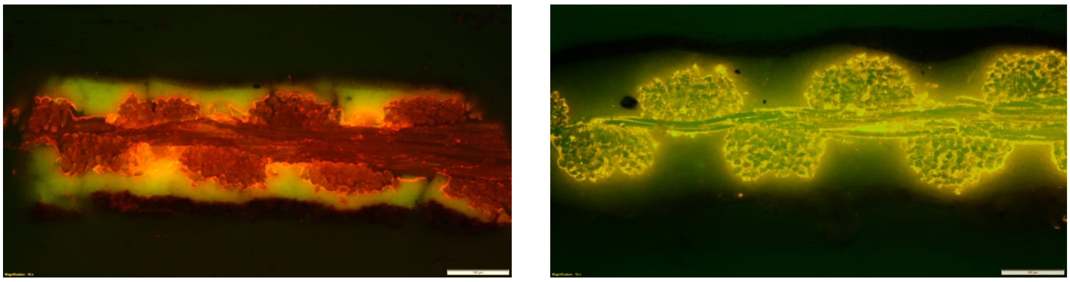
a)  b)

Figure 5.30. SYPRO® Ruby protein blot stain comparison of banner sample TS40 and *Reconstruction 1* sample RA2. The tonal differences are a consequence of the image acquisition software, not seen during live inspection.

The interpretation of Nile Red fluorescent staining is more complex than that of SYPRO® Ruby staining. The fact that the stain has an evident red autofluorescence in addition to its red-magenta colour under normal light increases the risk of false positive interpretations. The lack of specificity of the stain also supposes the potential staining of different types of hydrophobic molecules, namely lipids, plastics (i.e., PET, PE, PP, and PS), and hydrophobic proteins, all of which can be present in paintings and painted banners as part of the original technique or as added repairs/restorations. This makes it unsuitable as an identification technique on its own. Instead, it can only be recommended in conjunction with SYPRO® Ruby protein blot stain and FTIR analysis for verifying the location of previously identified oil-containing layers.

6 Results of the Scientific Examination of five Kenning banners of Glasgow Museums Collection

6.1 Introduction

This chapter presents the main analytical results and interpretation of the scientific examination of the five Kenning banners in the Glasgow Museums Collection. Following the methodologies described in Chapters 4 and 5, the wide range of organic and inorganic materials present in the multi-layered build-up of each of the five Kenning banners were identified, presented separately by the analytical technique used. The number of samples analysed per technique are shown in Figure 6.1 and a summary of the main findings is included at the end of each section.

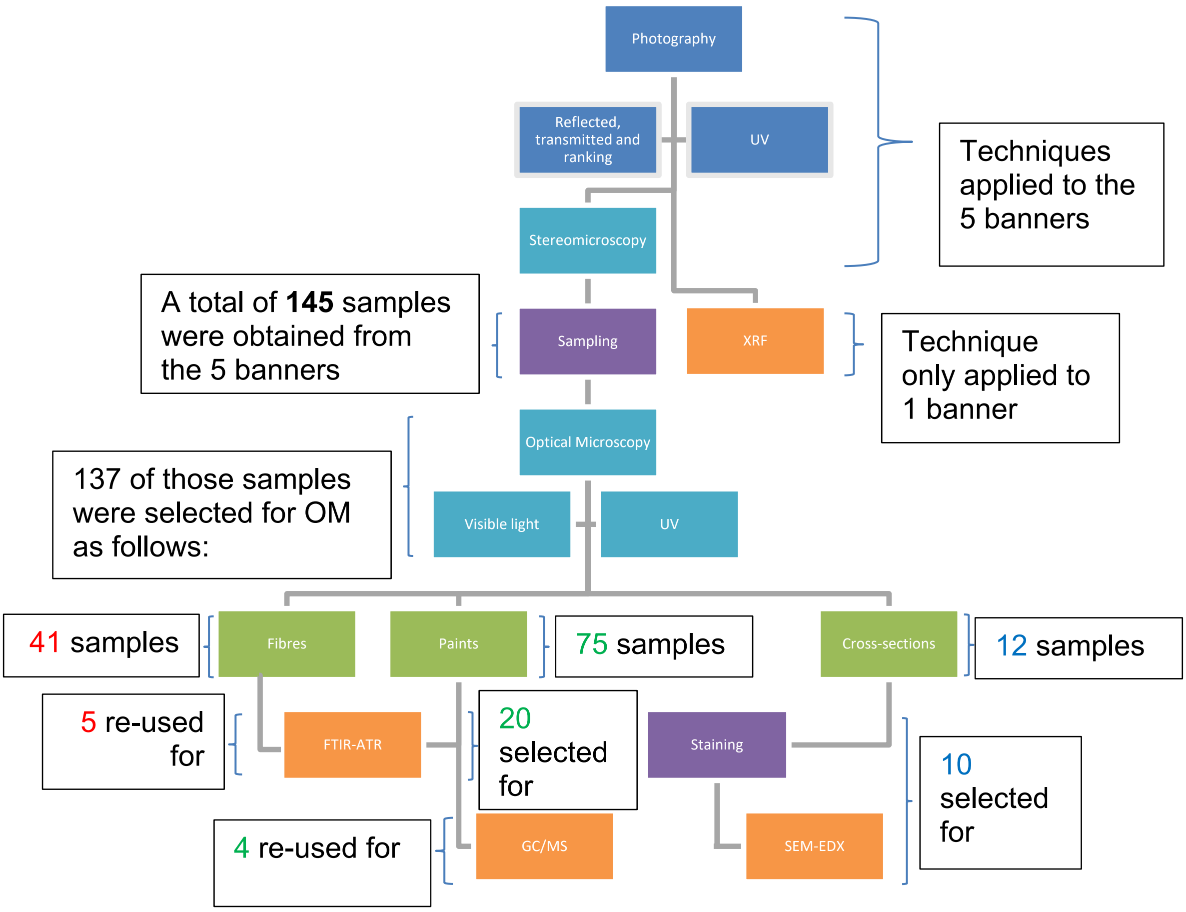


Figure 6.1 Diagram of the analytical methodology followed with indication of number and type of samples per technique.

6.2 Banners documentation

A documentation sheet was purposely designed for incorporating all the results gathered after the careful inspection of each of the five banners of Glasgow Museums Collection. The sheets include a detailed account of the measurements that were carried out on each banner, the most representative photographs acquired through reflected, raking, transmitted and UV illumination, as well as detailed images from the surface microscopy that was carried out *in situ* at GMRC. They also include the micrographs of their cross-sections, all their textile samples and selected paint and metal leaf samples. Each documentation sheet was divided accordingly in the following sections:

- General information
- Textile
- Silvering
- Gilding
- Painting
- Pole
- Box (only applicable to *The Scottish Tin Plate Braziers and Sheet Metal Workers'* banner)

Besides the general information section, the remaining sections were subdivided in the three categories considered for the banners' documentation: construction/structure, repairs, and condition.

The documentation sheets are included in Appendix I of the thesis.

6.3 Optical Microscopy

A total of 145 samples from the five banners of the research were acquired for its potential to identifying the constitutive materials of the five banners and aid in the understanding of their layering sequence. These included the five types of samples defined in Chapter 4: textile fibres, textile fibres large, paint samples, paint samples large and cross-sections, listed next to each banner code name in table 6.1.

Table 6.1. List of total samples per banner

Banner	Maker	Code name	Number of samples
The Glasgow Typographical Society	George Kenning	*Typographers*/TS	28
The Glasgow Upholsterers Society	George Kenning	*Upholsterers*/GU	29
The Grain Millers of Glasgow	George Kenning	*Millers*/MG	25
The National Union of Vehicle Builders, Glasgow Branch	George Kenning & Son	*Vehicle Builders*/VB	33
The Scottish Tin Plate Braziers and Sheet Metal Workers' Society	George Kenning & Son	*Metal Workers*/SM	30

After their careful inspection and prioritisation considering the time and budget restrictions of the research, a final number of 80 samples were analysed besides their photographic documentation, as listed in table 6.2.

Table 6.2 List of selected samples for analysis

Type of sample	Number	Analytical technique
Textile fibres	41	Polarised light microscopy/ fibre identification
	5	FTIR-ATR
Paint samples	20	FTIR-ATR
Paint samples large	4	GC-MS
Cross sections	10	Optical microscopy/ fluorescent staining
		SEM-EDX

Of the remaining 65 samples, 57 were inspected and documented at 50× and 100× under Olympus BX41 polarising microscope under dark field-crossed polarisers and under UV fluorescence filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm) for detection of auto-fluorescent materials. These included 1 paint sample (large) from *The Grain Millers of Glasgow* banner, 54 unembedded paint samples acquired for pigment palette/metal leave identifications, and 2 cross-section samples from red scroll of *The Scottish Tin Plate Braziers and Sheet Metal Workers'* and *The National Union of Vehicle Builders, Glasgow*

Branch's banners (see Chapter 4, section 4.6 for further details on the type of samples). Only the 8 textile fibres large were left without documentation and kept inside their vial to avoid cross-contamination. These samples were not analysed for exceeding the budget and timescale of the research. Although not used, they will all remain with the documented samples under custody of GMRC for their potential technical analysis in the future.

The resulting images of the 137 documented samples were stored according to the approved data management plan, to be handed to Glasgow Museums along with the physical samples, for the attachment to the banners documentation in the museum database (MIMSY) and their safe storage at GMRC after thesis completion.

6.3.1 Textile

A total of 41 textile fibre samples, obtained from the different textile components of the five banners of the research, were identified by means of polarised light microscopy. A variety of natural and man-made fibres were thus identified, being summarised in table 6.3. The close inspection of the samples showed homogeneity of identifying features in the five banners' fibres, thus a selection of the most representative samples is included in this chapter as example. The complete micrographic registry of the 41 textile samples at 200× is included in the documentation sheet of each banner (see Appendix III).

Table 6.3. Results of the microscopic identification of fibres per textile component of the five Kenning banners of Glasgow Museums Collection.

Banner code name	Main fabric*		Main sewing thread	Seam tape	Hanging loop		Fringe		Guide tape
	Warp	Weft			Warp	Weft	Coating	Core	
Typographers	S	S	S	___	S	C	S	C	___
Upholsterers	S	S	S	___	S	C	S	C	___
Millers	S	S	S	C	M	C	S	C	C
Vehicle Builders	S	S	S	___	S	C	W	W	C
Metal Workers	S	S	S	___	S	S	___	___	W

(S) silk, (C) cotton, (W) wool, (M) man-made.

*Confirmed with FTIR-ATR (see section 6.4).

For the identification of silk, the features observed were a smooth-surfaced and semi-transparent filament, with a sort of triangular cross-section and narrow diameter, showing interference colours under crossed-polarisers (Houck, 2009, pp. 59-61) (Figure 6.2). These features were consistent for the warp and weft directions of the main fabrics of the five banners, their main sewing threads, the warps of the hanging loops of all but *The Grain Millers of Glasgow* banner, as well as the fringe coating of the three George Kenning banners (Table 6.3). One sample from the main fabric of each banner was additionally analysed with FTIR-ATR to confirm the identification of silk, as shown in section 6.4.

a) b)

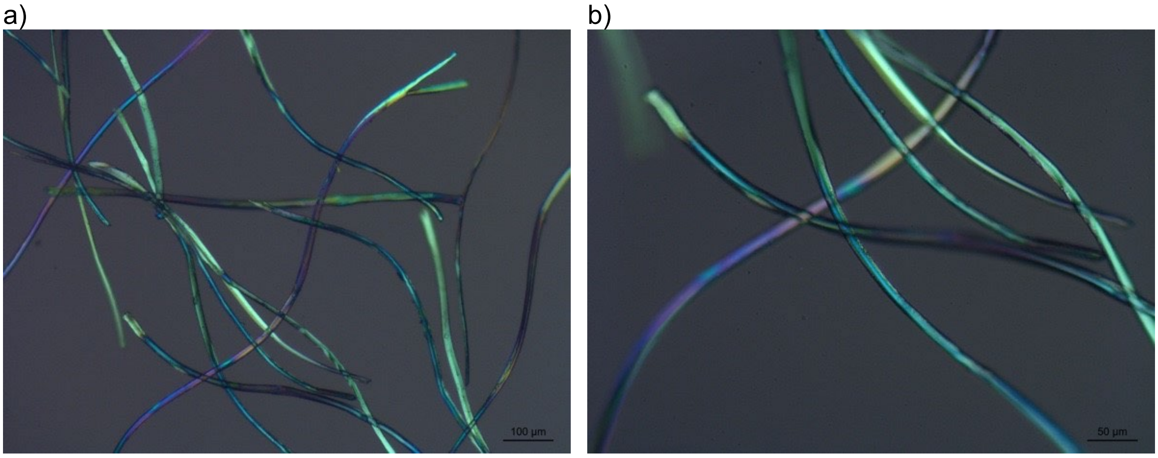


Figure 6.2. Example of silk fibre of sample SM02 (main fabric weft), seen under Zeiss Axiolab microscope with crossed polarisers at: a) 100×, b) 200×.

For the identification of cotton, the features observed were the characteristic convolutions at regular intervals in the fibres and a wide lumen (Houck, 2009) (Figure 6.3). These were seen consistently in the hanging loop wefts and fringe core of the three George Kenning banners and the hanging loop wefts of the banner of *The National Union of vehicle Builders, Glasgow Branch* (Table 6.3). An additional textile component also identified as cotton was detected in the banner of *The Grain Millers of Glasgow*; an undyed tape folded and sewed inside one of its seamed edges (see Appendix I for details).

a) b)

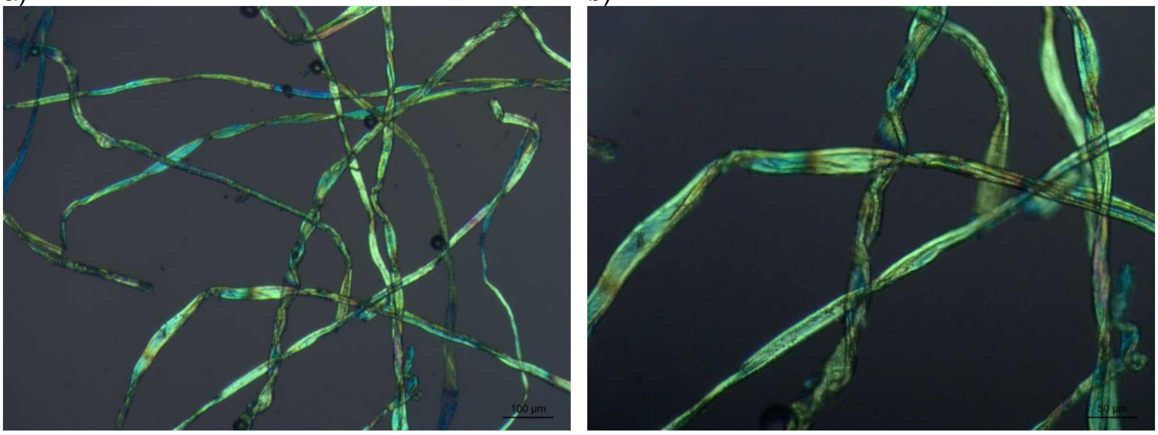


Figure 6.3. Example of cotton fibre of sample GU07 (fringe core), seen under Zeiss Axiolab microscope with crossed polarisers at: a) 100×, b) 200×.

For the identification of wool, an outer surface of overlapping scales was observed (Figure 6.4), with none or very thin medulla for the fine varieties and a dark medulla for the coarse types (CCI, 2010, p. 3). These features were seen in the fringe of *The National Union of vehicle Builders, Glasgow Branch* banner and the guide tape of *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* banner, both manufactured by the company of George Kenning & Son (Table 6.3).

a) b)

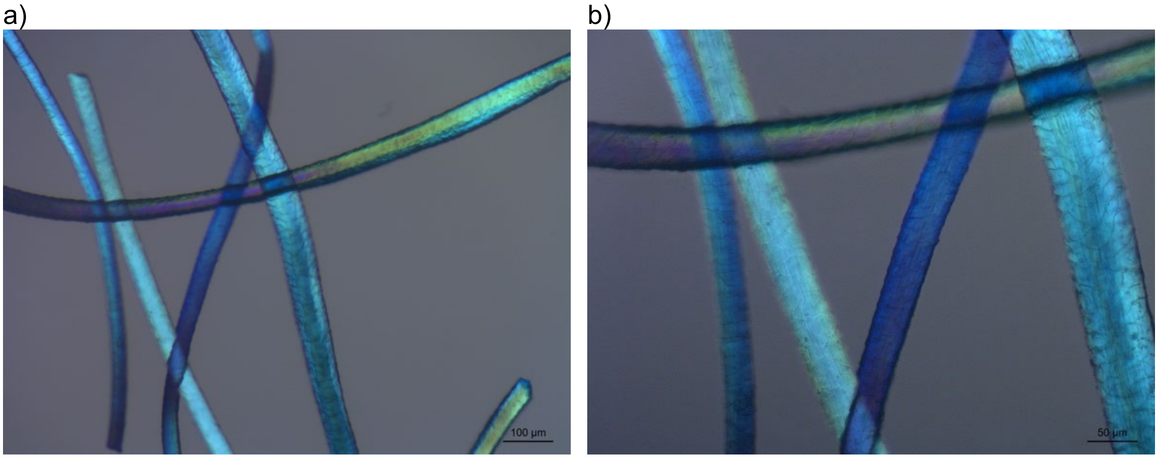


Figure 6.4. Example of wool fibre of sample VB07 (fringe) seen under Zeiss Axiolab microscope with crossed polarisers at: a) 100×, b) 200×.

Finally, man-made fibres were detected in the hanging loop warps of *The Grain Millers of Glasgow* banner (Table 6.3). The features observed coincided with those described for cellulose acetate fibres: a uniform width in their longitudinal view with few distinct longitudinal striations and an irregular cross-sectional view with a serrated outline (Houck, 2009) (Figure 6.5). This last feature was only partially seen during the live inspection of the sample in some of the fibre ends, as no specific cross-sectional preparation was prepared. Given that only the main textile fibres were selected for FTIR-ATR identification due to time and budgetary constrictions, further analysis by such technique is needed to confirm the preliminary identification of cellulose acetate in the said sample.

a) b)

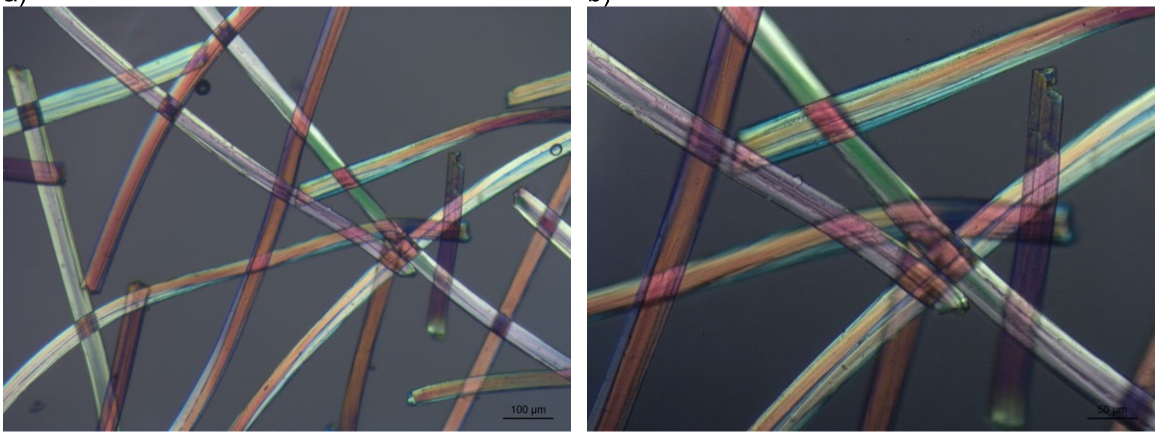


Figure 6.5. Example of man-made fibre (possible cellulose acetate) of sample MG04 (hanging loop warp), seen under Zeiss Axiolab microscope with crossed polarisers at: a) 100×, b) 200×.

6.3.2 Paint layer

A total of 54 paint samples, including examples of the different metal leaf decorations detected in the five banners, were documented by means of polarised and UV fluorescence microscopy. These helped with the interpretation of the banners layering sequence initially observed *in situ* through their photographic documentation. Acquired primarily for the identification of the pigment palette and metal leaves of each banner, this could not be achieved due to time, unavailability of equipment and budgetary constrictions. For the case of these paint samples, further studies would still be needed by means of a more appropriate pigment identification technique like Raman spectroscopy (Caggiani, Cosentino and Mangone, 2016; Macdonald et al., 2004). For the case of the metal leaf samples, additional studies with SEM-EDX would be required for their identification, as Raman spectroscopy is unable to identify metals (Macdonald et al., 2004, p. 227). The 54 samples, split between the five banners in table 6.4, will remain under custody of Glasgow Museums with the potential of being analysed in the future for increasing the material knowledge of nineteenth and twentieth century British double-sided painted banners on silk.

Table 6.4. List of non-used paint samples from the five Kenning banners of Glasgow Museums Collection		
Banner	Maker	Number of non-used samples
The Glasgow Typographical Society	George Kenning	7
The Glasgow Upholsterers Society	George Kenning	8
The Grain Millers of Glasgow	George Kenning	9
The National Union of Vehicle Builders	George Kenning & Son	15
The Scottish Tin Plate Braziers and Sheet Metal Workers' Society	George Kenning & Son	15

Representative examples under crossed-polarisers and UV epi-illumination of the two types of paint samples acquired, central paintings and metallic scrolls, are shown in figures 6.6 and 6.7. Relevant observations and micrographs were included in the documentation sheets and technical analysis results of each of the five Kenning banners of Glasgow Museums Collection in Appendices I and III.

6.3.3 Cross-section samples

A total of 10 cross-sections were embedded for microscopic documentation, fluorescent staining and SEM-EDX analysis. Selected from the two representative types of decoration of each banner, they yielded significant details about the characteristics of each layer and the exact layering sequence of the metallic scrolls and the central paintings. Two additional cross-section samples were acquired from the red/golden scrolls of the two George Kenning & Son banners, which had to be left for further research due to time and budgetary restraints of the research.

In addition to their order of application, described in the documentation sheets of each banner (see Appendix I), the cross-sections allowed the discerning of any joining or separation between the layers related to their technique or current condition, as suggested by Wolbers, Buck and Olley (2012, p. 326-328). It was possible to see the way in which the paint interacted with the textile, noticing any impregnation into the fibres and the presence of interfaces preventing such impregnation like the potential size layer. The microphotographs also prepared the samples for SEM-EDX analysis, helping to preliminarily locate all the layers, areas and particles of interest that would be identified through the coupled spectrometer. Examples of the annotated images of a scroll and a central painting sample are presented in Figure 6.6 a, b. The remaining annotated images are included in the SEM results of each of the five banners from Glasgow Museums Collection in Appendix III.

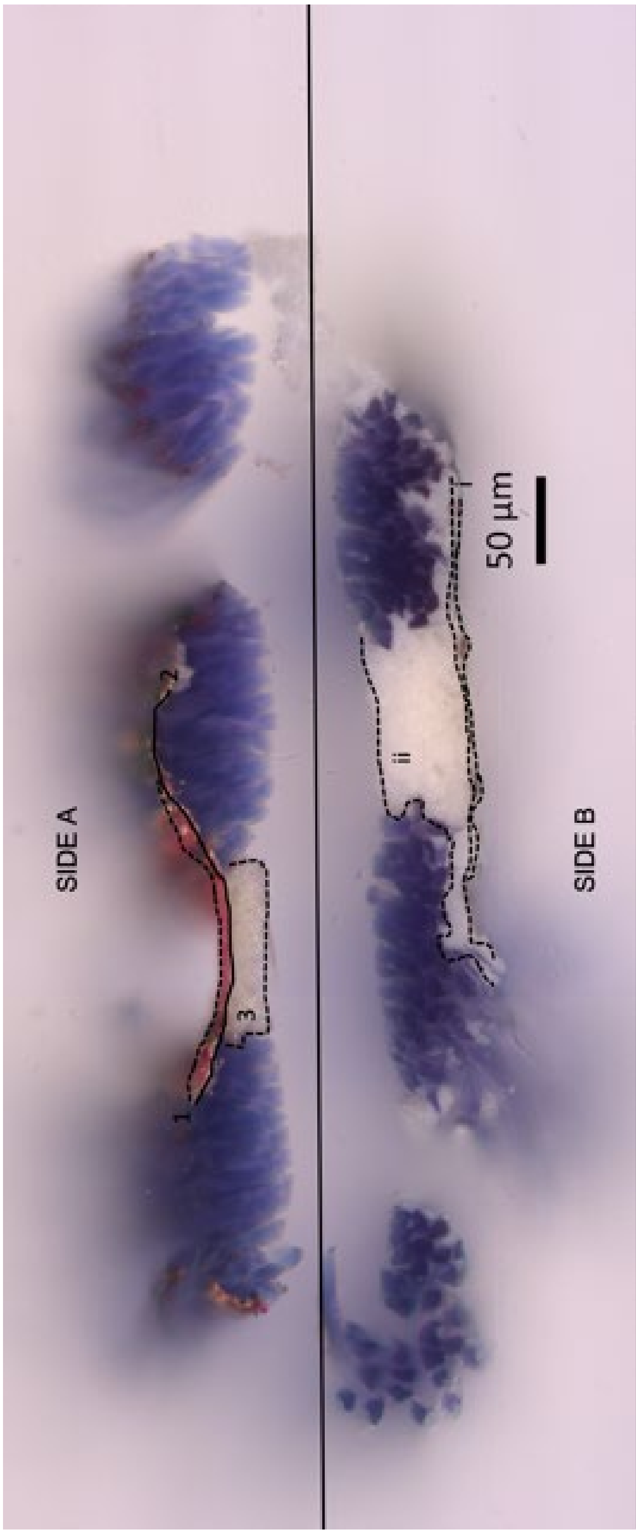


Figure 6.6. Annotated micrograph of cross-section TS08 from the metallic scroll of The Glasgow Typographical Society banner, seen under Olympus BX41 microscope with dark field-cross polarisers at 100×. Sample shows layers on side A: 1) red glaze, 2) metal leaf, 3) ground; and side B: i) possible residue of size, ii) ground.

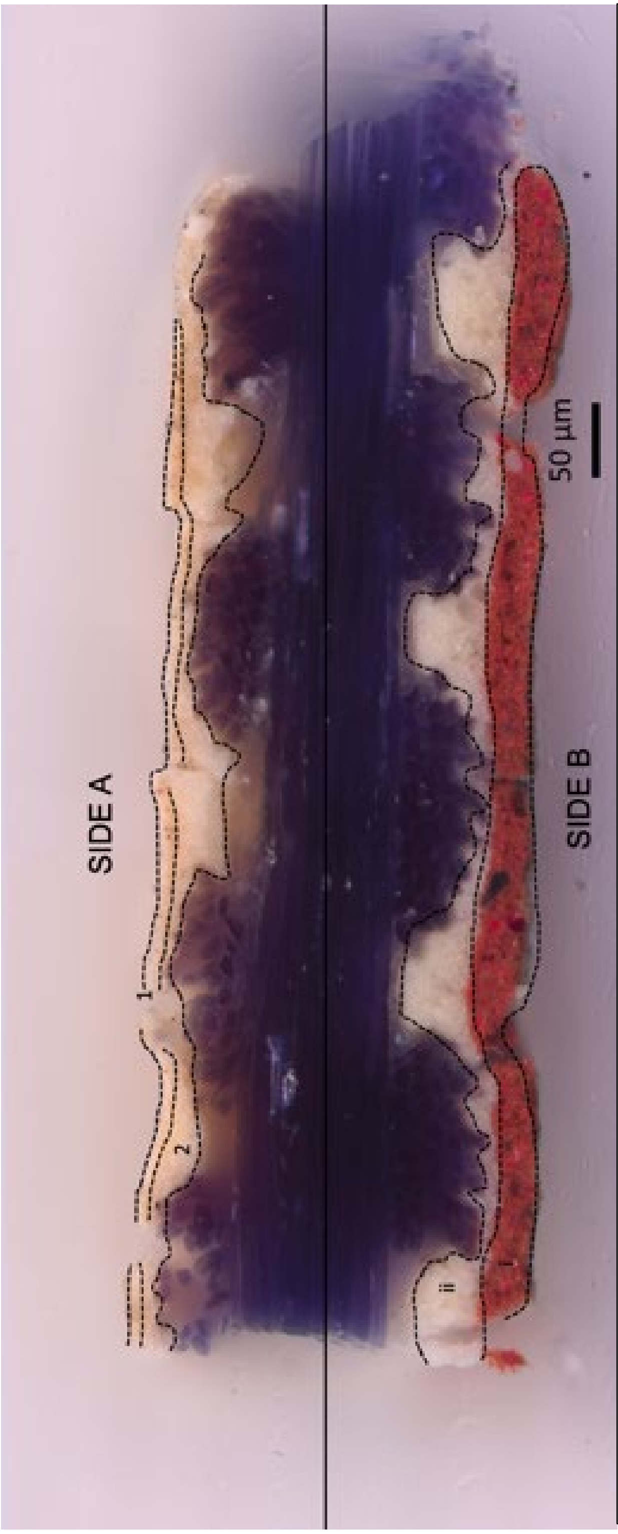
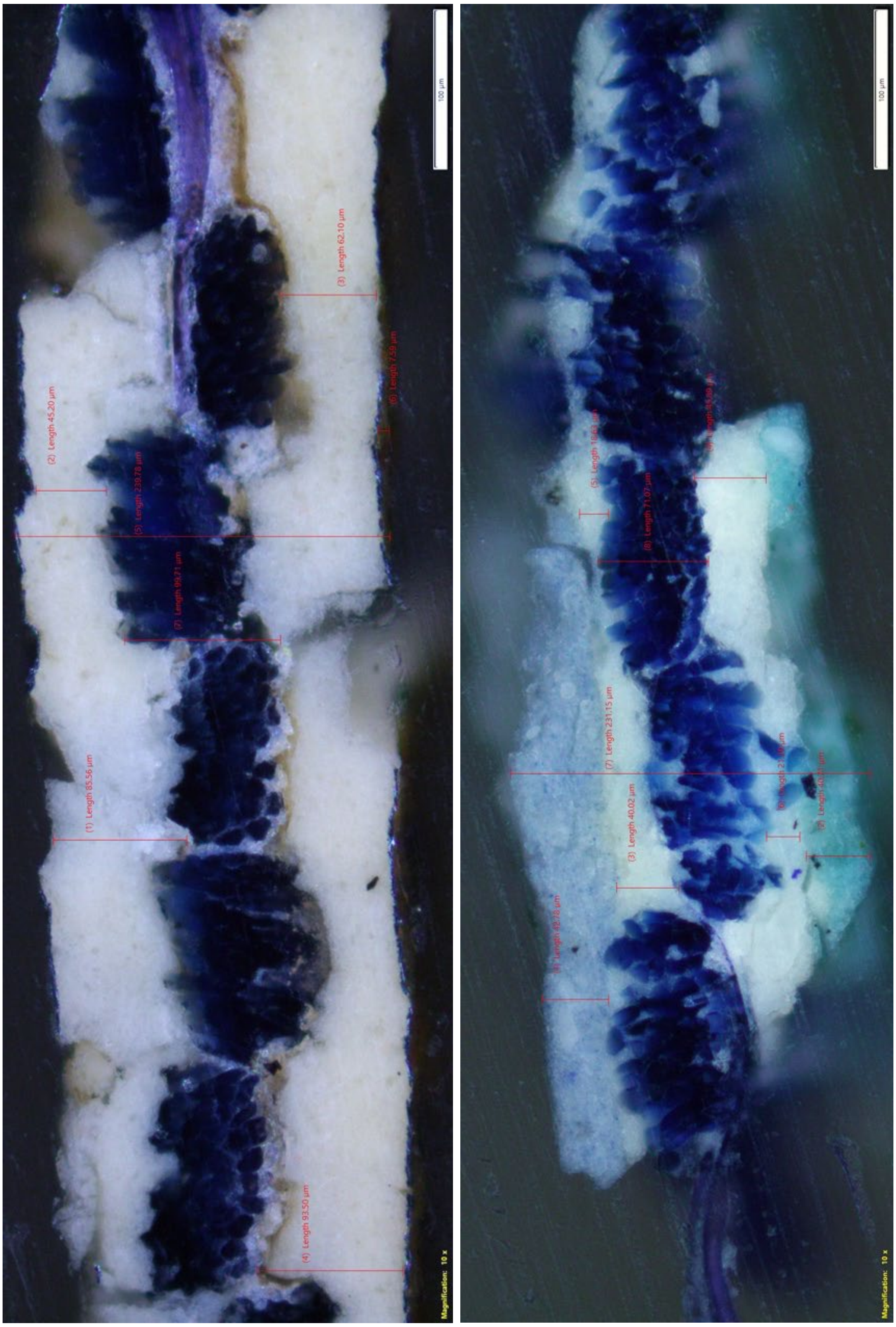


Figure 6.7. Annotated micrograph of cross-section TS40 from the central painting of The Glasgow Typographical Society banner, seen under Olympus BX41 microscope with dark field-cross polarisers at 100×. Sample shows one paint layer on each side (layers 1, i) and two ground layers on each side (layers 2-3, ii-iii).

The microscopic documentation of the ten cross-section samples from the five Kenning banners of Glasgow Museums Collection also allowed the exact measurement of each individual layer and their different thicknesses (i.e., sides A and B metal leaf thickness, sides A and B paint layer minimum and maximum, sides A and B ground layer minimum and maximum, textile minimum and maximum and full cross-section thickness), exemplified in Figure 6.8 a, b and included in the documentation sheet of each banner (see Appendix I). These provided significant knowledge about the differences and similarities between the thicknesses of the metallic scrolls and central paintings of the five Kenning banners of Glasgow Museums Collection, which are summarised in Table 6.7.



a) b)

Figure 6.8. Measured micrographs of cross-sections from The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner, seen under Olympus BX41 microscope with dark field-cross polarisers at 100×; a) SM21 (metallic scroll); b) SM16 (central painting).

Table 6.7. Comparison of different thicknesses within the cross-sections the five Kenning banners of Glasgow Museums Collection (full cross-section width).

Maker	Banner code name	Metallic scroll	Central painting
George Kenning	*Typographers*	204.51µm	213.81µm
	Upholsterers	284.63µm	393.30µm
	Millers	284.97µm	374.67µm
George Kenning & Son	*Vehicle Builders*	238.74µm	234.19µm*
	Metal Workers	239.78µm	231.15µm

(*) Measurement including the two added layers of the 1942 overpaint on side A was 262.20µm

6.3.4 Validation of the crossed staining methodology in cross-section samples from the banner of *The Glasgow Typographical Society*

Fluorescent staining proved an effective approach in the analysis of the experimental samples (Chapter 5). Given this, both fluorescent stains were subsequently applied as a crossed staining methodology (i.e., two different stains observed on the same sample simultaneously) to the cross-sections taken from the five Kenning banners of Glasgow Museums Collection. The first case was the banner of *The Glasgow Typographical Society*. Two samples were thus selected, TS08 from the metallic scrolls and TS40 from the central painting.

6.3.4.1 Textile

An unexpected autofluorescence of the same colour as SYPRO® Ruby was observed under filtering conditions U-MWB2 in the silk fibres of both samples before staining, changing from the dark-blue colour detected under normal light to a bright orange tone (Figures 6.9 and 6.10). It was expected to obtain a bright orange, fluorescent tone as a positive stain with SYPRO® Ruby, but that was not distinguished from the autofluorescence of the blue dye which also had a bright orange, fluorescence tone as it is shown in the images.

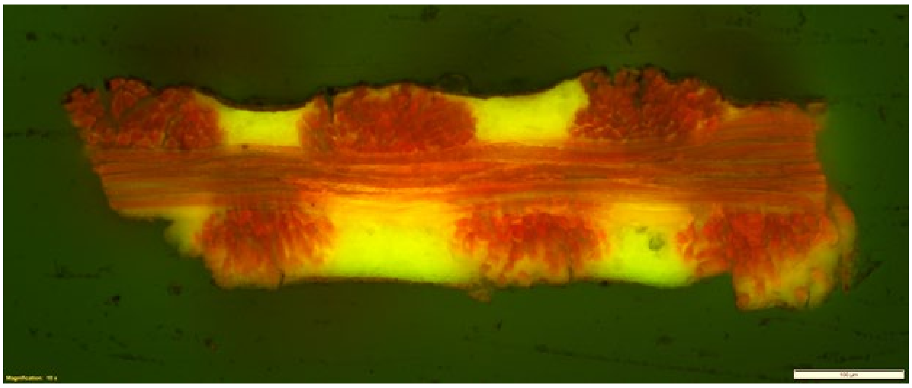


Figure 6.9. Sample TS40 seen under Olympus BX41 optical microscope, 100× magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm), before staining.

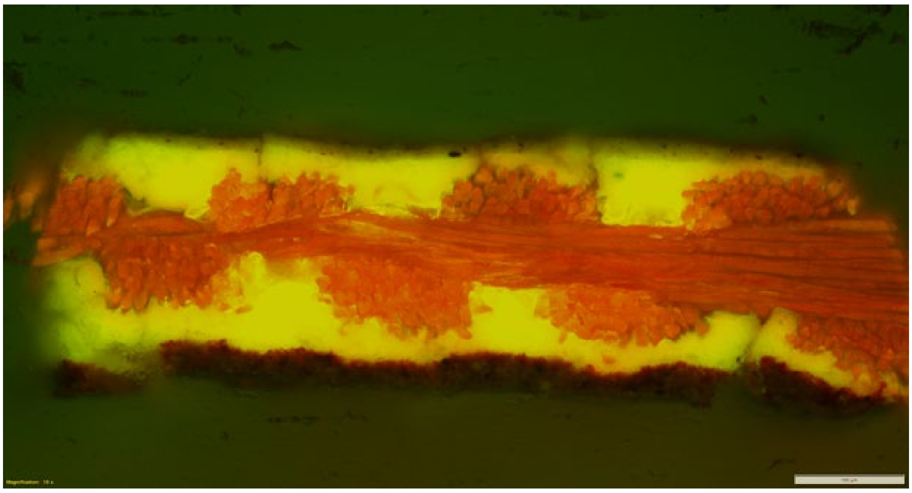


Figure 6.10. Sample TS40 seen under Olympus BX41 optical microscope, 100× magnification, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm), before staining.

Clarke has reported that natural dyes are typically not fluorescent, in contrast with most synthetic dyes (Clarke, 1999, p. 1421-1436). This suggests the use of a synthetic dye for the dyeing of the TS banner, having a clearly definable fluorescence similar to the materials reported by Pronti et al. (2018), Grazie et al., (20110 and van Bommel et al., (2007), listed in Table 5.1. An early synthetic blue dye, identified with the Colour Index (C.I.) name Basic Violet 1, has been reported to fluoresce in the 600nm (orange) region of the visual spectra (Soltzberg et al., 2012, 625). Also known with the general name Methyl Violet, the dye was discovered by Lauth in 1861 and said to soon replace the first fully synthetic dye Mauveine on the market (Cliffe, 1957, p. 312). Methyl Violet has been previously analysed with high-performance liquid chromatography (HPLC) by van Bommel et al. (van Bommel et al., 2007, p. 267), and is one of the five classes of early synthetic dyes identified in historical Chinese silk textiles dating from the late nineteenth century (Liu et al., 2016, 177-185). Given that Kenning advertised his banners as made with “the finest Chinese silk” (*George Kenning and Son. Summer Number [Supplement]*, 1901), it is possible that Methyl Violet dye, with an orange fluorescence under said conditions, might be present in the banner. However, the use of HPLC for dye analysis was outside the budget of this research and remains as a hypothesis.

6.3.4.2 Size layer

Despite not being able to distinguish the positive orange staining of the silk with SYPRO® Ruby from the orange autofluorescence of the dye, there was a positive and unmistakeable staining of what was thus identified as a proteinaceous size layer. This was observed as a continuous thin orange line surrounding the yarns in the weft and warp directions of both samples (Figure 6.11, a and Table 6.8). Similarly, a proteinaceous coating was seen over the metal leaf of sample TS08 (Figure 6.11, b). This result is consistent with the findings of Smith, Thompson and Hermens (2016) in a similar banner, and those of Emmerling et al. in a group of coloured glazes on metal leaf from the Baroque and Rococo period (Emmerling, et al., 2013). Such a coating was recommended by Kelly as a preventive measure against the tarnishing of silver leaf in painted banners (Kelly, 1911, p. 108). This effect was also observed in Reconstruction 2, where it proved to be useful for the application of paint and glazes during the making of that banner reconstruction (see Appendix IV). Not only did it prevent the tarnishing of the silver leaf in the applied areas, but also improved the application of the glazes in comparison to the areas left uncoated (Figure 6.12).

All the fluorescence results seen under the Olympus BX41 microscope after staining with SYPRO® Ruby were equivalent to the experimental samples, but with a weaker fluorescence intensity. This has been previously ascribed by Sandu et al. to the oxidisation of proteins as part of their ageing (Sandu, et al., 2012, p. 321), which diminishes the uptake and subsequent fluorescence of the stain. The result differed from another appreciation about the autofluorescence of naturally aged materials, which has been reported to increase or even start happening after ageing has taken place (de la Rie, 1982, p. 65-69).

a) b)

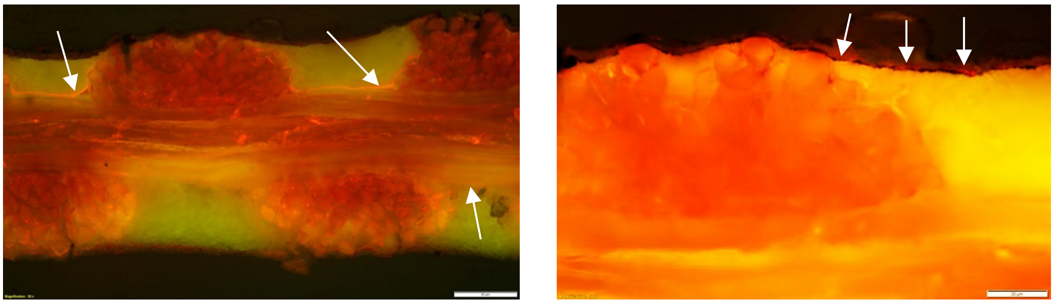


Figure 6.11. Sample TS08 after SYPRO® Ruby staining seen through Olympus BX41 optical microscope, filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm); a) 200× magnification, b) 500× magnification. White arrows are signalling the orange, fluorescent line of proteinaceous size layer surrounding the yarns in a) and over the metal leaf in b).

a) b)

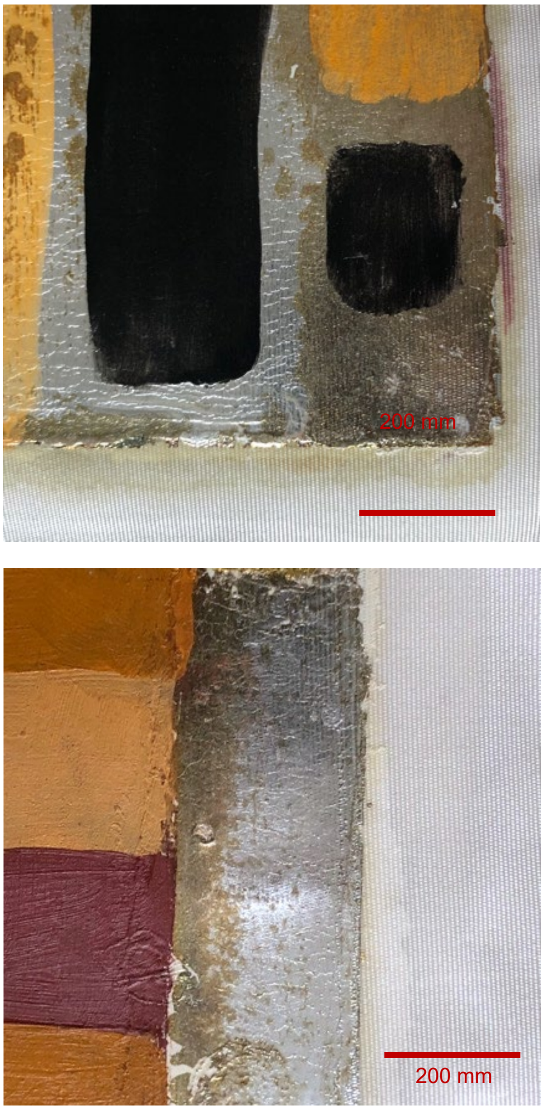


Figure 6.12. Details of second banner reconstruction (side A) showing tarnishing of the silver leaf after 6 months in the intentionally un-coated areas and the almost perfect state of the silver leaf coated with a single layer of rabbit skin glue 5% w/v; a) upper section (lettered scroll reconstruction), b) lower section (border of painting reconstruction).

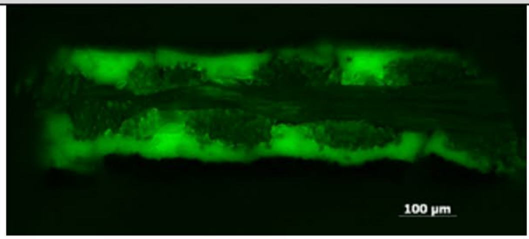
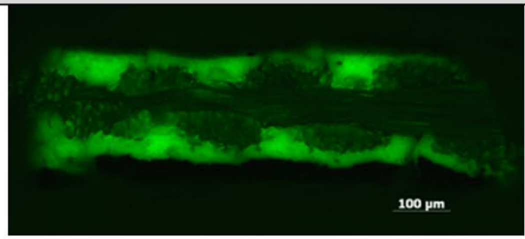
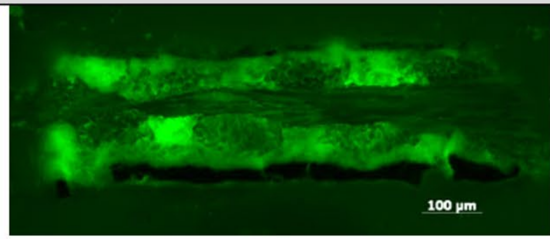
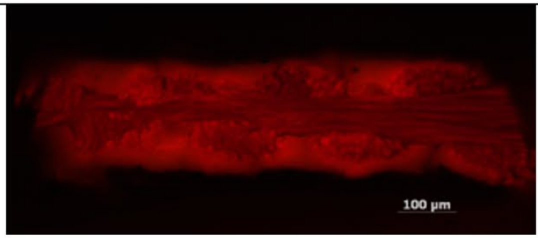
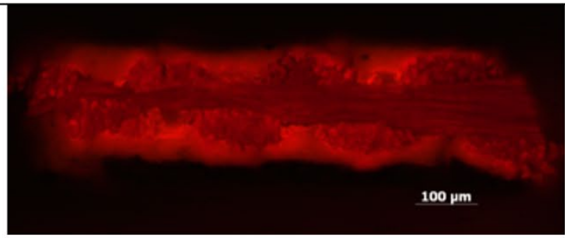
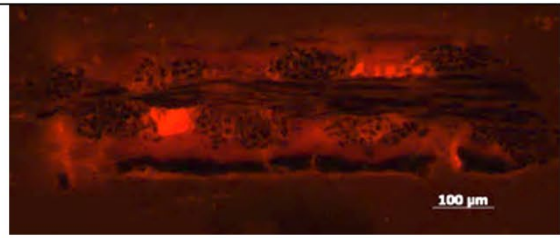
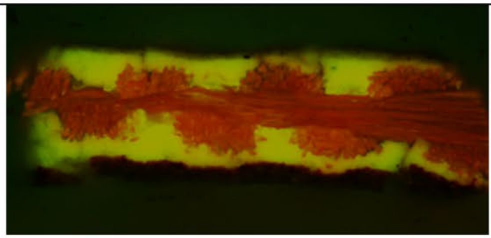
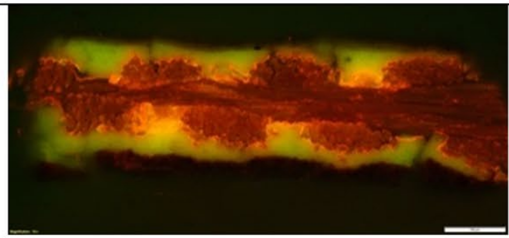
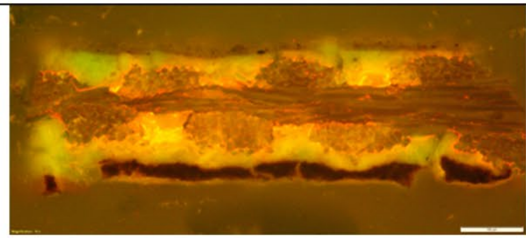
6.3.4.3 Paint layer

Sample TS40of the *Typographers*' banner was additionally selected for analysis using the crossed staining protocol with Nile Red using the same methodology outlined in section 5.6.3. The reason for its selection was the considerable thicker layers in comparison to sample TS08, which would allow further grinding if necessary. The results observed under the Zeiss Axioscop microscope similarly showed how Nile Red's positive stain is seen as an overall green or red glow, depending on the filtering conditions, throughout the layers of the cross-section (Table 6.8).

Staining with Nile Red made the paint layers on both sides A and B of the banner much brighter, which were not visible before staining nor after the staining with SYPRO® Ruby (Table 6.8, filter sets for fluorescein and rhodamine after Nile Red). This is particularly evident in image After Nile Red with U filter set (Table 6.8), where the positive staining of the embedding resin reflects light onto the sample, making it looks as if it had a varnish layer, which it does not.

The stain also suggests the heterogeneity in the polarity of the oxidised oil and a possible accumulation of oil in the ground layers that happened with the oil drying process, appearing as blotches of bright green/red colour depending on the settings. Consistent with reconstruction sample RB1, SYPRO® Ruby's fluorescence was surpassed by Nile Red's under the Zeiss Axioscop microscope but remained discernible under the Olympus BX41 (Table 6.8, filter set U-MWB2) due to the much wider range of wavelengths passed through its barrier filter (see Chapter 5). Nile Red stain quenched the autofluorescence colour of the dyed silk yarns, seen as a complete absence of fluorescence under the Zeiss Axioscop microscope and as a blue-grey tone under the Olympus BX41 microscope. As with the experimental samples, the fluorescence quenching of proteinaceous materials caused by Nile Red's uptake confirmed their hydrophilic nature and distinguished them from the surrounding hydrophobic matrix. This could be indicating an oil binder in the paint and ground layers.

Table 6.8. Example of cross-staining on sample TS40 with SYPRO® Ruby and Nile Red, seen under Zeiss Axioscop microscope at 100× magnification with settings for fluorescein and rhodamine; and Olympus BX41 microscope with filter U-MWB2.

Filter set	Before staining	After SYPRO® Ruby	After Nile Red
F			
R			
U			

* F (fluorescein), R (rhodamine), U (U-MWB2)

6.3.5 Crossed staining of cross-section samples from the remaining four Kenning banners of Glasgow Museums Collection

Following the results obtained for samples TS08 and TS40 from the banner of *The Glasgow Typographical Society*, the same crossed staining methodology was planned for the remaining four Kenning banners of Glasgow Museums Collection. Unfortunately, due to COVID-19 restrictions in force within the university at the time of this study, use of the Zeiss Axioscop microscope with filters for fluorescein and rhodamine was not permitted, restricting the observation and documentation to the Olympus BX41 microscope. Two samples, one from the metallic scrolls and one from the central painting, were selected per banner as listed in Table 6.9.

Table 6.9 Cross section samples selected for fluorescent staining.

Banner	Metallic scroll	Central painting
The Glasgow Upholsterers Society banner	GU08	GU09
The Grain Millers of Glasgow banner	MG26	MG10
The National Union of Vehicle Builders, Glasgow Branch banner	VB11	VB12
The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner	SM21	SM16

6.3.5.1 Textile

A distinctive autofluorescence colour was likewise observed in the silk yarns of all eight cross-sections under filtering conditions U-MWB2. The colours changed from the original dark-blue hue to different shades of red (Table 6.10, before staining), as well as a mixed fluorescence of pink and purple/light blue (Table 6.10, before staining).

The autofluorescence of the dyed silk revealed the use of different dyes across the banners' fabrics. The four cross-sections dated 1884 showed a similar red fluorescence in their yarns (Table 6.10, before staining), while the four cross-sections dated in the 20th century showed a different mixed fluorescence of pink in the centre and purple to light blue towards the exterior of each fibre (Table 6.10 (continued), before staining). This indicates that the dyes used in these two George Kenning banners are similar to each other but different from the dye used in the banner of *The Glasgow Typographical Society*. These dyes are also different from those found in these two George Kenning & Son examples from the 20th century, which additionally seem to differ from each other. Nevertheless, none of the samples showed exactly the same fluorescence colour, proving what has been previously highlighted by Clarke and by van Bommel et al. about the limitations of fluorescence for the identification of synthetic dyes (Clarke, 1999, p.1431-1436; van Bommel et al., 2007, p.263). Other factors such as ageing of the samples may have also changed their properties.

6.3.5.2 Size layer

Regarding the identification of the proteinaceous size layer, SYPRO® Ruby positively stained a continuous orange line of variable thicknesses surrounding the yarns on the weft and warp directions of all but one sample, SM16, which showed no evidence of size layer (Table 6.10, after SYPRO® Ruby). This indicates that all silvered areas of the four banners were impregnated with a proteinaceous size before the application of the ground layer, as recommended by the historical techniques described in Chapter 3. In comparison, not all the central painted sections seemed to have a size layer, as sample SM16 from the *Scottish Tin Plate Braziers and Sheet Metal Workers' Society* banner proved.

The results of the identification of proteinaceous coating over the metal leaf, were positive for samples GU08, MG26 and VB11, but negative for sample SM21 (Figures 6.13 a-d). This was expected for both Kenning banners as they have a tarnishable silver leaf that required isolation but was unexpected for the *National Union of Vehicle Builders Glasgow Branch* banner, as it too has a non-tarnishable aluminium leaf like the negatively stained *Scottish Tin Plate Braziers and Sheet Metal Workers' Society*. Further insight into this finding is given by the FTIR-ATR results on sample VB14 (front), where a presence of a proteinaceous material like rabbit skin glue was detected within the spectra of the golden coating (see section 6.4 FTIR-ATR). This suggests that the company mantained the same methodology used in their older silver leaf banners until 1914, as the coating was not detected in the more recent banner dating c.1916. This practice has been identified in polychrome glazes on metal leaf (Emmerling et al, 2013), trailing from a mediaeval tradition. The ease of application of glazes over protein-coated metal versus non-coated was indeed experienced during the making *Reconstruction 2* (see Appendix IV).

Table 6.10. SYPRO® Ruby and Nile Red staining comparison of cross-sections from the remaining four Kenning banners of Glasgow Museums Collection, seen under Olympus BX41 microscope with filter U-MWB2. GU, VB, and SM at 100× magnification, MG at 50× magnification

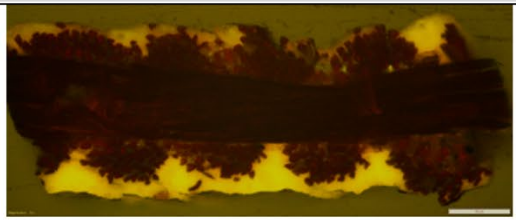
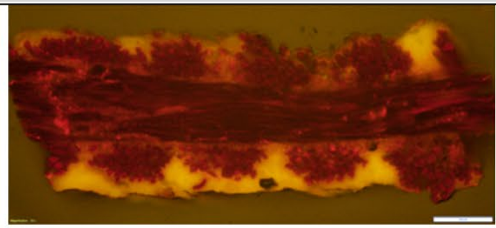
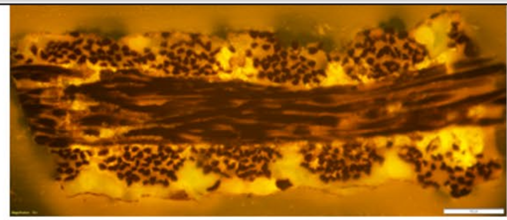
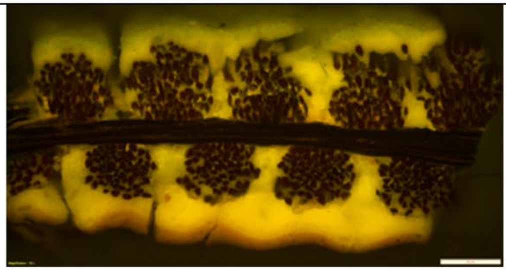
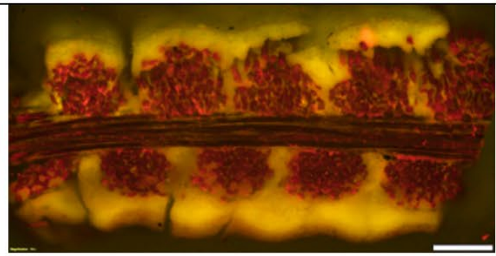
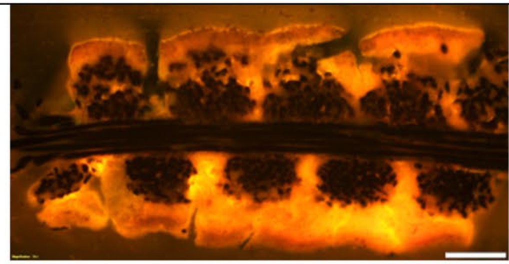
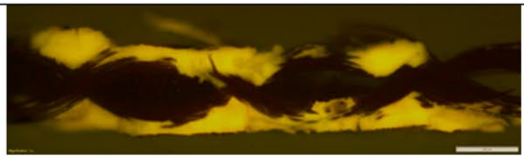
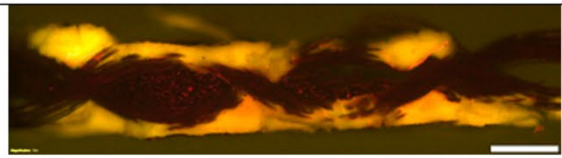
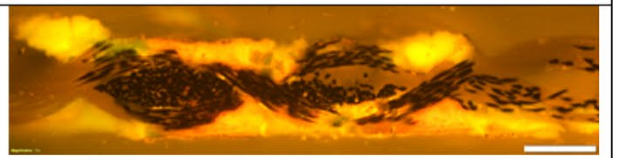
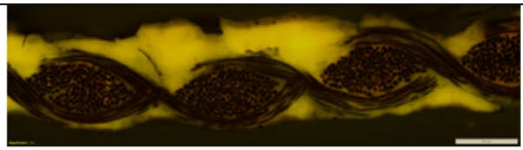
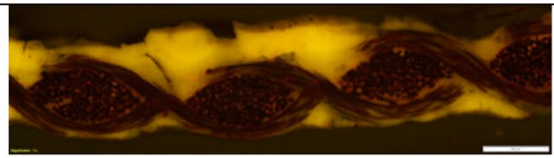
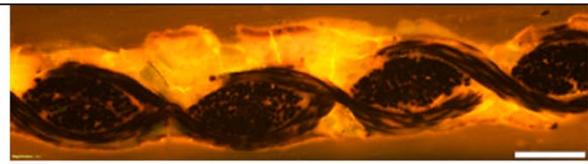
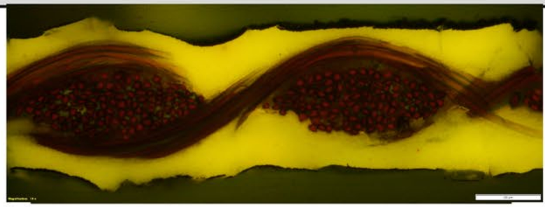
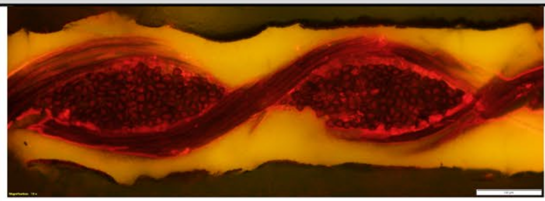
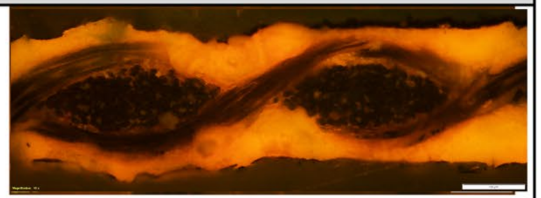
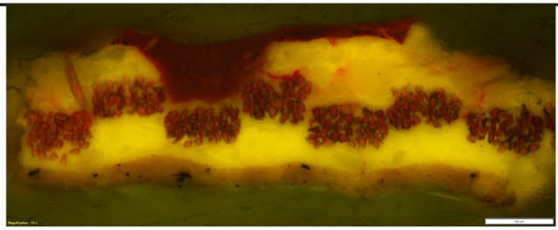
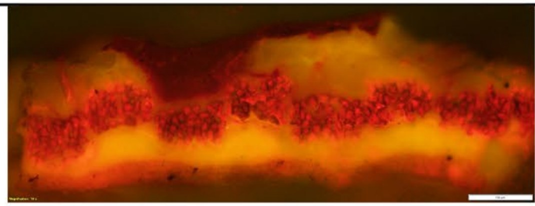
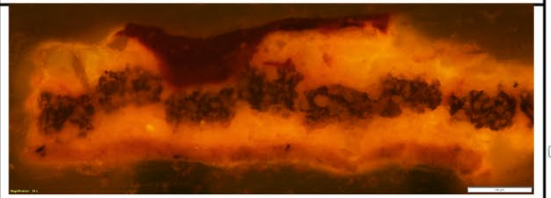
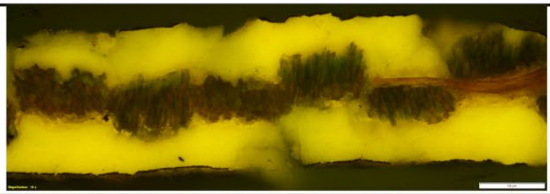
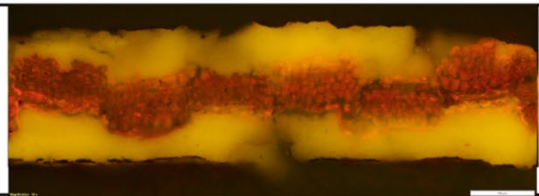
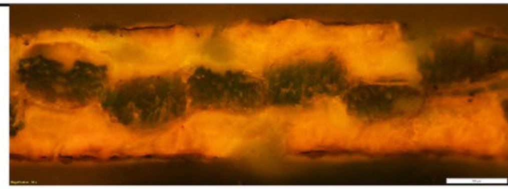
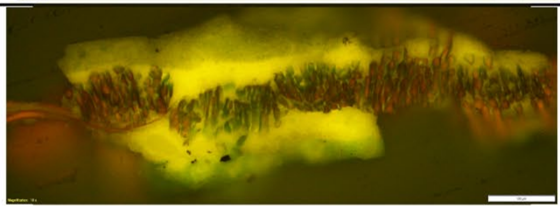
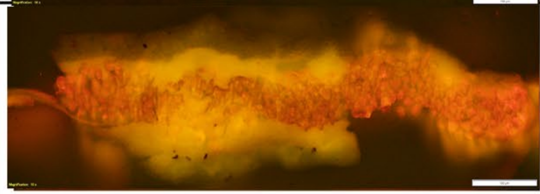
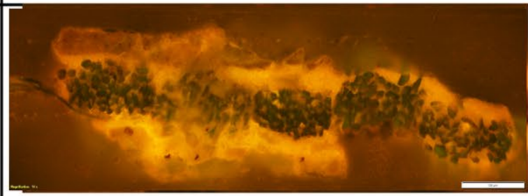
Sample code	Before staining	After SYPRO® Ruby	After Nile Red
GU08			
GU09			
MG26			
MG10			

Table 6.10 (continued) SYPRO® Ruby and Nile Red staining comparison of cross-sections from the remaining four Kenning banners of Glasgow Museums Collection, seen under Olympus BX41 microscope with filter U-MWB2. GU, VB, and SM at 100× magnification, MG at 50× magnification

Sample code	Before staining	After SYPRO® Ruby	After Nile Red
VB11			
VB12			
SM21			
SM16			

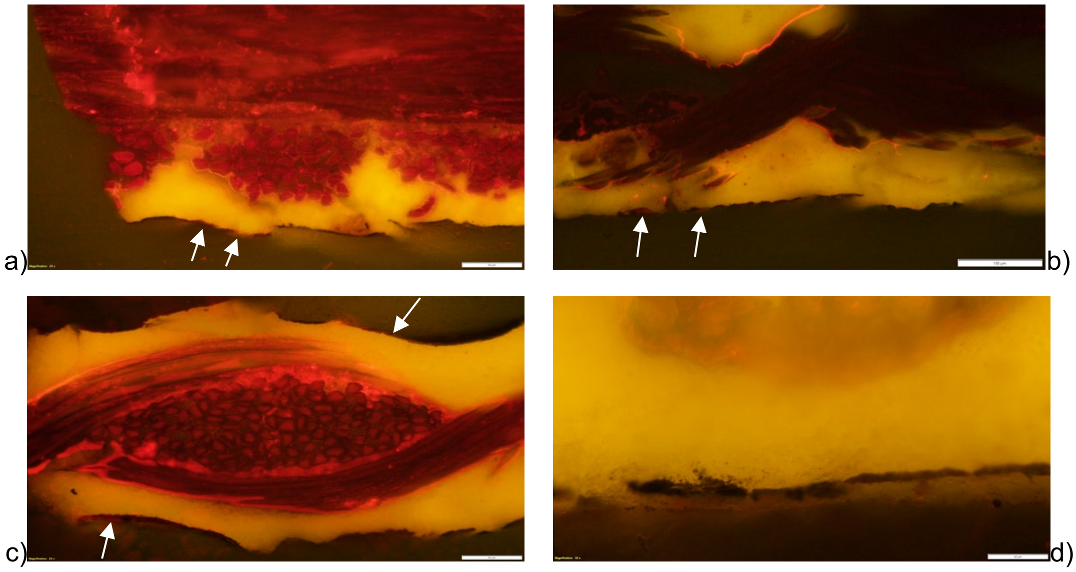


Figure 6.13. Detail of metallic sections after SYPRO® Ruby staining with and without proteinaceous coating, seen under Olympus BX41 optical microscope with filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm); a) GU08, positive stain, 200× magnification; b)MG26, positive stain, 100× magnification; c)VB11, positive stain, 200× magnification; d)SM21, negative stain, 500× magnification. *White arrows indicate orange fluorescence line over metal leaf.

6.3.5.3 Paint layer

The identification and localisation of oil media with Nile Red, showed a positive stain in the oil-containing layers of ground and paint, registered as an intense fluorescence in various hues of yellow and orange (Tables 6.10, after Nile Red). This was consistent with the results of the experimental samples observed under the Olympus BX41 optical microscope with filter U-MWB2. Unfortunately, no comparison was possible with the Zeiss Axiocam microscope to confirm the previous results.

In contrast to the result observed for sample TS40, SYPRO® Ruby's fluorescence was not discernible after the cross-staining with Nile Red unless they were re-stained. Given that sample TS40 was re-stained with SYPRO® Ruby for its observation under the Zeiss Axioscop microscope, sample MG26 was additionally selected for re-staining with SYPRO® Ruby after Nile Red, obtaining a positive result. This indicates that for a simultaneous localisation of oil and proteinaceous layers, the crossed staining needs to be carried out in the same session, and SYPRO® Ruby needs to be re-applied either before or after Nile Red's application, without the need of vapour fixation nor further polishing.

Nile Red staining similarly quenched the autofluorescence colour of the dyed silk yarns. Samples GU08, GU09, MG26, MG10, VB11 and VB12 were seen under the Olympus BX41 microscope in a dark blue/black tone, whilst samples SM21 and SM16 were seen in a blue-grey tone (Table 6.10, after Nile Red). Correspondingly, the fluorescence quenching of proteinaceous materials caused by Nile Red's uptake, distinguished them from the surrounding oil binder of the paint and ground layers.

In two cases, samples SM16 and GU08, the positive stain with Nile Red additionally highlighted the seeping of oil media into their silk yarns (Figure 6.14), not previously seen before staining. Smith et al. have recently suggested that the seeping of lead white oil paint into the yarns is dependent on the absence or presence of size layer and its concentration (Smith et al., 2019, pp. 4-5). This was consistent with sample SM16 in which no size was stained with SYPRO® Ruby but inconsistent with sample GU08 that showed evidence of size layer after staining.

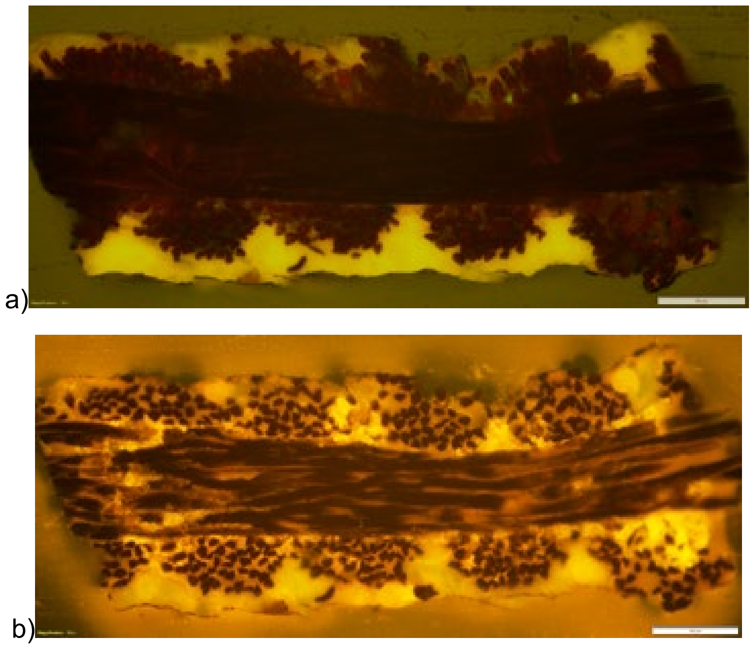
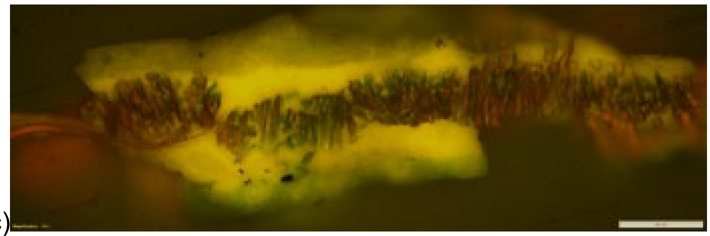
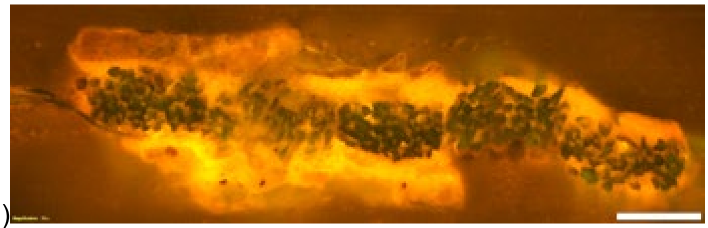


Figure 6.14. Comparison of samples GU08 (a, b) and SM16 (c, d) before and after Nile Red staining showing the seeping of oil into their yarns. Seen under Olympus BX41 optical microscope with filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm) at 100× magnification.



c)



d)

Figure 6.14 (continued) Comparison of samples GU08 (a, b) and SM16 (c, d) before and after Nile Red staining showing the seeping of oil into their yarns. Seen under Olympus BX41 optical microscope with filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm) at 100× magnification.

Finally, Nile Red's solvatochromatism was detected on the positive stain of samples MG10, MG26 and sample TS40, like that reported by Schaeffer (1997). This localised change in fluorescence colour shifting from a golden-yellow hue to a green hue, alike sample TS40. Blotches of green hue fluorescence were also detected on samples MG10 and MG26. These contrasted with the overall golden-yellow hue of their positively stained white ground (Figure 6.15, a, b and c). Additionally, localised blotches of red hue fluorescence were seen on samples MG10 and MG26. The remaining cross-sections showed a more homogeneous fluorescence colour of either a yellow-golden hue or an orange hue (Table 6.10).

According to Schaeffer, Nile Red has a green hue fluorescence in heptane, a yellow-golden hue in xylene, and variable red hues in either acetone, ethanol, or a mixture of both under UV light (366 nm) (Schaeffer, 1997). These fluorescence colours highlight the low, medium, and high polarity of the solvent Nile Red is dissolved into, which could relate to the variable changes in polarity within linseed oil media, a complex process that has been explained by van der Berg, and by van der Berg and Boon because of its curing and aging (van der Berg, van der Berg and Boon, 1999).

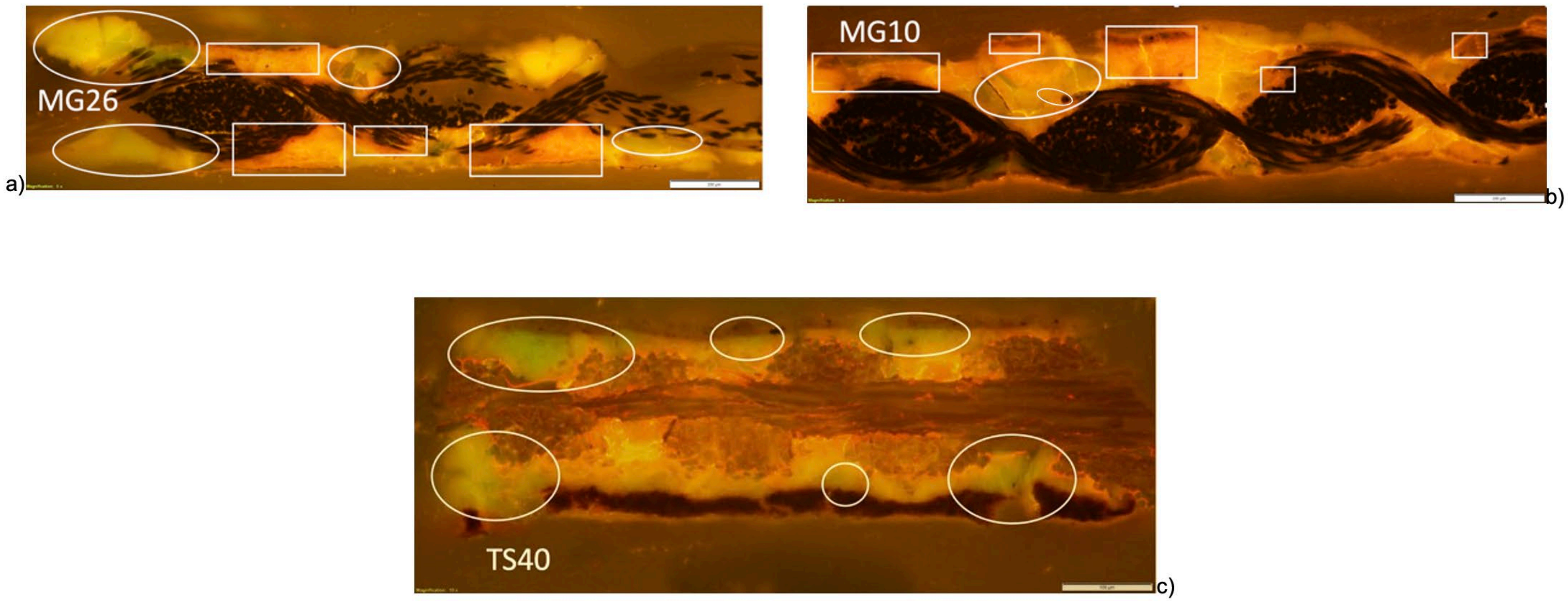


Figure 6.15. Nile Red solvatochromatism in samples from George Kenning banners, seen under Olympus BX41 optical microscope with filter U-MWB2 (BP 460-490nm, BS 500nm, LP 520nm); a) MG26 at 50× magnification; b) MG10 at 50× magnification; c) TS40 at 100× magnification. *Circles indicate green hue fluorescence and rectangles indicate red hue fluorescence.

6.4 Portable XRF results of *The Glasgow Typographical Society* banner

A total of 26 different locations were analysed by portable XRF, 1 from the silk textile, 9 from the metallic scrolls and 16 from the central paintings (see Appendix II, Sampling Protocols). The results are indicative and not proof alone of the material composition. All the compiled spectra are included in Appendix III, showing labels only on the peaks that were equal or above 75 counts/sec in the graphs for clarity (see Appendix III).

Due to the configuration of the analyser, two artefacts were identified *a priori*: rhodium (Rh Kα1=20.21 KeV, Kß1=22.72 KeV) and copper (Cu Kα1=8.04 KeV). According to the supplier of the equipment (Granger, 2020), the first was related to the main filter mode, which although made of silver (Ag), it is reported to yield large Rayleigh Ag peaks and Compton peaks looking like Cd and Rh-Pd at 40 keV. The second was related to the copper filter (Cu@20kV) used for low range analysis.

Four main elements were identified in the table surface according to their emission lines (Table 6.11): calcium (Ca Kα1=3.69 KeV, Kß1=4.01 KeV), titanium (Ti Kα1=4.51 KeV, Kß1=4.93 KeV), iron (Fe Kα1=6.40 KeV, Kß1=7.05 KeV) and zinc (Zn Kα1=8.63 KeV). Given the white colour of the table, made of plywood covered with Formica, the detection of titanium was interpreted as the white pigment titanium oxide ($TiO2$), widely used in the modern manufacture of white objects (CAMEO, 2022). However, the interpretation of the calcium content was inconclusive. It was impossible to relate it to either calcium carbonate ($CaCO_3$) or calcium sulphate ($CaSO_4$), as the selected settings impeded the detection of sulphur (S). The finding of the two metals iron and zinc was interpreted as galvanized iron, the material with which the table structure seemed to be made of. As no additional elements were detected in the silk sample, it was considered as not adding to the acquired spectra of the scrolls and central paintings sampling points.

Table 6.11. XRF results from the table and silk backgrounds of *The Glasgow Typographical Society* banner.				
Sample	Spectrum	Elements	KeV	Materials
TSXRF_1 (Table)	Typographical 97	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ti	4.51, 4.93	Titanium white (TiO2)
		Fe	6.41, 7.05	Iron (Fe)
		Zn	8.57	Zinc (Zn)
TSXRF_2 (Table)	Typographical 98	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ti	4.51, 4.92	Titanium white (TiO2)
		Fe	6.39, 7.05	Iron (Fe)
		Zn	8.65	Zinc (Zn)
TSXRF_3 (Table)	Typographical 99	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ti	4.51, 4.93	Titanium white (TiO2)
		Fe	6.39, 7.05	Iron (Fe)
		Zn	8.63	Zinc (Zn)
TSXRF_15 (Silk background)	Typographical 104	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ti	4.51, 4.92	Titanium white (TiO2)
		Fe	6.39, 7.05	Iron (Fe)
		Zn	8.58	Zinc (Zn)

6.4.1 Ground layer

Given that the main element detected on all sampling points of both scrolls and central paintings was lead (Tables 6.12–6.19), it was interpreted as the main component of the ground layer of the banner. It was identified by its characteristic L lines (Pb $L\alpha 1$= 10.55 KeV, $L\beta 1$=12.61 KeV, $L\gamma$=14.76 KeV) and its M line (Pb $M\alpha 1$=2.34 KeV) (McGlinchie, 2013 p. 154). This was interpreted as the pigment lead white or lead carbonate ($2PbCO_3.Pb(OH)_2$), used both in the grounds under the metallic leaves and in the paint and/or grounds of the central paintings. Given the double layout of the paintings and the penetration of the X-rays, it was impossible to discern if the lead content was exclusive to the ground or if it was in mixture with the paints. Hence, SEM-EDX was conducted for such purpose (see section 6.5).

6.4.2 Metal leaf layer

The metal silver (Ag) was identified on all the samples from the metallic scrolls (Tables 6.12-6.15), by the detection of its L lines (Ag Lα1=2.98 KeV, Lß1=3.15 KeV, Lß2=3.34 KeV). This was interpreted as silver leaf due to the appearance under the optical microscope (see Appendix I). Two further points were selected in areas that showed evident tarnishing (Table 6.12), detecting silver, lead and calcium. The lead corresponded to the lead carbonate ground but similarly to the table, it was not possible to discern between calcium carbonate or sulphate, as well as to detect potential silver sulphurs causing the apparent tarnishing.

Table 6.12. XRF results from the tarnishing of the metallic scrolls of *The Glasgow Typographical Society* banner.

Sample	Spectrum	Elements	KeV	Materials
TSXRF_13 (Tarnishing)	Typographical 102	Pb	2.37, 10.55, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ag	2.99, 3.15, 3.35	Silver leaf (Ag)
TSXRF_17 (Tarnishing)	Typographical 106	Pb	2.37, 10.55, 12.62, 14.75	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ag	2.99, 3.15, 3.35	Silver leaf (Ag)

6.4.3 Coloured glazes

Barium was detected in two of the glazes on the scrolls' samples, red and brown: TSXRF_14, TSXRF_20 and TSXRF_12 (Tables 6.13 and 6.14). In all cases it was identified by its L lines (Ba Lα1=4.46 KeV, Lß1=4.82 KeV, Lß2=5.15 KeV) and interpreted as the pigment/extender barium white or barium sulphate ($BaSO_4$). McGlinchie reports the difficulty of discerning between barium and titanium due to their overlapping lines (McGlinchie, 2013, p. 139-40). Hence, the interpretation in all barium samples was done only after confirming the detection of all three L lines. Two of the barium findings were located in the red banding sites of the scrolls (Table 6.13) and as no other indication of red pigment was detected, it can be interpreted as possibly containing an organic red lake with barium sulphate as substrate (Eastaugh et al., 2004, p. 809). Neither tin (Sn) nor aluminium (Al) were detected with XRF as potential red lake substrate, but they were identified and mapped with SEM-EDX (see section 6.6.5).

Iron and manganese were detected in scroll samples TSXRF_12, TSXRF_21and TSXRF_22, identifying their K- lines: iron (Fe Kα1=6.40 KeV, Kβ1=7.05 KeV) and (Mn Kα1=5.89 KeV, Kβ1=6.49 KeV) (Tables 6.14 and 6.15). They were interpreted as two possible pigments depending the analysed colour, yellow iron oxides or yellow ochre ($Fe(OH)_3$) and brown umber or iron-manganese oxides ($Fe(OH)_3$ + MnO_2). However, they could also be interpreted as manganese driers and another type of iron pigment, so the results were contrasted with those acquired with SEM-EDX (see section 6.5).

Table 6.13. XRF results from the red glazes of the metallic scrolls of *The Glasgow Typographical Society* banner.

Sample	Spectrum	Elements	KeV	Materials
TSXRF_14 (Red banding)	Typographical 103	Pb	2.37, 10.55, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ca	3.71, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ba	4.46, 4.8, 5.15	Barium white ($BaSO_4$)
		Ag	2.99, 3.15, 3.35	Silver leaf (Ag)
TSXRF_20 (Red banding)	Typographical 107	Pb	2.36, 10.55, 12.62, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ca	3.71, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ba	4.47, 4.8, 5.15	Barium white ($BaSO_4$)
		Ag	2.99, 3.15, 3.35	Silver leaf (Ag)
TSXRF_44 (Red banding)	Typographical 124	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Pb	2.37, 10.56, 12.63, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ag	2.99, 3.15, 22.1, 24.9	Silver leaf (Ag)

Table 6.14. XRF results from the lettering and brown lines of the metallic scrolls of *The Glasgow Typographical Society* banner.

Sample	Spectrum	Elements	KeV	Materials
TSXRF_12 (Black lettering)	Typographical 101	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ba	4.47, 4.8, 5.15	Barium white ($BaSO_4$)
		Pb	10.55, 12.63, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Mn	5.9, 6.41	Umber ($Fe(OH)_3$ + MnO_2)
		Fe	6.41, 7.04	Umber ($Fe(OH)_3$ + MnO_2)
		Ag	2.97	Silver leaf (Ag)
TSXRF_16 (Brown line)	Typographical 105	Pb	2.37, 10.56, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ag	2.99, 3.15, 3.35	Silver leaf (Ag)
		Fe	6.39, 7.05	Iron oxides ($Fe(OH)_3$)
TSXRF_21 (Brown line)	Typographical 109	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Pb	2.36, 10.56, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
		Mn	5.9, 6.41	Umber ($Fe(OH)_3$ + MnO_2)
		Fe	6.41, 7.04	Umber ($Fe(OH)_3$ + MnO_2)
		Ag	2.97, 3.15, 3.35	Silver leaf (Ag)

Table 6.15. XRF results from the golden glaze of the metallic scrolls of *The Glasgow Typographical Society* banner.

Sample	Spectrum	Elements	KeV	Materials
TSXRF_22 (Golden coating)	Typographical 108	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Pb	2.37, 10.55, 12.63, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Mn	5.9, 6.41	Umber ($Fe(OH)_3$ + MnO_2)
		Ag	2.99, 3.15, 3.35	Silver leaf (Ag)
		Fe	6.41, 7.04	Umber ($Fe(OH)_3$ + MnO_2)
TSXRF_22 (Golden coating)	Typographical 110	Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Pb	2.37, 10.55, 12.62, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Fe	6.39, 7.04	Yellow ochre ($Fe(OH)_3$)
		Ag	2.99, 3.15	Silver leaf (Ag)

6.4.4 Paint layer

Regarding the central paintings, two red pigments were interpreted from their sampling points (Table 6.16): red iron oxides or red ochre ($Fe(OH)_3$) and vermilion or mercury sulphide (HgS). The identification of mercury was based on the location of its L lines (Hg Lα1=9.98 KeV, Lß1=11.82 KeV). However, as each sampling point coincided with a potential iron-containing colour (i.e., brown, yellow or pink; see Appendix Sampling Protocols) located on the opposite side of the banner (sides A and B), it is unclear if the two pigments were mixed together, or they belonged to different sides. Thus, the results were also contrasted with those acquired with SEM-EDX (see section 6.5). Further examples of two yellow samples from the central paintings are included in Table 6.17.

Table 6.16. XRF results from the red-containing tones of the central paintings of *The Glasgow Typographical Society* banner.

Sample	Spectrum	Elements	KeV detected	Materials interpreted
TSXRF11 (Pink rose)	Typographical 100	Pb	2.37, 10.55, 12.62, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$), red lead (Pb_3O_4)
		Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
TSXRF_30 (Light red)	Typographical 111	Pb	2.38, 10.56, 12.62, 14.75	Lead white ($2PbCO_3.Pb(OH)_2$)
		Hg	9.98, 11.87	Vermillion (HgS)
		Fe	6.39, 7.04	Iron oxides (Fe2O3)
TSXRF_36 (Dark red)	Typographical 113	Pb	2.36, 10.55, 12.62, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Hg	9.99, 11.84	Vermillion (HgS)
		Fe	6.41, 7.05	Iron oxides (Fe2O3)
		Ca	3.71, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
TSXRF_32 (Light magenta)	Typographical 114	Pb	2.38, 10.56, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
		Hg	9.98, 11.8	Vermillion (HgS)
		Ba	4.47, 4.8, 5.15	Barium white ($BaSO_4$)
		Ca	3.71, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Fe	6.41, 7.04	Iron oxides (Fe2O3)
TSXRF_33 (Dark magenta)	Typographical 115	Pb	2.37, 10.56, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ba	4.47, 4.8, 5.15	Barium white ($BaSO_4$)
		Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Fe	6.41, 7.04	Iron oxides (Fe2O3)
TSXRF_40 (Flesh tone)	Typographical 120	Pb	2.37, 10.56, 12.62, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Hg	9.98, 11.87	Vermillion (HgS)
		Fe	6.41, 7.04	Iron oxides (Fe2O3)
		Hg	10.01, 11.88	Vermillion (HgS)
		Fe	6.41, 7.04	Iron oxides (Fe2O3)

Table 6.16 (continued) XRF results from the red-containing tones of the central paintings of *The Glasgow Typographical Society* banner.

Sample	Spectrum	Elements	KeV detected	Materials interpreted
TSXRF_42 (Purple "retouching")	Typographical 122	Pb	2.36, 10.56, 12.63, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Hg	10.01, 12.18	Vermillion (HgS)
		Ca	3.71, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Fe	6.41, 7.04	Iron oxides (Fe2O3)
TSXRF_46 (Flesh tone)	Typographical 126	Pb	2.37, 10.56, 12.62, 14.79	Lead white ($2PbCO_3.Pb(OH)_2$)

Table 6.17. XRF results from the yellow tones of the central paintings of *The Glasgow Typographical Society* banner.

Sample	Spectrum	Elements	KeV detected	Materials interpreted
TSXRF_31 (Light yellow)	Typographical 112	Pb	2.38, 10.56, 12.62, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Fe	6.39, 7.04	Yellow ochre ($Fe(OH)_3$)
TSXRF_41 (Beige background)	Typographical 121	Pb	2.37, 10.56, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)

Chrome was detected in the two green samples of the banner (Table 6.18), identified by its K-lines (Cr Kα1=5.41 KeV, Kß1=5.95 KeV). It could only be interpreted as chromium green or chromium oxide (Cr_2O_3) in sample TSXRF_45, a pigment developed in 1809 and commercially available from 1840 (Newman, 1997). However, in sample TSXRF_10 the chrome content can also be interpreted as chrome yellow, given the iron (Fe) content also detected which could indicate Prussian blue, thus a mixture of blue and yellow for achieving the green. Unfortunately, this could not be corroborated under OM due to bad quality of paint sample.

Table 6.18. XRF results from the green tones of the central paintings of *The Glasgow Typographical Society* banner.

Sample	Spectrum	Elements	KeV detected	Materials interpreted
TSXRF_10 (Green leaf)	Typographical 96	Pb	2.36, 10.56, 12.63, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Fe	6.42, 7.04	Yellow iron oxides ($Fe(OH)_3$)
		Cr	5.42, 5.95	Chromium green (Cr_2O_3)
TSXRF_45 (Olive green leaf)	Typographical 125	Ca	3.71, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
		Ba	4.47, 4.8, 5.15	Barium white ($BaSO_4$)
		Pb	2.34, 10.56, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
		Cr	5.42, 5.95	Chromium green (Cr_2O_3)

The blue sampling points were inconclusive under the applied conditions for suggesting a potential pigment (Table 6.19). Besides the lead content associated to the lead carbonate of the ground layer and/or the paint layer, calcium and barium were found on sample TSXRF_35. Barium was interpreted as barium sulphate, as no other barium-containing pigment was found to be reported. Similarly to the previous cases, it was impossible to determine whether the calcium content was associated to sulphur (thus identifying calcium sulphate) or carbon (thus identifying calcium carbonate). XRF was also unable to determine if said extenders were mixed with the paint, with the ground or both, thus the results were contrasted with those obtained with SEM-EDX (see section 6.5).

Table 6.19. XRF results from the blue tones of the central paintings of *The Glasgow Typographical Society* banner (continuation).				
Sample	Spectrum	Elements	KeV detected	Materials interpreted
TSXRF_34 (Light blue)	Typographical 116	Pb	2.37, 10.55, 12.63, 14.78	Lead white ($2PbCO_3.Pb(OH)_2$)
TSXRF_35 (Dark blue)	Typographical 117	Pb	2.37, 10.56, 12.63, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)
		Ba	4.47, 4.8, 5.15	Barium white ($BaSO_4$)
		Ca	3.69, 4.01	Chalk ($CaCO_3$) or gypsum ($CaSO_4$)
TSXRF_43 (Grey scrollwork)	Typographical 123	Pb	2.37, 10.55, 12.62, 14.76	Lead white ($2PbCO_3.Pb(OH)_2$)

A summary of the main results interpreted from the XRF spectra are presented in the table 6.20.

Table 6,20. Summary of XRF results interpretation.			
Ground layer	Metallic scrolls	Coloured glazes	Paint layer
Lead white	Silver leaf	Barium white (possible red lake substrate)	*Lead white
		Umber	Barium white
		Iron oxides	Umber
		*Lead white	Red ochre
			Vermillion
			Yellow ochre
			Chromium green
*Unable to be distinguished from the ground layer.			

6.5 FTIR-ATR results of the five Kenning banners of Glasgow Museums Collection

A total of 25 samples from the five Kenning banners of Glasgow Museums Collection were analysed with FTIR-ATR: five from the *Typographers*, five from the *Upholsterers*, five from the *Millers*, five from the *Vehicle Builders* and five from the *Metal Workers*. The samples were analysed on either one or both of sides, depending on the type of sample as described in Chapter 4. All the spectra were normalised for clarity of comparison applying baseline correction with the software Spectrum version 5.0.1. Baseline correction is reported to theoretically increase the small differences between spectra that show seemingly the same behaviour (Sarmiento et al., 2011, pp. 3605), as those acquired from the paint samples and the textile fibres of the five banners.

To help with the identification, the spectra acquired from the banners' samples were compared against standard materials' ones. The reference spectra were used from previous research looking at the manufacturing process of nineteenth and twentieth century British double-sided silk painted banners (Rogerson and Lennard, 2004; Macdonald et al., 2004; Smith, Thompson, and Hermens, 2016). In addition, other standards were included based on what suggested by the historical sources reviewed in Chapter 3.[46] The analysis of both standard and historical samples was conducted using the same equipment and experimental conditions reported by Smith, Thompson, and Hermens (2016), in order to give continuity to their work and allow direct comparison. The spectra of the reference materials are depicted in Figures 6.16 and 6.17, with their characteristic bands. The list of standards used and the complete spectra of all the samples are included in Appendix III, Analytical results. The interpretation of the spectra is explained as follows, divided in textile, size layer, ground layer, paint layer and coloured glazes.

[46] Unfortunately there was restricted archival access with respect to British banner production because of the COVID-19 pandemic.

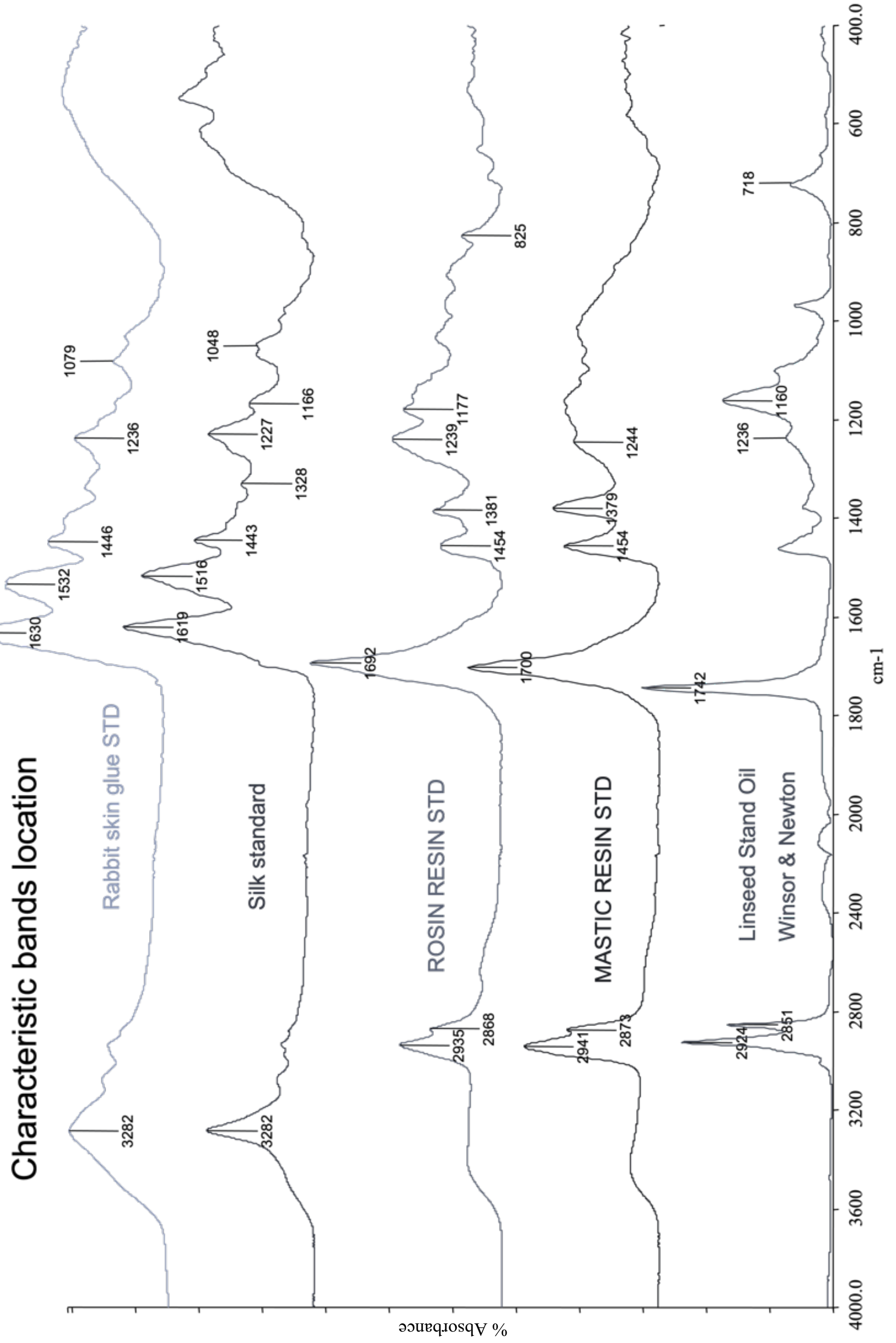


Figure 6. 16. Characteristic bands location of the organic standards used.

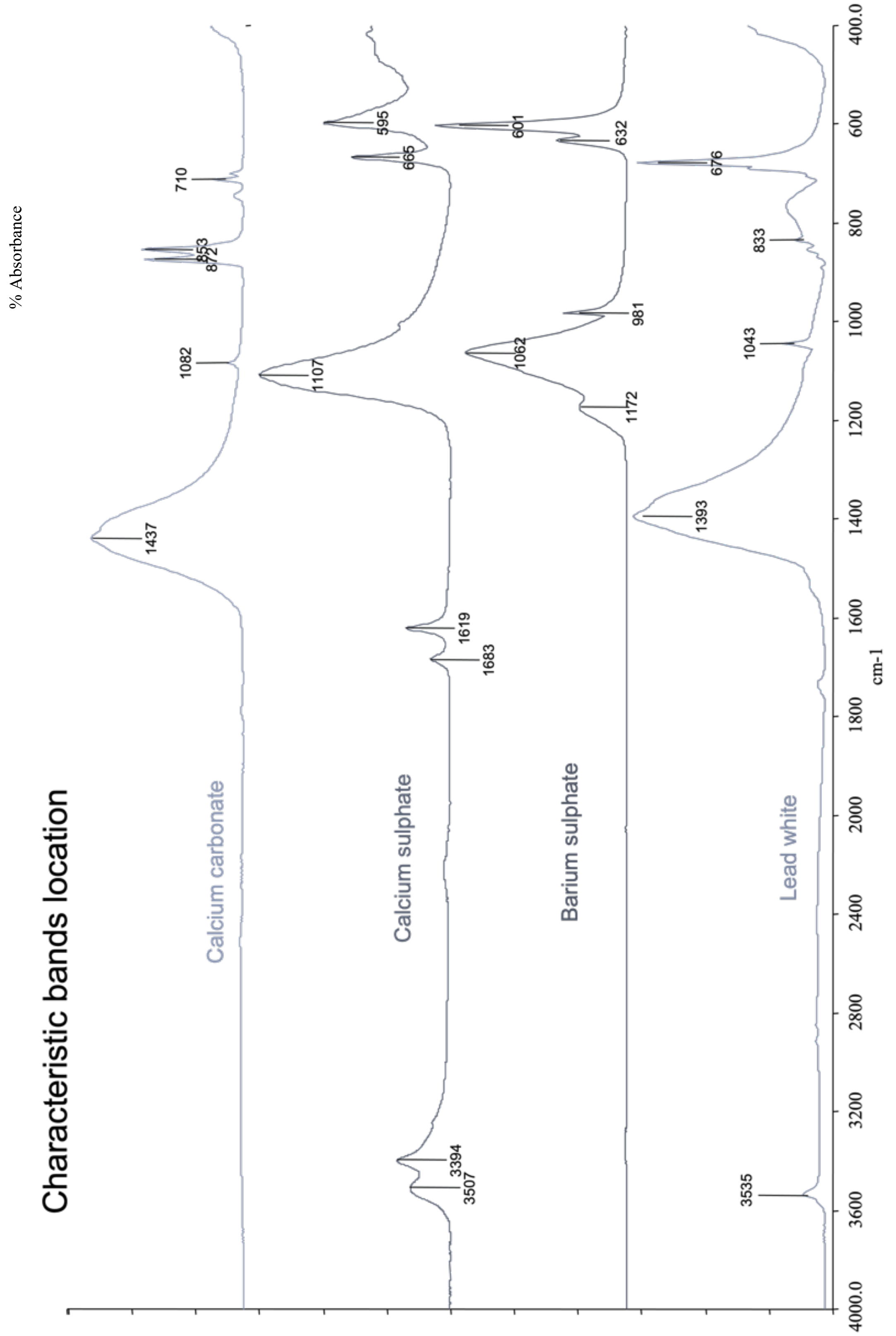


Figure 6. 17. Characteristic bands location of the inorganic standards used.

6.5.1 Textile

FTIR-ATR confirmed the use of silk in the fabric of the banners on all textile samples; TS01, GU01 and MG22 taken from the warps of the three George Kenning examples, and samples VB01 and SM02 taken respectively from the warp and weft of the two George Kenning & Son specimens. All five spectra had a good match with a silk standard (Figure 6.18), detecting the typical strong combination bands of N-H deformation and C-N stretching vibrations around 1620 cm^{-1} associated with primary amides, and around 1515 cm^{-1}, associated with secondary acyclic amides (Cross, 1960, p.66). Both bands have been previously identified through FTIR-ATR analysis in a similar painted banner as amide I and amide II and they are typical of proteinaceous materials (Smith, Thompson and Hermens, 2016, p. 5). Additionally, two medium bands related to silk's fibroin were also detected on all fibre samples at around 1445 cm^{-1} and 1165 cm^{-1}, reported as arising from the side chains vibrations of their alanine and tyrosine content (Zhang and Wyeth, 2010, p. 629). These two bands can be considered characteristic for silk fibres; indeed, they were not detected in the spectra of the rabbit skin glue standard.

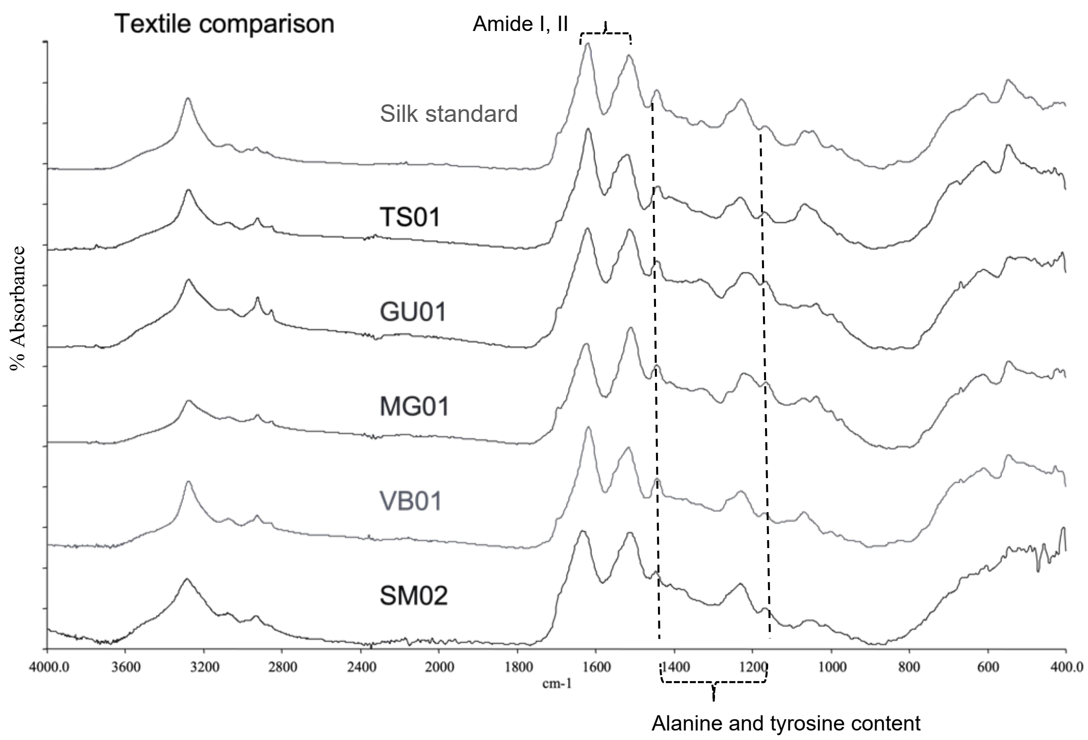


Figure 6.18. Spectra comparison of the textile samples of five Kenning banners with a silk standard, with indication of the amide I and II region at the top, and of the alanine (1445 cm^{-1}) and tyrosine (1165 cm^{-1}) bands throughout.

Although sericin was not looked for in the banner samples due to budget and time constraints, it is inferred that the five silk fabrics were at least partially degummed because: a) individual fibroin brins were seen in their cross-section images instead of silk baves (Figure 6.18 bis), and b) the results with SYPRO® Ruby were visually equivalent to those of the identified degummed reconstruction silk fabric (see sections 5.6.1 and 6.3.5.2).

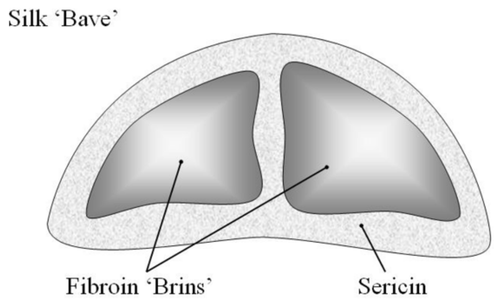


Figure 6.18 bis. Digital drawing of a typical gummed silk bave. Image © Paul Garside.

6.5.2 Size layer

FTIR-ATR analysis detected the presence of a proteinaceous material on the back of samples TS11, TS19, and MG18, taken from the pictorial layers of two George Kenning banners.

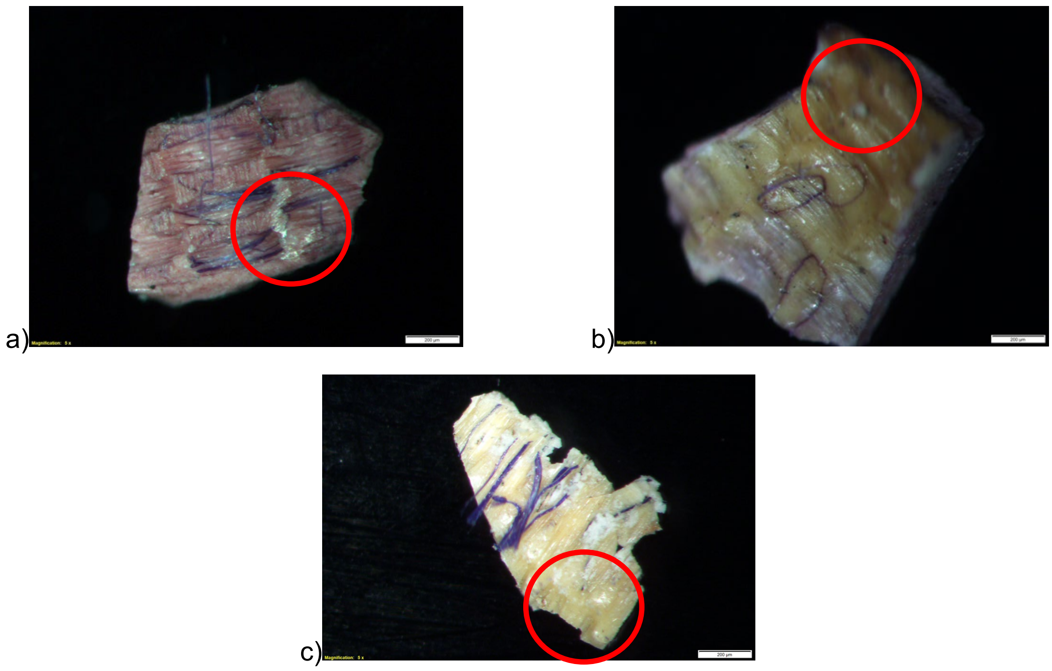


Figure 6.19. Micrographs showing a yellow residue potentially related to the size layer of samples: a) TS11b, b) TS19b and MG18b, seen under Olympus BX41 microscope at 50×. The analyses were performed on the areas without fibres marked with a red circle.

The samples showed the aspect of the paint side and the ground side (when applicable) of one side of the banners. Some textile fibres were embedded within the pictorial materials. From an initial macro and microscopic examination, it was thought that samples TS19 and MG18 had a paint layer on the front and ground layer with a thick residue on top on the back. Such residue was preliminary identified as their potential size (Figures 6.19 b, c). Sample TS11 apparently only presented a paint layer and no ground layer, but it also showed a yellow residue on the back under the microscope (Figure 6.19 a).

The three spectra were compared against a rabbit skin glue standard (Figure 6.20), showing matching bands at 1628cm^{-1}, 1538cm^{-1}, and 1236cm^{-1} associated with the amides of the proteinaceous material (Derrick, et al., 1999, p. 102). Additionally, the three samples showed a medium and broad band centred at 3282cm^{-1} related to N-H content (Cross, 1960, p. 65). This same band showed a different shape in the silk standard, narrower and sharper (Figure 6.20).

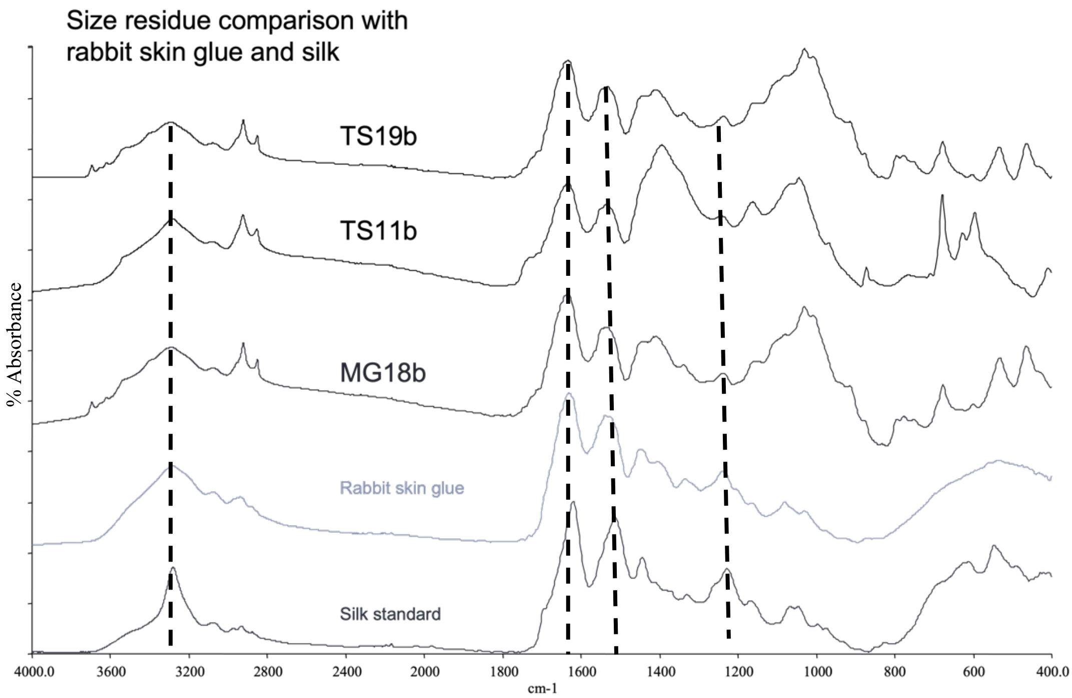


Figure 6.20. Spectra comparison of the size residue samples of *Typographers* and *Millers* banners with a rabbit skin glue and silk standards. Lines indicate the characteristic protein bands around 3282 cm^{-1}, 1630 cm^{-1}, 1532 cm^{-1} and 1236 cm^{-1}.

Although neither of these bands are exclusive to rabbit skin glue, as they are seen in other types of proteinaceous materials (including silk), some evident differences allowed their distinction. Amide I and II peaks were differentiated depending on three characteristics: band position, band shape and band relative intensity (Garside, 2022). In this sense, the characteristic amide I and amide II bands of both proteins showed tangible differences (Figure 6.21):

- Position: Amide I and II bands in the silk samples and standards were located at 1620cm^{-1} and 1515cm^{-1}, while the same bands in the size samples and rabbit skin glue standard were located at 1630cm^{-1} and 1535cm^{-1}.

- Shape: Amide I and II bands in the silk samples and standards showed two narrower pointed peaks, while the same bands in the size samples and rabbit skin glue standard showed broader curved peaks.

- Relative intensity: Amide I and II bands in the silk samples and standards showed similar relative intensity between them, while the size samples and rabbit skin glue standards all showed a higher relative intensity on the amide I band and a lower relative intensity on the amide II bands. This, however, has been reported to shift in extremely damaged silk samples (Serrano et al., 2020, p. 91-100), thus needs to be considered depending on the case.

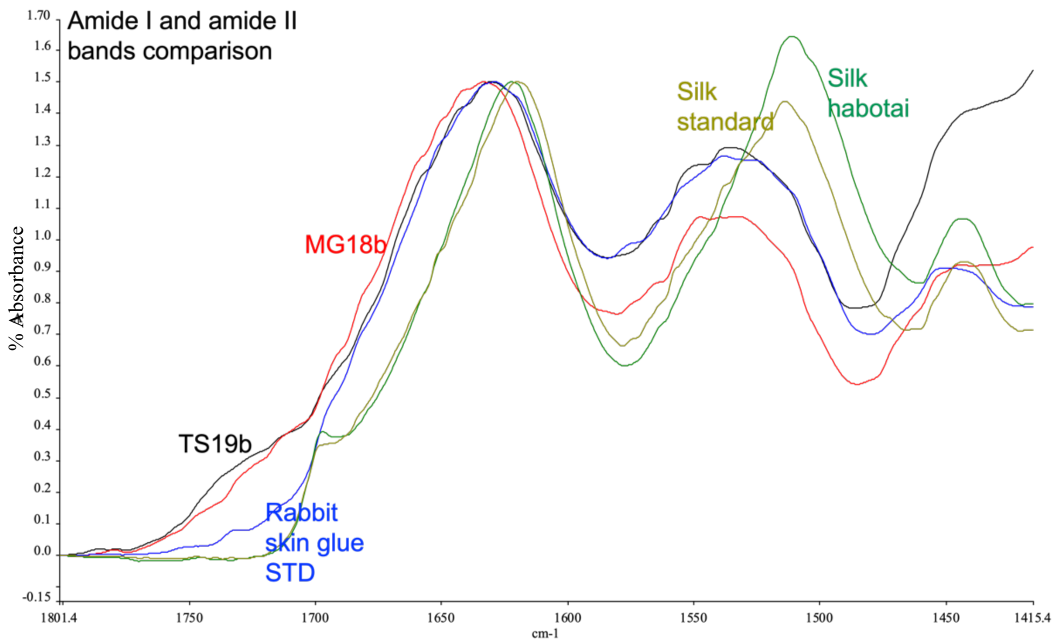


Figure 6.21. Spectra comparison of amide I and II bands in size residue samples TS19b and MG18b with a rabbit skin glue, silk, and silk habotai standards.

The differences in amide I and II peaks helped identifying the size layer residue on the back of samples TS19, TS11 and MG18 as a different kind of protein than silk. In particular, the material was identified as a type of collagen for its proximity with the rabbit skin glue standard. Similarly shaped amide I and II bands were also located on the spectra from the back of samples MG17 and SM23 which showed no apparent size residues under the microscope, indicating a similar presence of proteins potentially related to their size layer (see Appendix III for full results). These results reaffirmed the fluorescent staining finding described in section 6.2.4 of this chapter, confirming the selective application of a collagen-based size layer onto the silk textile in all the areas that were intended to be painted and silvered. The results were compared with areas not painted in which cases only silk was identified. Additionally, the front of samples TS22, MG19, GU25, GU26, VB14A and VB14B had matching bands with the same rabbit skin glue standard. The rabbit skin reference samples provided a useful match for a collagen glue but not for the type of protein, thus indicating the use of a similar protein as that of the size layer for other purposes. This is further explained in section 6.4.5.

6.5.3 Ground layer

Due to the complex stratigraphy of the samples, identifying the composition of the ground layer was not straightforward. Amongst the reported factors limiting the interpretation of infrared spectroscopy in artworks there are the low quality and weak absorption obtained from the microsamples, the simultaneous presence of organic and inorganic materials with overlapping peaks, as well as the lack of homogeneity of the samples (Sarmiento et al., 2011, pp. 3602-3603). All these factors were applicable to the banners' samples.

Spectra collected from the analysis of the ground layer in the five samples are depicted in Figure 6.7. Samples TS19b and MG18b showed the protein-related bands that were identified for the size layer residues, as well as other bands indicating such mixture of materials. The IR spectrum of sample GU26b is similar to that of sample VB27b, thus suggesting a similar composition. Sample SM24b differed slightly from the rest, although showed closer relation to the *Upholsterers* and *Vehicle Builders* samples.

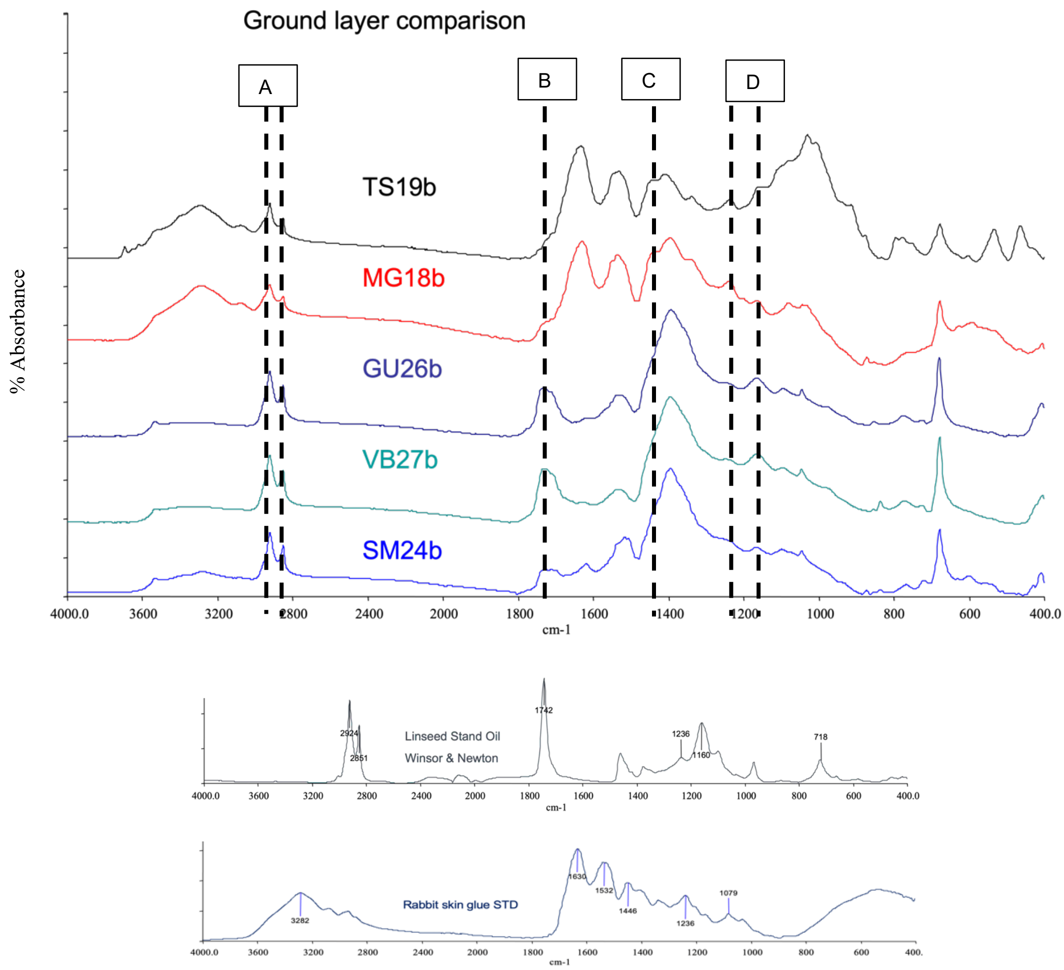


Figure 6.22. Spectra comparison of the ground layer samples of five Kenning banners. Characteristic bands for linseed oil are indicated as follows: A, 2927cm^{-1} and 2853cm^{-1}; B, 1746cm^{-1}; C, 1460cm^{-1}; D, 1239cm^{-1} and 1164cm^{-1}. Bottom spectra are of linseed oil and rabbit skin glue standards used.

Table 6. 21. Interpretation of infra-red spectroscopy parameters of linseed oil standard, based on Derrick, 1989, p.46; Rohman and Che Man, 2010, p. 888; Cross, 1960, p. 50-75.

Material	Main group(s)	Frequency (cm^{-1})	Type of vibration
Linseed oil	Aliphatic, ester	2927 s	Asymmetrical and symmetrical stretching vibration of methylene (-CH_2) group
		2853 s	Asymmetrical and symmetrical stretching vibration of methylene (-CH_2) group
		1746 s	Stretching of the ester carbonyl functional group of the triglycerides
		1460 m	Bending vibrations of the CH_2 and CH_3 aliphatic groups
		1239 m	C-O stretching ester
		1164 s	C-O stretching ester

For the identification of the type of organic binder in the ground layer samples, the acquired spectra were compared against reference standards (Figure 6.22), identifying an oil most likely to be linseed oil, based on the historical portray of double-sided painted silk banners described in Chapter 3. The parameters were compared with those reported in the literature for oils in general and linseed oil in particular (Derrick, 1989, p.46; Rohman and Che Man, 2010, p. 888; Cross, 1960, p. 50-75), obtaining a table that defined the characteristic bands (Table 6.21).

For the identification of linseed oil, the reported very strong peaks due to the stretching of CH_2 group, were detected at around 2920cm^{-1} and 2850cm^{-1} (Smith, Thompson and Hermens, 2016, p. 6). Another diagnostic peak for oils is the one centred at 1746cm^{-1} due to the stretching of the ester carbonyl functional group (Cross, 1960, p. 64). Two other characteristic bands associated to the C-O stretching of the esters were located around 1239 cm^{-1} and 1164 cm^{-1}, whilst a medium band located around 1460 cm^{-1} indicated the bending vibrations of the CH_2 and CH_3 aliphatic groups (Figure 6.22).

For the identification of the inorganic materials in the ground layer samples, the spectra were compared against the selected reference standards (Figure 6.17), finding a close match with lead white, $2PbCO_3{\cdot}Pb(OH)_2$, and some correspondences with calcium carbonate, $CaCO_3$ (Figures 6.23 and 6.24). The spectra of the five ground layer samples corresponded with characteristic bands reported for both types of carbonates (Smith, Thompson and Hermens, 2016, p. 7). For the lead white, the CO_3^{-2} bands were located around 1393cm^{-1} and around 680cm^{-1}, while calcium carbonate were around 1437cm^{-1} and 872cm^{-1}.

Samples SM17f and SM24f appeared to show peaks that could be assigned to metal soap formation, particularly lead soaps expected to show a strong band in the approximate region of 1508-1513 cm^{-1} (Izzo et al., 2021, p. 913), also reported for painted banners by Smith et al. (2016, p.7). However, after a closer look, only sample SM17f had a weak peak at 1515 cm^{-1} (see Appendix 9.3.1.8), with the other expected bands resulting from a lead soap being impossible to be observed without significant spectral processing and deconvolution due to the sample complexity (Garside, personal communication, 2023). FTIR imaging in conjunction with SEM-EDX is recommended for future research.

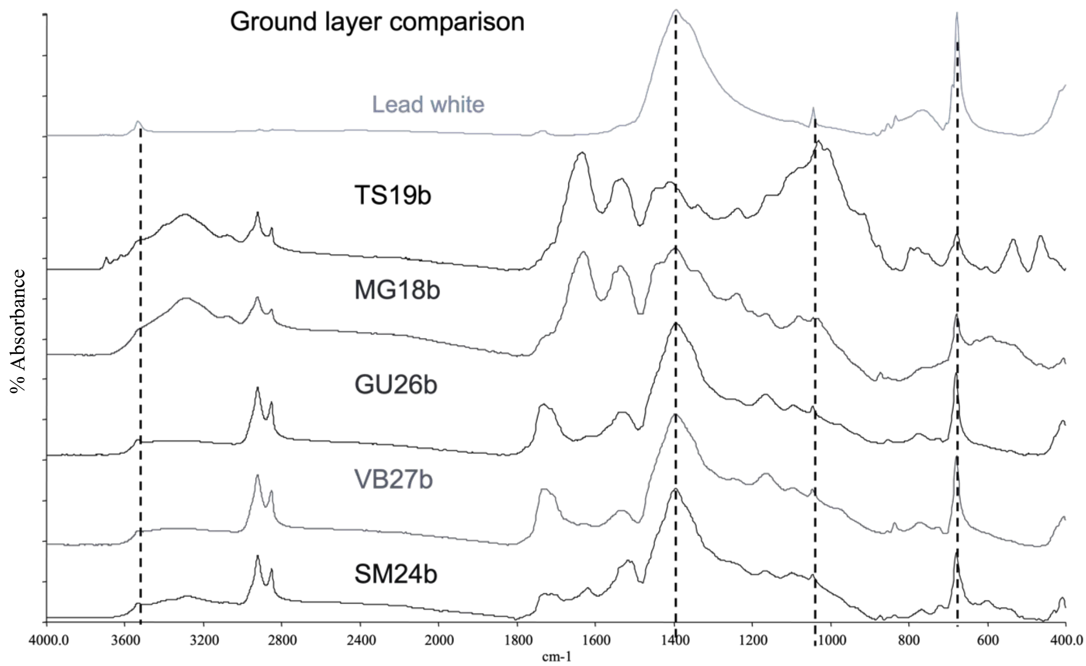


Figure 6.23. Spectra comparison of the ground layer samples of five Kenning banners with a lead white standard, with indication of coinciding characteristic bands throughout.

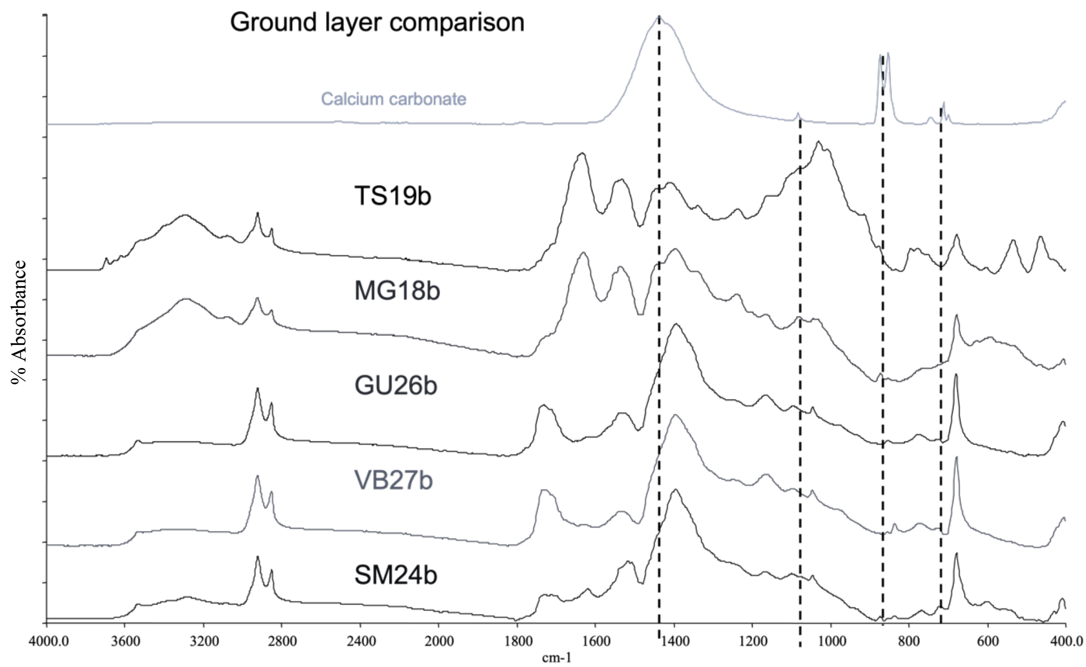


Figure 6.24. Spectra comparison of the ground layer samples of five Kenning banners with a calcium carbonate standard, with indication of coinciding characteristic bands throughout.

Due to the complex spectra acquired, it is only possible to confirm the use of linseed oil as binding media and lead white as the main inorganic component. The identification of calcium carbonate in the ground layer required a more punctual analysis for confirmation, which was conducted on other comparable samples with SEM-EDX (see section 6.5).

6.5.4 Coloured glazes

Four different coloured glazes were sampled from the five Kenning banners of Glasgow Museums and analysed: a golden, a red, a yellow, and a purple glaze. Although they all showed similar colour and texture when observed through optical microscopy (Figures 6.25 a-e, 6.26 a-c, 6.27 a,b and 6.28 a-d), a variety of organic binders was detected in their FTIR-ATR spectra. Given the thinness in comparison to the paint layers, the identification of inorganic materials in the glazes was not pursued as it would not be possible to distinguish their signals from those of the underlying ground.

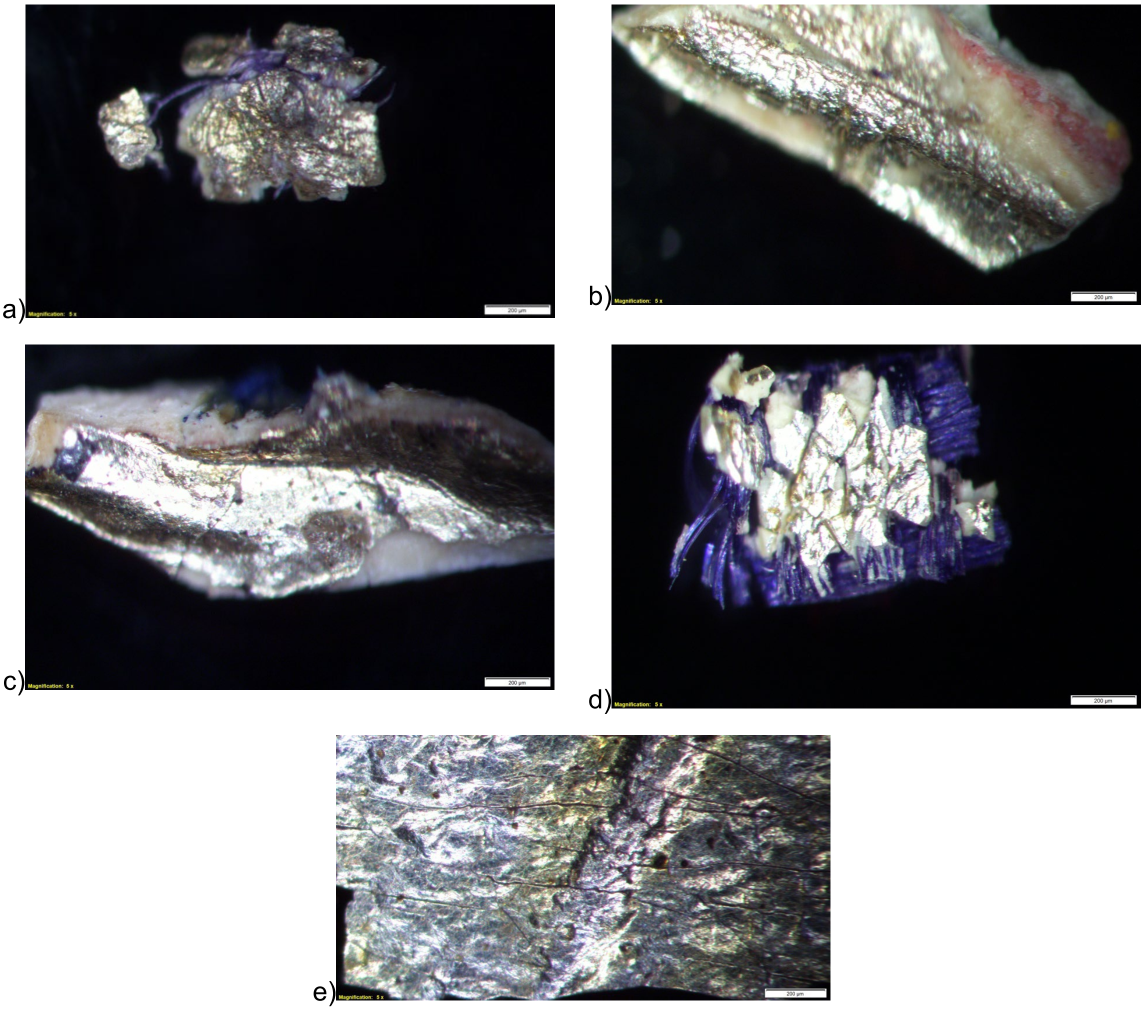


Figure 6.25. Golden glaze samples seen under Olympus BX41 microscope at 50×: a)TS22f, b)MG19f, c)GU26f, d)VB14A, and e)SM23f.

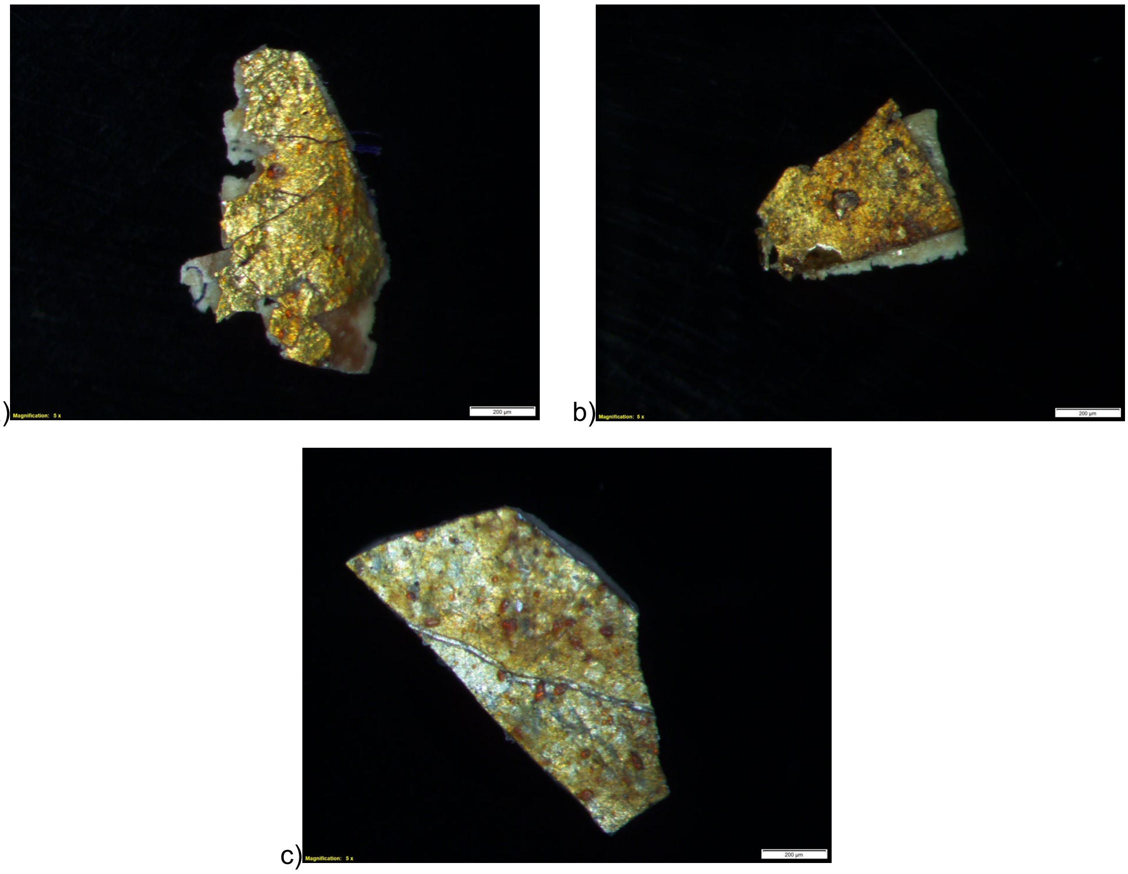


Figure 6.26. Yellow glaze samples seen under Olympus BX41 microscope at 50×: a)MG18f, b)GU25f, and c)SM24f.

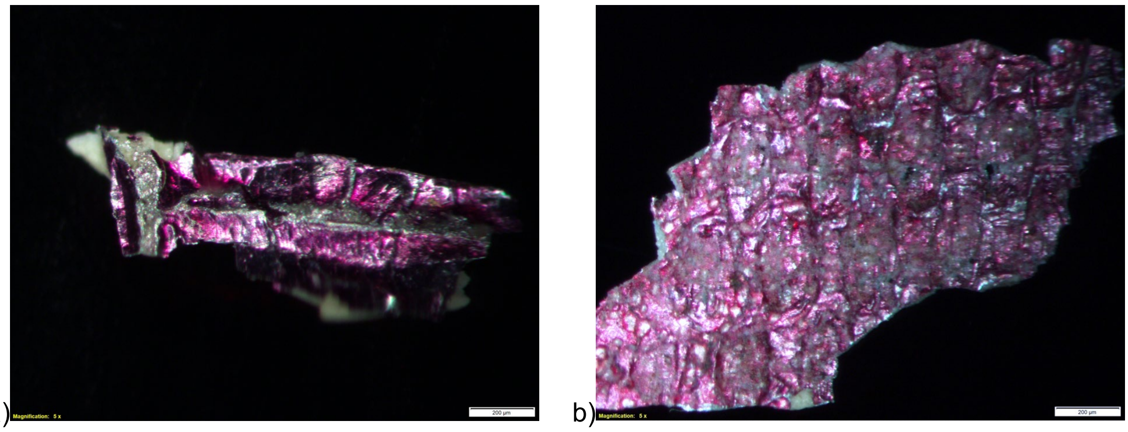


Figure 6.27. Purple glaze samples seen under Olympus BX41 microscope at 50×: a)VB27f, b)SM25f.

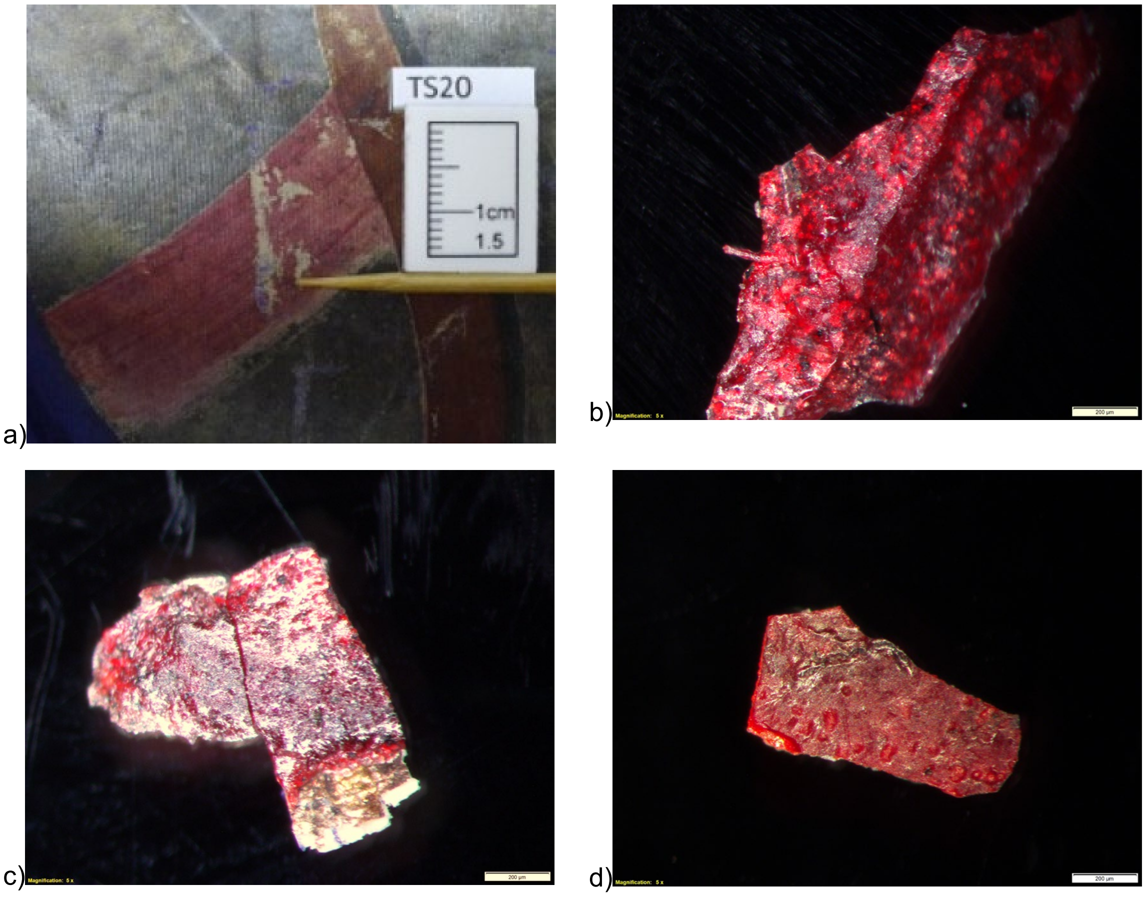


Figure 6.28. Red glaze samples seen under Olympus BX41 microscope at 50×: a)TS20f*, b)MG17f, c)GU24f , and d)SM29f. *Unfortunately the micrograph files of sample TS20f got corrupted and lost.

All but one of the golden glaze samples showed similar spectra, on which two kinds of organic materials were identified: proteinaceous and resinous (Figure 6.25). The characteristic amide I and II bands of proteins were clearly seen in sample spectra TS22f, MG19f, GU26f and both sides of cross-section sample VB14 (A and B). This indicated a protein-based coating, likely related to the suggested isolation layer to prevent the tarnishing of the silver leaf (Kelly, 1911). It is underlined that the use of such isolating layer has also been detected in coloured glazes on metal leaf of the Baroque and Rococo periods in Germany (Emmerling, et al., 2013). Additionally, two double bands identified at 1239cm^{-1} and 1177cm^{-1} indicated the presence of rosin resin in the surface. These bands were seen in the reference standard (Figure 6.29) and were more noticeable in spectra VB14A and VB14B.

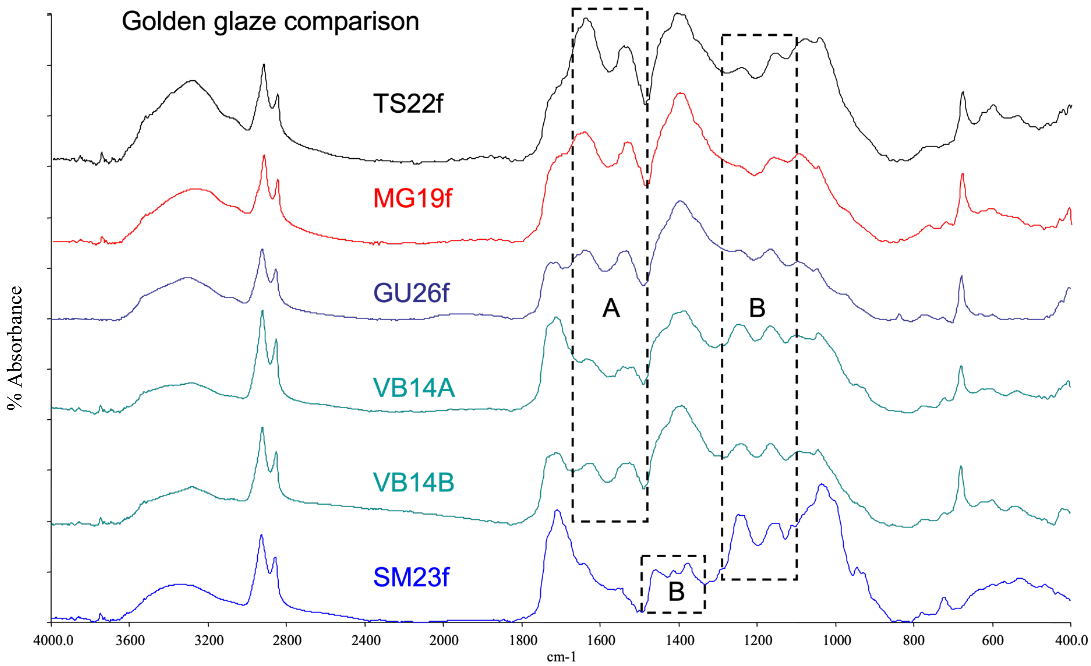


Figure 6.29 Spectra comparison of the golden glaze samples of banners the *Typographers*, *Millers*, *Vehicle Builders*, and *Metal Workers*. Area A indicates protein's amide I and II bands; area B indicates the paired bands seen in the rosin resin standard that are not seen in linseed oil.

In comparison, spectrum SM23f showed a very close coincidence with the rosin resin standard, clearly presenting the aforementioned double bands, plus other two at 1454cm^{-1} and 1381cm^{-1} (Figure 6.29). To aid with the interpretation of the material, the characteristic bands of mastic and rosin resins are described in Table 6.22. Importantly, the typical peaks of the resinous materials differ from those of the linseed oil (Table 6.21).

The sole identification of resin rosin in the golden sample of the *Metal Workers* banner and no proteinaceous coating over its metal leaf, indicates a change of technique with respect to the other golden glaze examples. The substitution made sense given that the metal leaf identified in the banner was aluminium and not silver (see section 6.5.3), which would not need an isolation coating due to its non-tarnishing nature.

Table 6.22. Interpretation of infra-red spectroscopy parameters of standards of rosin and mastic/dammar resins, based on Cross, 1960, p. 50-75.			
Material	Main group(s)	Characteristic wavelengths	Type of vibration
Rosin resin	Aromatic, carboxylic acid	2932 m	Asymmetrical and symmetrical stretching vibration of methylene (-CH_2) group
		1702 s	Unsaturated aldehyde C=O stretching vibrations
		1692 s	C=O stretching in carboxylic acid
		1384 s	C-H deformation vibrations of $C(CH_3)_2$ groups (alkane)
		1236 s	CO_2H vibrations (carboxylic acid)
Mastic/Dammar resin	Aromatic, aldehyde	2940-2930 m	Asymmetrical and symmetrical stretching vibration of methylene (-CH_2) group
		2872-2968 m	Asymmetrical and symmetrical stretching vibration of methylene (-CH_2) group
		1456-1454 m	Asymmetric deformation of C-CH_3 groups (alkane)
		1380-1378 m	Aryl aldehyde C-H bending

The yellow glazes identified in samples GU25f, MG18f and SM24f all gave a good match with the linseed oil standard (Figure 6.30), thus indicating the presence of such material as the main binder. Both spectra from the two George Kenning banners of the *Millers* and *Upholsterers* also showed indications of the amide I and II bands of the proteinaceous coating, whilst the *Metal Workers* sample lacked such bands. This might indicate that George Kenning & Son's banner technique seemed to abandon the proteinaceous coating at least from the year of manufacture of the *Metal Workers* banner c.1916. Further analysis of contemporary, previous, and later banners from that moment of the company (1895-1937) would be needed to confirm the latter.

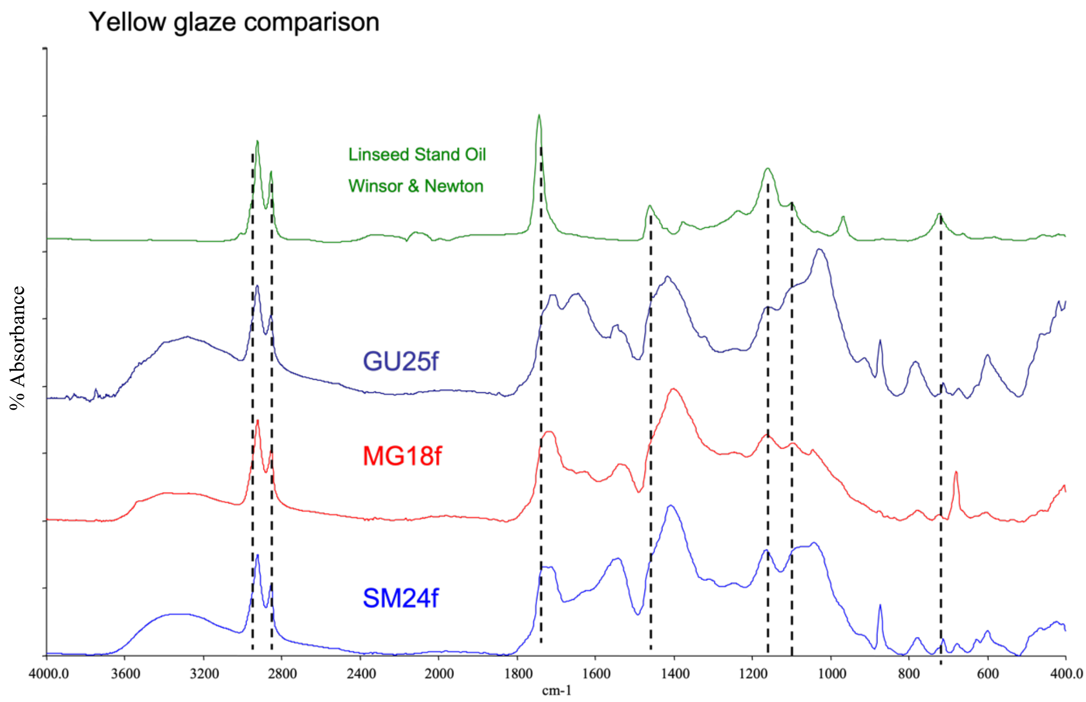


Figure 6.30. Spectra comparison of yellow glaze samples of banners of the *Upholsterers*, *Millers*, *Metal Workers*, and a linseed oil standard, with indication of coinciding bands throughout.

The spectra comparison of the red glazes showed coincidences mostly with the linseed oil standard, suggesting its presence as the main binder of the coloured coatings on the metal leaves (Figure 6.31). The comparison with both of the natural resin standards was inconclusive, as signals from other materials absorbing in the region of interest possibly mask those related to the resins. The identification of the potential organic red lake preliminarily detected through UV inspection, both macroscopically and microscopically, could not be determined as it would have required a spectroscopic approach able to investigate also the far-infrared range (600-10 cm^{-1}) (Schiering et al., 2018).

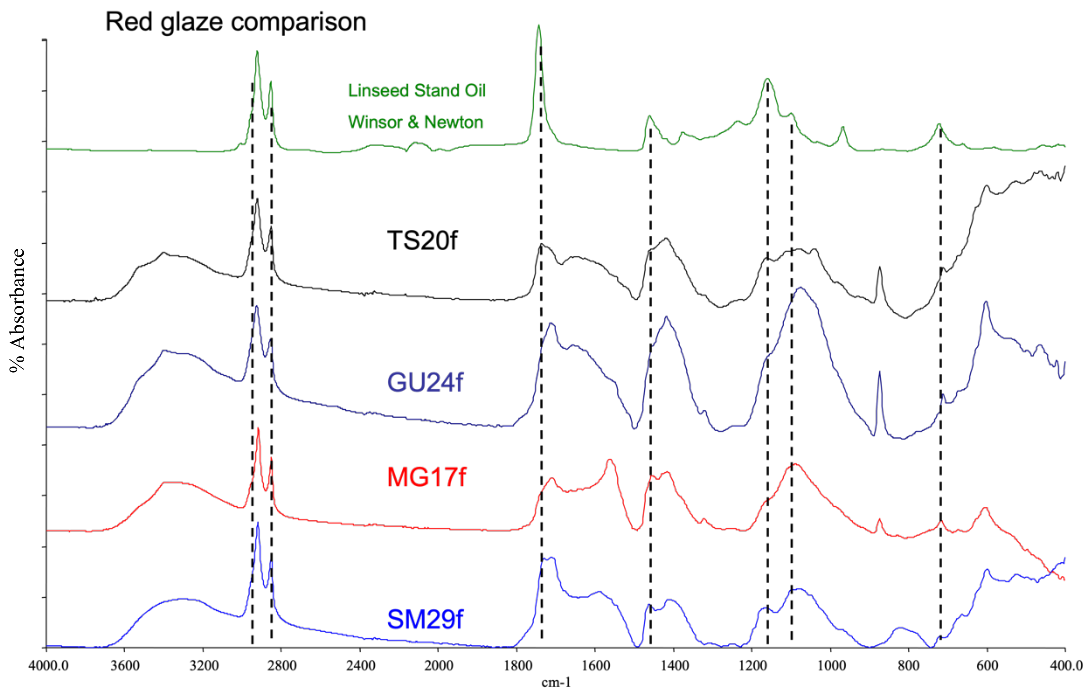


Figure 6.31. Spectra comparison of the red glaze samples of banners of the *Typographers*, *Upholsterers*, *Millers*, and *Metal Workers*.

Finally, the purple glaze on samples VB27f and SM25f showed some similarities with the rosin resin standard. While in the case of the *Vehicle Builders*' samples there is a strong spectral match, the identification of the resin in the sample from the *Metal Workers* banner is unsure (Figure 6.32). Again, the presence of other bands related to lead and calcium carbonate, possibly masked the peaks from either type of natural resins or linseed oil. The presence of such bands was also difficult to distinguish from the ground layer, thus reiterating the need for a mapping technique such as FTIR Imaging, as recommended by Emmerling et al. for coloured glazes on metal leaf (Emmerling et al., 2013). It was impossible to determine if the purple was achieved with a specific colorant or if it was a mixture of red and blue.

FTIR spectrum of the coloured glazes were not compared against standards of organic colorants due to the impossibility of distinguish them from the complex mixture of materials in the banners' samples. The same approach was followed for coloured pigments.

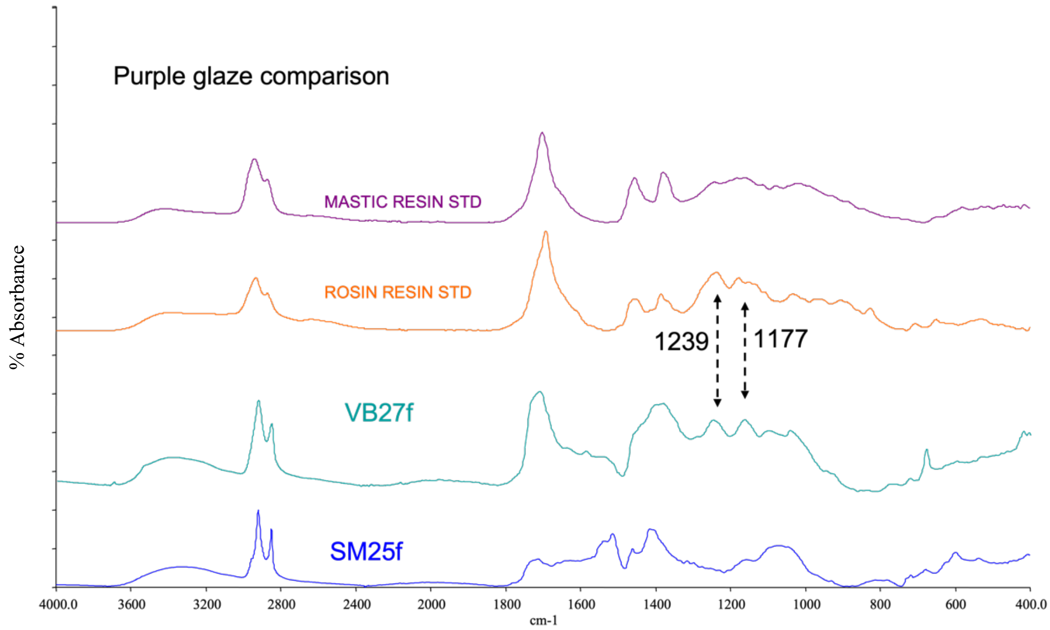


Figure 6.32. Spectra comparison of the purple glaze samples of banners VB and SM.

6.5.5 Paint layer

The identification of the paint samples was as difficult as that of the ground layer samples previously described. The acquired spectra gave partial matches with the selected reference standards (Figures 6.16 and 6.17) due to the presence of both organic and inorganic materials in the mixture. For the identification of the binder media, the spectra were compared with the linseed oil standard, locating four coinciding peaks around 2920cm^{-1}, 2850cm^{-1}, 1740cm-1 and 1160cm^{-1} (Figure 6.33). The spectra were also compared against the rosin and mastic resins standards, but the results were not conclusive.

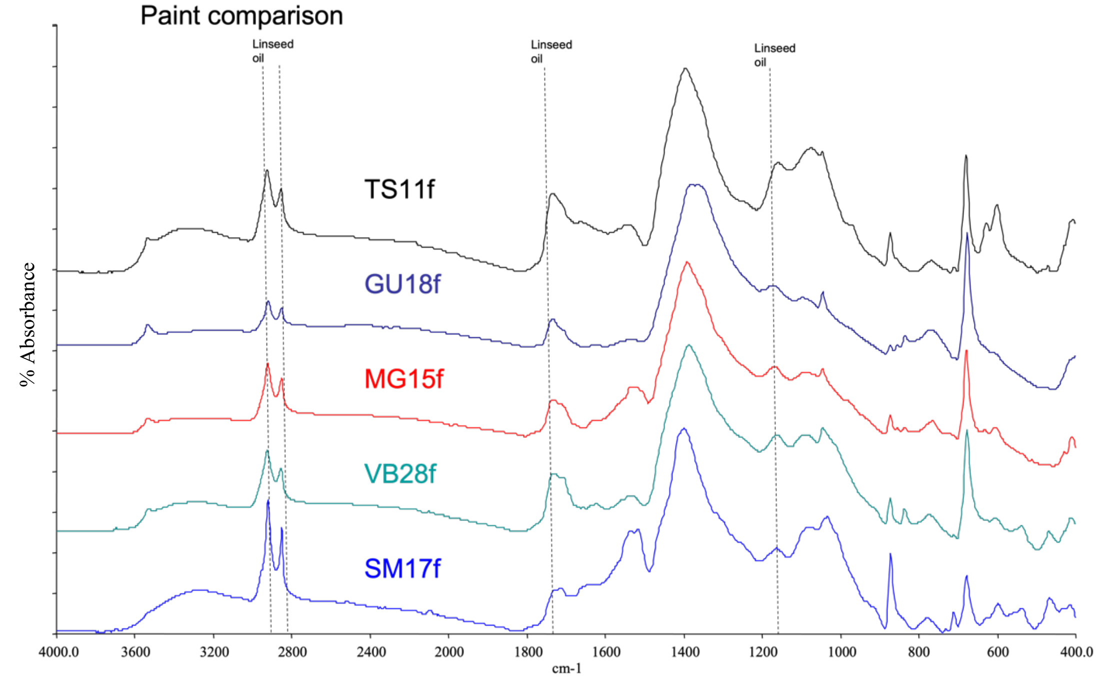


Figure 6.33. Spectra comparison of the paint samples of five Kenning banners with indication of coinciding characteristic bands associated with linseed oil.

For the identification of inorganic materials, the spectra comparisons of the five paint samples showed very strong bands in the region between 1410-1450 cm^{-1}, indicating the presence of carbonates (Figure 6.34) (Cross, 1960, p. 75). All five paint samples also showed the characteristic peak around 680cm^{-1}associated to lead carbonate (Smith, Thompson and Hermens, 2016, p. 7), as well as a coinciding peak with the lead white standard located at 3535 cm^{-1}. Contrary to the ground samples, the comparison with calcium carbonate showed a better coincidence with the paint samples' spectra and the used standard, clearly locating the double peak at 873cm^{-1} and 853cm^{-1} in samples GU18f, MG15f and VB28f, indicating its mixture within the paint layer. A third inorganic compound, barium sulphate, was also detected in the five paint samples, with sample TS11f showing the best match (Figure 6.11). This material has been reported as one of the three common fillers in nineteenth century oil paints, along the aforementioned calcium carbonate and gypsum (Sanches, et al., 2017, p. 201). The material was identified by the strong sulphate band located between 1080cm^{-1} and 1130cm^{-1} (Cross, 1960, p. 75), as well as a double peak located in the selected standard at 632cm^{-1} and 601 cm^{-1} (Figure 6.17). Contrastingly, no coincidences with the calcium sulphate standard were found, thus ruling out the detectable presence of such material in the mixture.

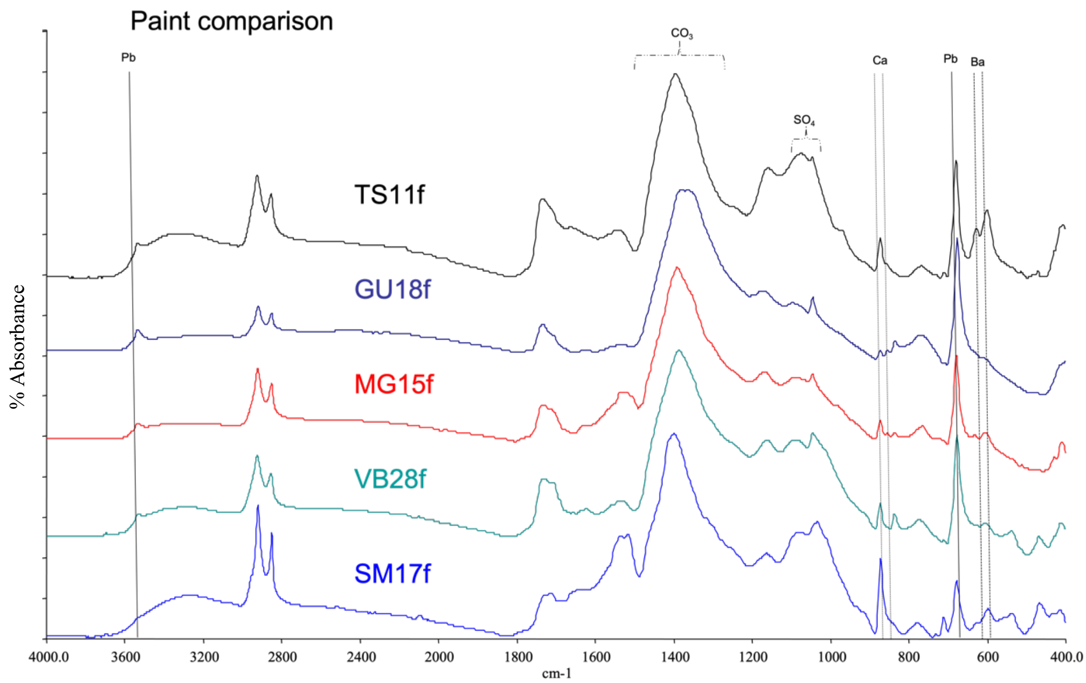


Figure 6.34. Spectra comparison of the paint samples of five Kenning banners with indication of carbonates (CO_3^{2-}) and sulphates (SO_4^{2-}) regions, as well as two characteristic bands associated to lead carbonate, calcium carbonate and barium sulphate indicated with the respective cation (Pb^{2+}, Ca^{2+} and Ba^{2+}).

Hence, according to the FTIR-ATR analysis, the paint layer of the five samples contains a mixture of linseed oil, lead carbonate, calcium carbonate and barium sulphate. Given that sample TS11 without ground layer had the same results as the front of samples GU18, MG15, VB28 and SM17, it was interpreted that the mixture with barium sulphate was related to the paint and not the ground layer, very likely as a filler (Sanches et al., 2017, 201-211). However, these results were in contrast with those from the SEM-EDX analysis, where barium was also found in the ground layers in variable weight percentages (see section 6.5).

A summary of the main results per banner is presented in table 6.3.

Table 6.23. Summary of FTIR-ATR results of the five Kenning banners of Glasgow Museums Collection.

Banner	Textile	Size	Ground	Paint	Golden glaze	Yellow glaze	Red glaze	Purple glaze
Typographers	S	CO	LO LC	LO LC CC BS	CO RR	Not detected	LO	Not detected
Upholsterers	S	Not detected	LO LC	LO LC CC BS	CO RR	LO	LO	Not detected
Millers	S	CO	LO LC	LO LC CC BS	CO RR	LO	LO	Not detected
Vehicle Builders	S	Not detected	LO LC	LO LC CC BS	CO RR	Not detected	Not detected	RR
Metal Workers	S	CO*	LO LC	LO LC CC BS	RR	LO	LO	Not detected

(S) silk, (CO) collagen glue, (LO) linseed oil, (LC) lead carbonate, (CC) calcium carbonate, (BS) barium sulphate, (RR) rosin resin. *Only detected on the back of scroll sample SM23b.

6.6 SEM-EDX results of the five Glasgow Museums banners

A total of 10 cross-section samples from the five Kenning banners of Glasgow Museums Collection were documented through SEM and analysed with the coupled EDX. Five samples from the silvered scrolls (Figures 6.35 a, b, c; 6.36 a, b) and five from the central paintings (Figures 6.37 a, b, c; 6.38 a, b). Additionally, two representative sections of sides A and B of each sample were selected for remote punctual identification and elemental mapping through Aztec software. The following section describes the interpretation of these results, ordered according to the type of layer as follows: size layer, ground layer, metal leaf layer, paint layer and coloured glazes. The results in full are included in Appendix III. Technical Analysis.

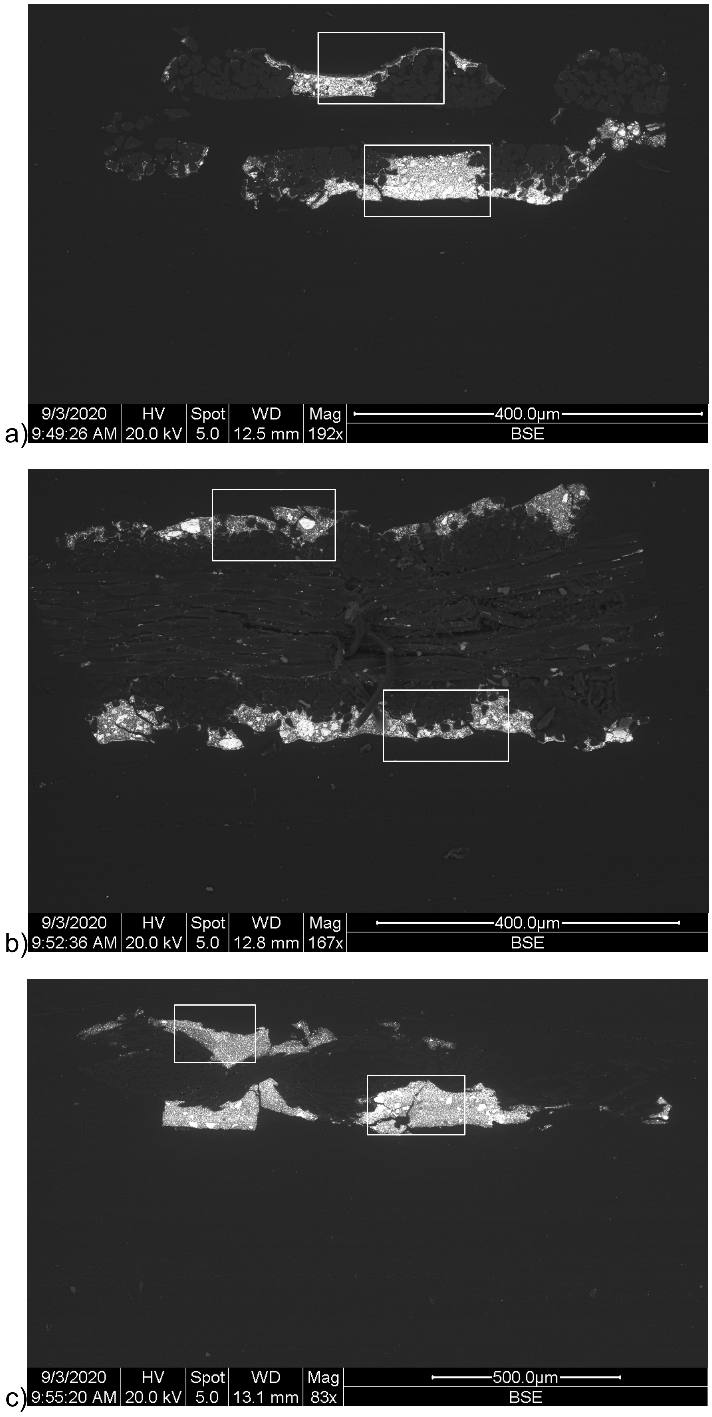
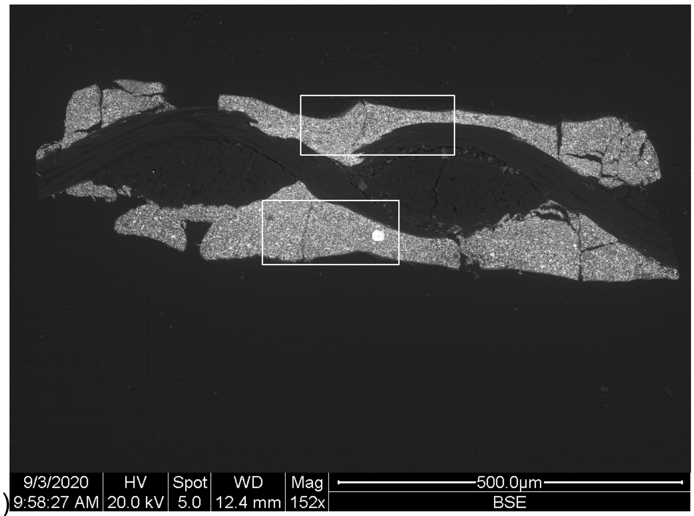
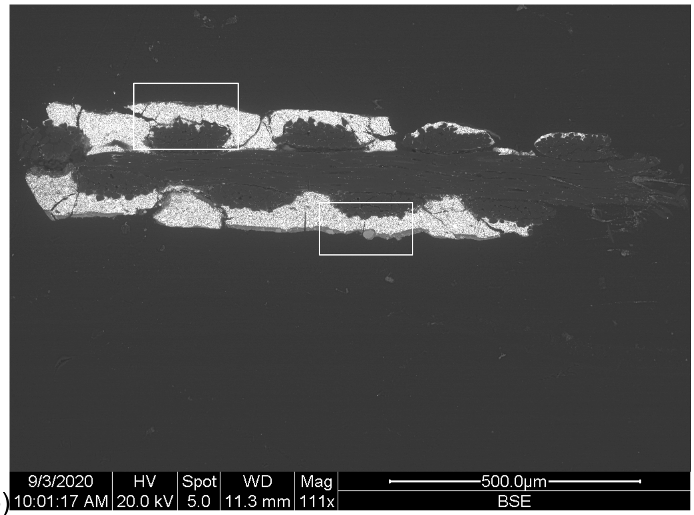


Figure 6.35. BSE images of metallic scrolls cross-sections of the three George Kenning banners (backscattered electron images, Carl Zeiss Sigma SEM): a) sample TS08 at 192×, b) sample GU08 at 167×, c) MG26 at 83×. * Areas inscribed in rectangles were selected for punctual EDX analysis and elemental mapping.



a)



b)

Figure 6.36.BSE images of metallic scrolls cross-sections of the two George Kenning & Son banners (backscattered electron images, Carl Zeiss Sigma SEM): a) sample VB11 at 152×, b) sample SM21 at 111×. *Areas inscribed in rectangles were selected for punctual EDX analysis and elemental mapping.

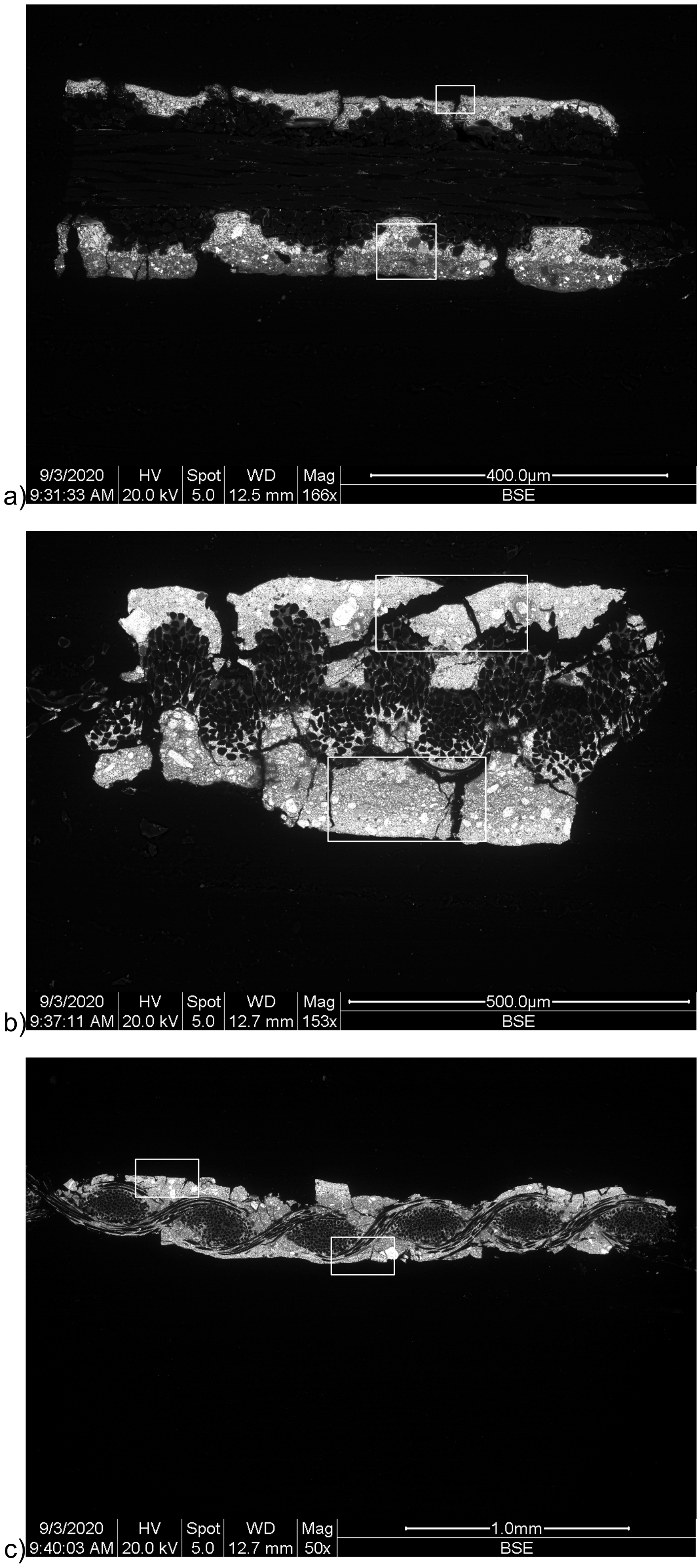
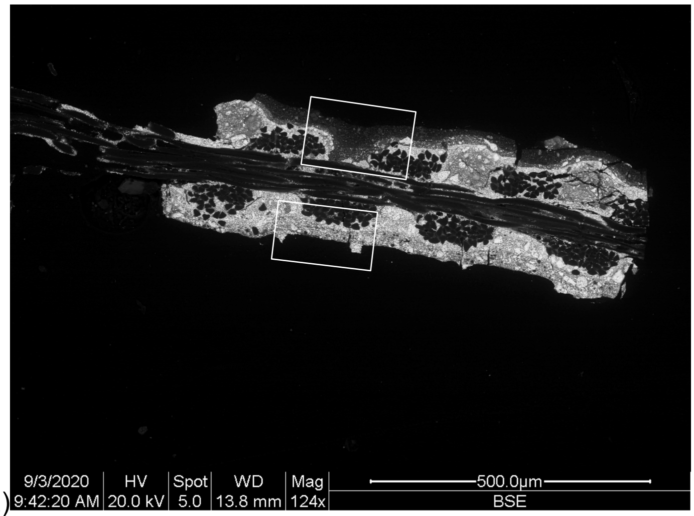
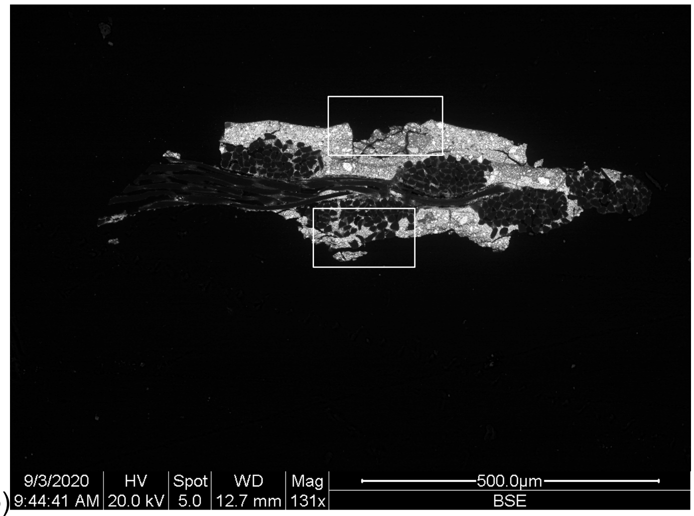


Figure 6.37. BSE images of central painting cross-sections of the three George Kenning banners (backscattered electron images, Carl Zeiss Sigma SEM): a) sample TS40 at 166×, b) sample GU09 at 153×, c) MG10 at 50×. *Areas inscribed in rectangles were selected for punctual EDX analysis and elemental mapping



a)



b)

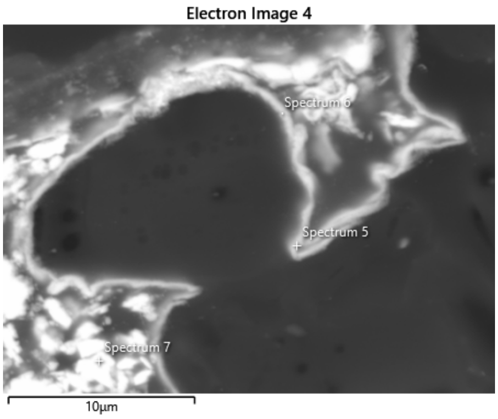
Figure 6.39. BSE images of central paintings cross-sections of the two George Kenning & Son banners (backscattered electron images) sample VB12 at 124× and sample SM16 at 131×, Carl Zeiss Sigma SEM. * Areas inscribed in rectangles were selected for punctual EDX analysis and elemental mapping.

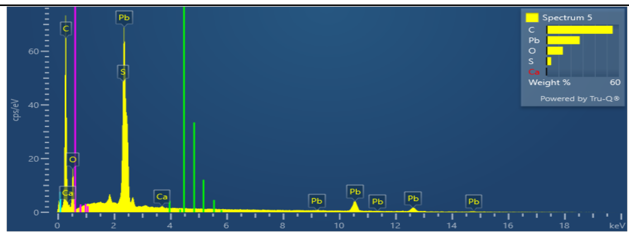
6.6.1 Size layers

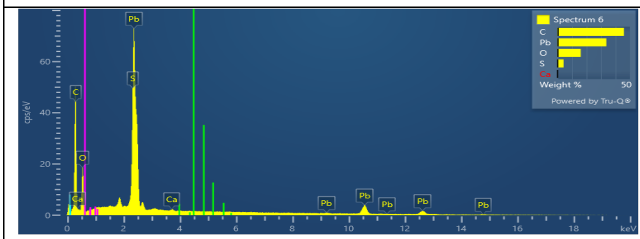
The backscattered electron image showed a dense material dissolved into the proteinaceous size layer (Tables 6.24, 6.25, and Appendix III for full results). The point analysis in spectra 5 and 6 detected mostly carbon (organic layer), sulphur (possibly associated with the collagen), and lead. An adjacent particle was analysed for comparison in spectrum 7, only identifying lead oxide content. This suggests that the lead content detected in the size layer could be of a different source than that of the ground, thus intentionally added to the mixture. These size layers show a homogeneous white tone in the BSE images, suggesting the solubilisation of lead into them prior application. Such lead-containing size layer was only detected in 6 cross-section samples: TS08, TS40, GU08, MG26, VB11 and SM26. In the remaining 4 samples, such white line was not seen.

A darker shade of grey indicating an organic material was seen between the yarns of samples GU09, MG10, VB12 and SM16 (Table 6.26 and Appendix III for full results). Although such material also contained lead in the corresponding EDX point analyses, it was proportionally less than that detected in the lead-containing size layers. Thus, it was interpreted as a lead-containing linseed oil that seeped into the textile from the ground. This could have been either for lacking size layer (i.e., sample SM16) or for other reason (e.g., possible yarn separation due to taut stretching of the textile), as samples GU09, MG10 and VB12 all had a positive staining with SYPRO® Ruby (see section 6.2.4).

Table 6.24. BSE close up of lead-containing size layer from metallic scroll cross-section sample TS08 side A (backscattered electron image, Carl Zeiss Sigma SEM), with corresponding EDX spectra 5, 6 and 7 as located in the electron image.







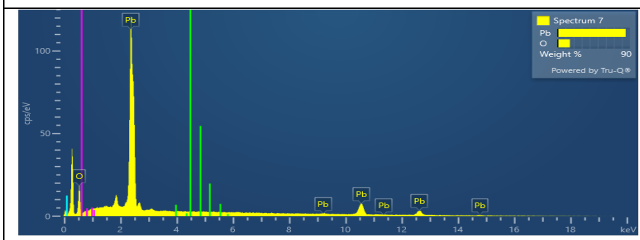


Table 6.25. BSE close up of lead-containing size layer from metallic scroll cross-section sample GU08 side B (backscattered electron image, Carl Zeiss Sigma SEM), with corresponding EDX spectra 8 and 9, located in the electron image.

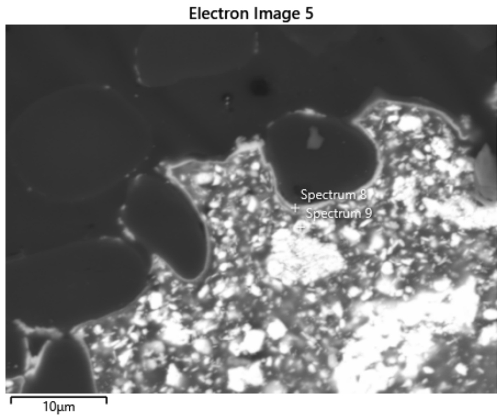
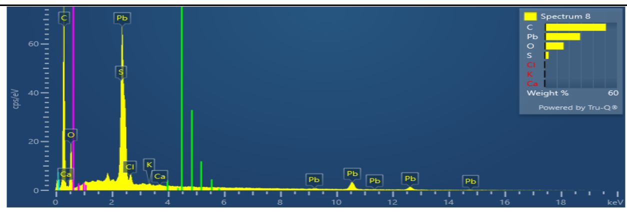
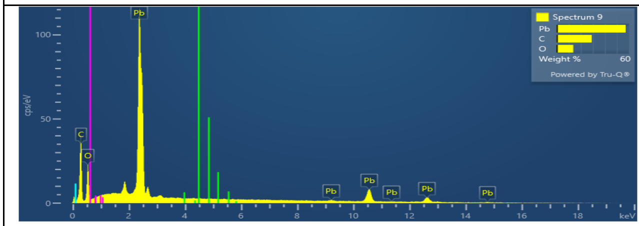
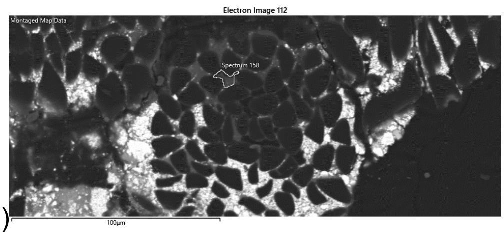
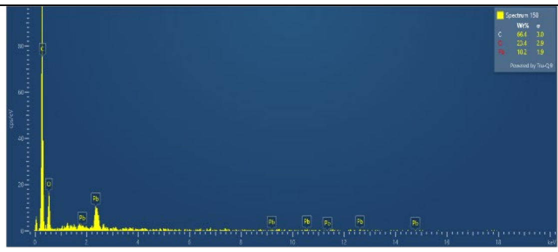
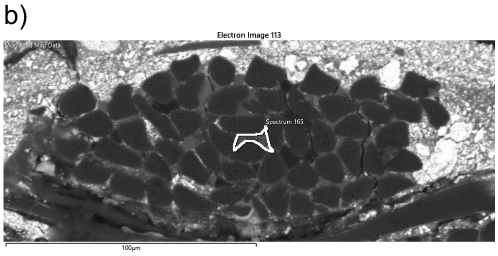
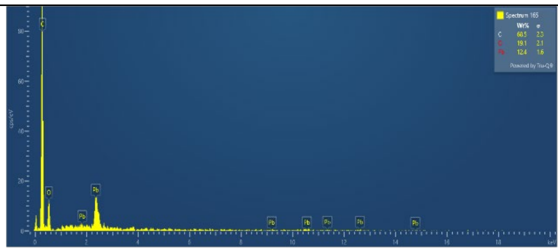
<table>
<tr><td rowspan="2">
</td><td>
</td></tr>
<tr><td>
</td></tr>
</table>

Table 6.26. BSE close up of lead-containing size layer from metallic scroll cross-section of samples: a) GU09 side B and b) SM16 side A (backscattered electron image, Carl Zeiss Sigma SEM), with corresponding EDX spectra 158 and 165 as located in each electron image.

<table>
<tr><td>a) 
</td><td></td></tr>
<tr><td>b) 
</td><td></td></tr>
</table>

6.6.2 Ground layers

The EDX analysis showed a predominant content of lead in the ground layers of all five banners, with variable traces of barium, sulphur and calcium scattered at different weight percentages (Tables 6.27 and 6.28). Only the VB samples showed an exclusive content of lead, carbon, and oxygen, thus interpreting pure lead carbonate in their ground layer. The remaining samples were identified as a mixture of pigment and extenders, having lead carbonate hydroxide ($2PbCO_3.Pb(OH)_2$, the synthetic analogue material of cerussite (Eastaugh, et al., 2004, p.843)) the main component; with added barium sulphate ($BaSO_4$), a common extender pigment and therefore encountered in numerous contexts (Eastaugh, et al., 2004, p. 809), as well as chalk or calcium carbonate ($CaCO_3$) of synthetic source, due to the lack of coccoliths in the samples (Young et al., 1997, 819) and the lack of coincidence between the Ca and S single element maps (see Appendix III).

Table 6.27. Ground composition weight percentages of the scrolls' cross-section samples

Banner sample code	Side A			Side B		
	Lead	Calcium	Barium	Lead	Calcium	Barium
TS08	28%	0	0	49.50%	0	0
GU08	31.90%	0	0	38.50%	0.10%	0
MG26 (layer a)	17.10%	0	0	19%	0.70%	0
MG26 (layer b)	37.10%	0.10%	0.05%	26.30%	0	0.05%
VB11	44.40%	0	0	40.80%	0	0
SM21	56.40%	0.05%	1%	28.40%	0	0.90%

Table 6.28. Ground composition weight percentages of the central paintings' cross-section samples

Banner sample code	Side A			Side B		
	Lead	Calcium	Barium	Lead	Calcium	Barium
TS40	34.60%	1.10%	14.50%	24.50%	2.20%	2.80%
GU09	30.80%	0.10%	0	47.40%	0.50%	1.50%
MG10 (layer a)	30.20%	0.40%	0	30.10%	1.40%	0
MG10 (layer b)	50.20%	1.40%	1%	20.80%	0.50%	0.50%
VB12	44.70%	0	0	46.70%	0	0
SM16	50%	0.05%	0.05%	28.80%	0	0

The content of lead carbonate in the ground layers seemed to be purer in the scroll samples than in the central paintings, possibly due to its use as gold-size for adhering the metal leaves as explained in Chapter 3. A different finding was the double layout of the ground layers on both samples of *The Grain Millers of Glasgow* banner. Previously noticed with optical microscopy as two different granulometries (coarse and fine), two different layer thicknesses and apparently two different degrees of compactness (Figure 6.40 a, b), EDX weight percentages showed a slight difference in composition (Tables 6.27 and 6.28).

a)

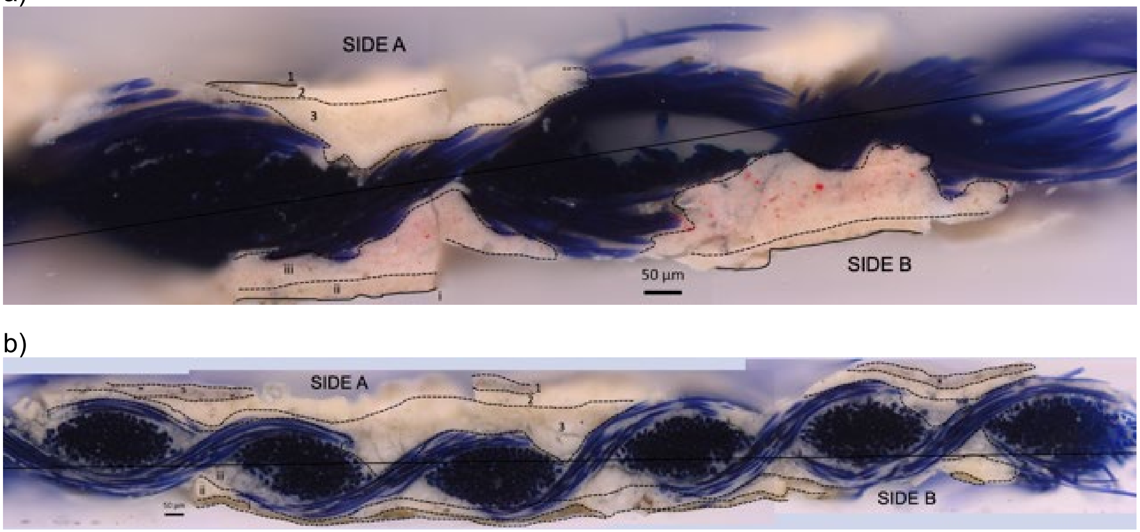


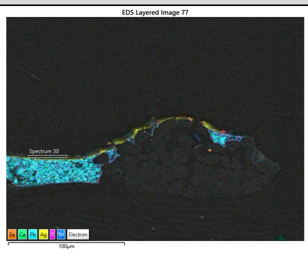
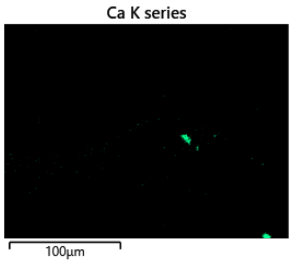
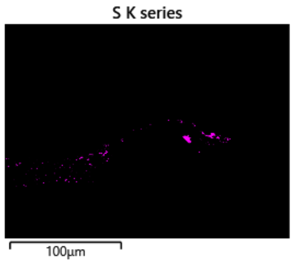
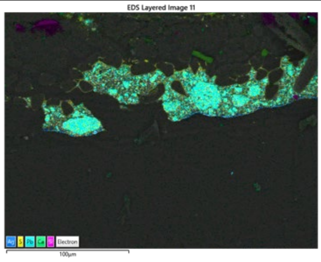
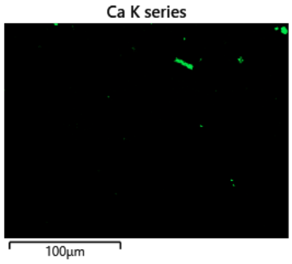
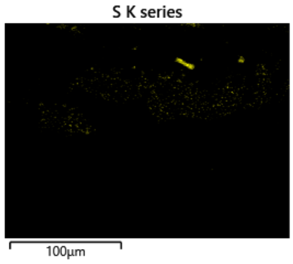
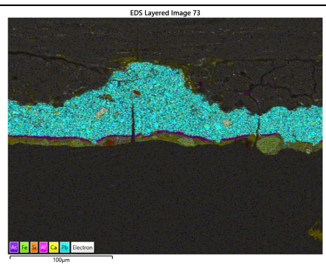
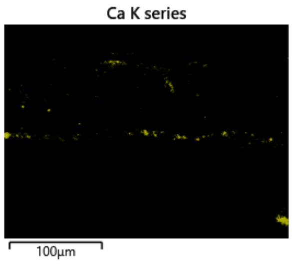
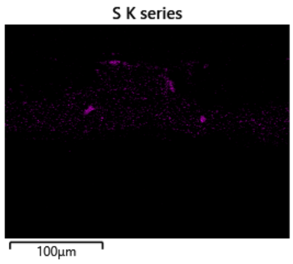
Figure 6.40 is in panels a) and b).

Figure 6.40. Annotated *Millers* cross-section samples under incident light, bright field, Axioskop 2 Zeiss, 100×; a) MG26 from silvered frame showing two ground layers per side and red pigment content on layer b of side B; b) MG10 from central painting showing two ground layers per side.

The *Millers*' ground layers '2 and ii' had either lead carbonate on its own or with a low content of calcium carbonate, whilst the *Millers*' ground layers '3 and iii' had in addition variable traces of barium sulphate (Table 6.27 and 6.28). Furthermore, side B of sample MG26 had a red pigment mixture in its ground layer 'iii' (Figure 6.40, b), punctually identified as mercury sulphide/vermilion pigment, red lead oxide and red iron oxides (see Appendix III). As the sample was obtained from an interface between central painting and metallic frame (see Appendix III), these red pigments could be interpreted as an indication of the areas that were to be silvered, possibly employing a coloured ground to distinguish from the white silvering areas.

Another material related to the possible tracing of the design onto the banners' textiles by the method of pouncing (see Chapter 3), was found in cross-section samples of the *Typographers*, *Upholsterers* and *Metal Workers*. Unbound particles of gypsum or calcium sulphate ($CaSO_4$) were identified through point analysis with EDX (see Appendix III for full results) and were also seen in the coinciding single element maps of Ca and S (Table 6.29). It was evident in the backscattered electron images that the gypsum particles were ingrained directly onto the yarns of the textile and not mixed within the ground layer, indicating their occurrence before the application of size. Being the silk textile of a dark colour, the use of a white material for poncing is logical, similarly as red for distinguishing two white-coloured surfaces. However, it could also be contamination.

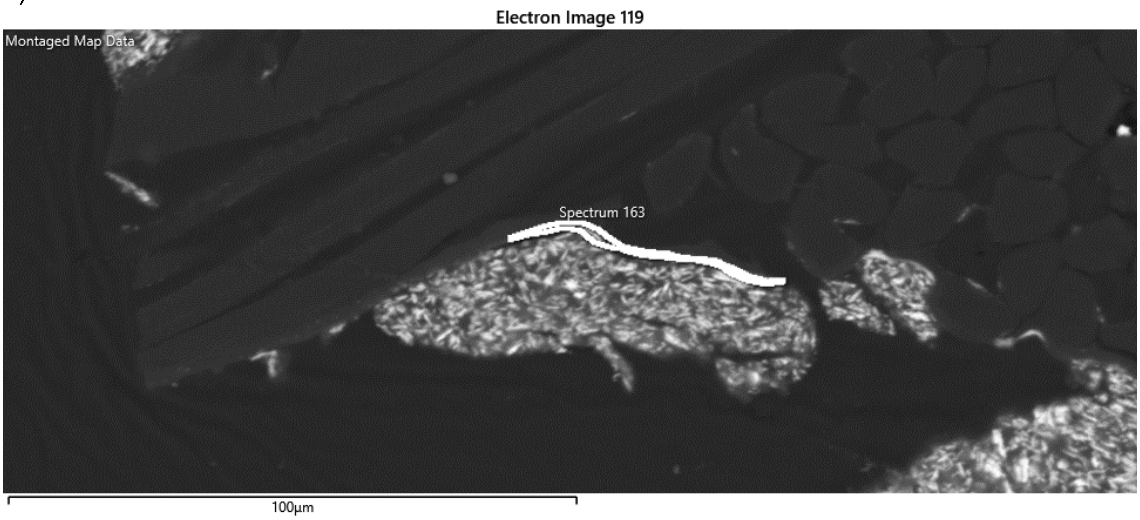
Table 6.29. Elemental mapping of calcium sulphate ($CaSO_4$) particles ingrained onto the yarns, Carl Zeiss Sigma SEM, 1200×

Sample	Composite element map	Single element map (Ca)	Single element map (S)
TS08			
GU08			
SM21			

Regarding the shape of the lead carbonate particles, both George Kenning & Son samples from the metal scroll showed a different type than their corresponding central paint samples, differing at the same time from all the George Kenning banners samples. They were identified as related to the Cremnitz process described by Eastaugh et al., for lead white pigment made by the Cremnitz process and other modern processes produces a very fine particle size that appears rounded or "bacteroid" (Figure 6.41, a, b) (Eastaugh et al., 2004, p.

843). This contrasts with the particles produced with the Dutch stack processes, which Eastaugh et al. report that produces fine-to medium-grained lead white particles, with euhedral and subhedral hexagonal shapes, similar to those seen in all the George Kenning samples and in the central painting samples SM16 and VB12 (Figure 6.42, a, b). The contrast between these two types of lead carbonate pigment particles has also been highlighted by Carlyle in cross-sections of historically accurate reconstructions seen under SEM (Carlyle, 2017, p.29).

a)



b)

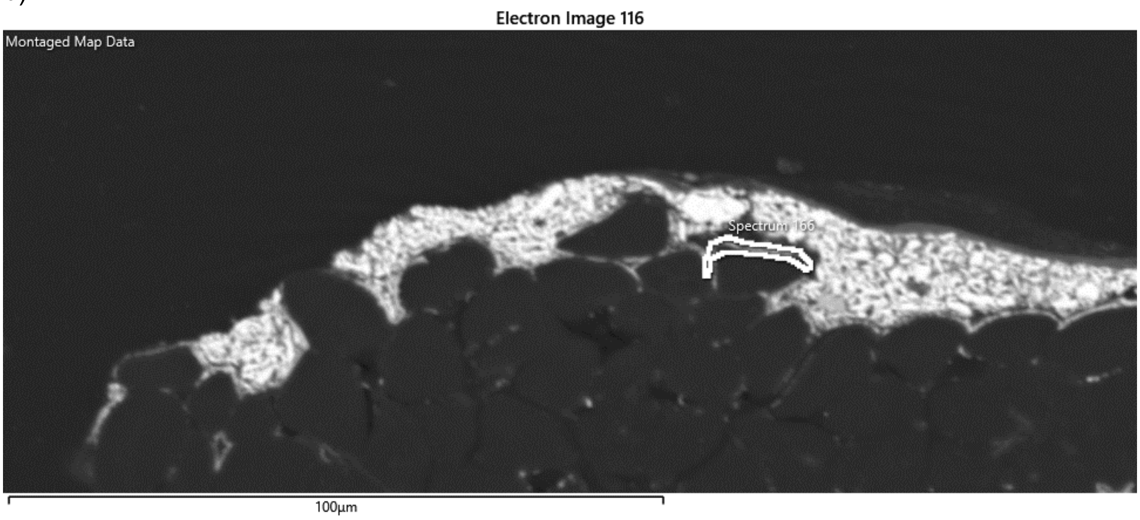
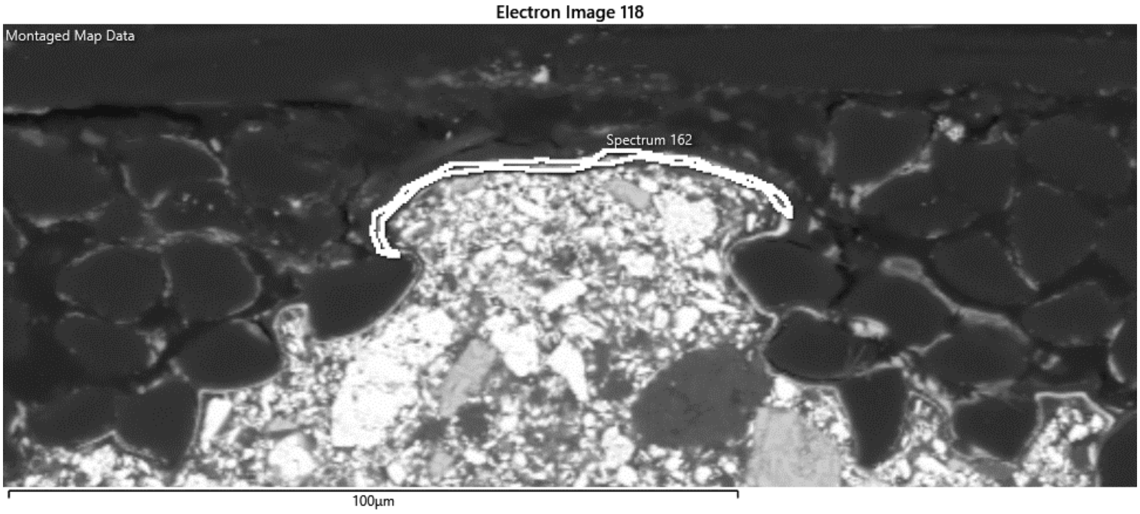


Figure 6.41. Back-scattered electron images of samples a) VB11 and b) SM26 showing the typical bacteroid shape of modern-process lead carbonate, Carl Zeiss Sigma SEM, 1200×.

a)



b)

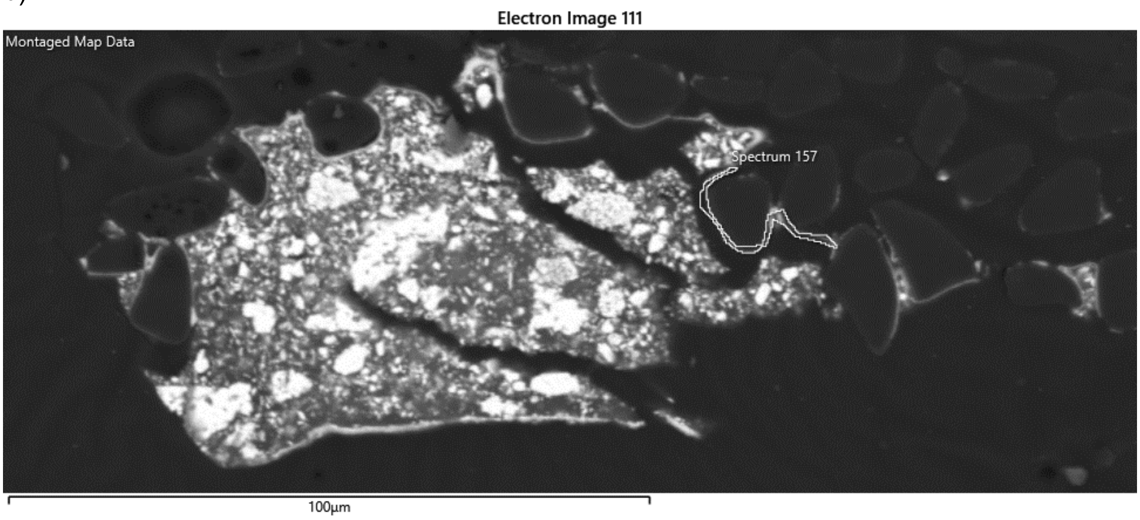


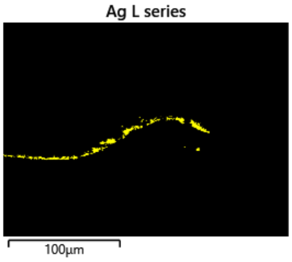
Figure 6.42. Back-scattered electron images of samples a) TS08 and b) GU08 showing the typical hexagonal shape of stack-process lead carbonate, Carl Zeiss Sigma SEM, 1200×.

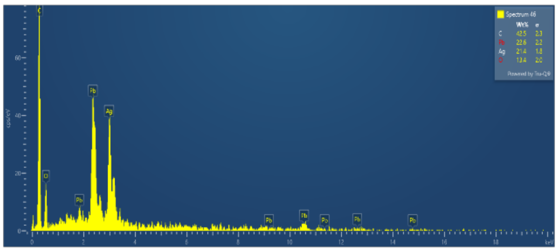
6.6.3 Metal leaf layers

EDX analysis detected the use of pure silver leaf in the three metallic scrolls cross-section samples of the George Kenning banners (Figure 6.30). The additional detection of sulphur in the samples indicated the formation of corrosion products such as silver sulphides. Along with the detection of chlorine, this has been deemed as an indication of metal alteration (deterioration products) in silver leaf (Emmerling, et al., 2013, p. 335).

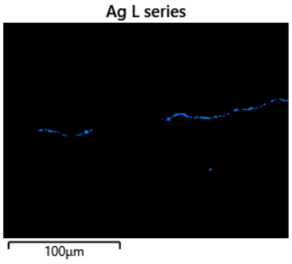
Table 6.30. Elemental mapping of silver from cross-sections of metallic scrolls of three George Kenning banners, with corresponding EDX spectra.

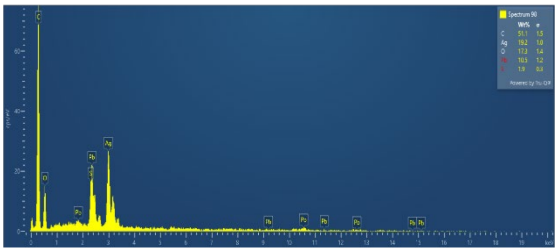
TS08 (side A)



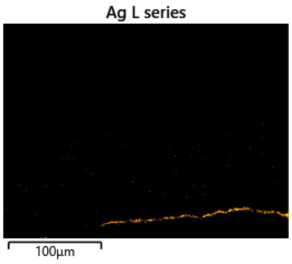


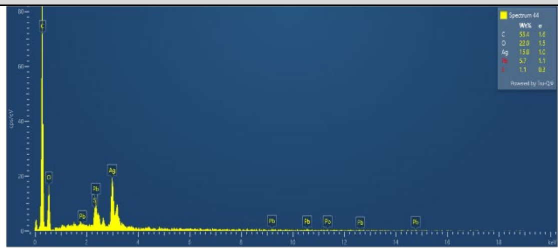
GU08 (side B)





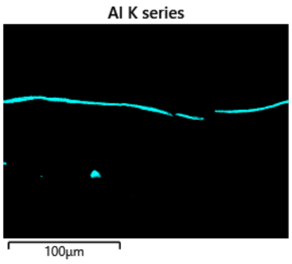
MG26 (side B)

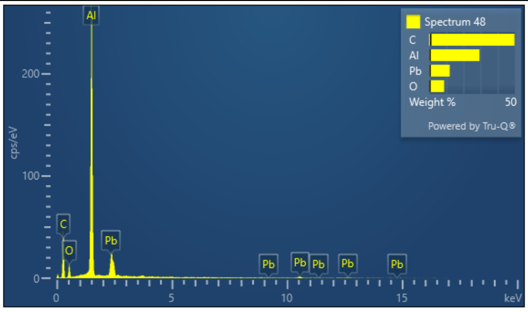


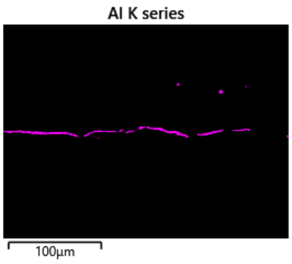


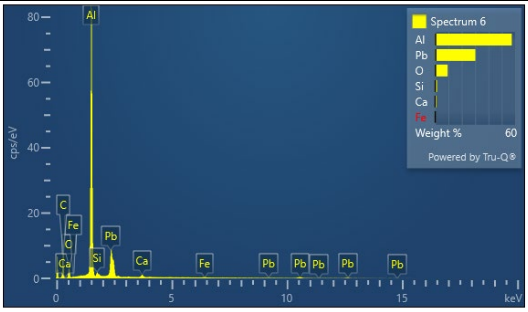
EDX analysis also detected the use of pure aluminium leaf in the two metallic scrolls cross-section samples of the George Kenning & Son banners (Table 6.31). Aluminium has been previously identified in a 1950s George Tutill banner by means of SEM-EDX analysis by Smith, Thompson and Hermens (2016, p. 4, 18). Albeit was interpreted as an aluminium paint, it could also be a metal leaf, since the close inspection of the reported banner, still in custody of the former CTC-TAH, showed evidence of square-shaped borders overlapping in sections.

Table 6.31. Elemental mapping of aluminium from cross-sections of metallic scrolls of two George Kenning & Son banners, with corresponding EDX spectra.

<table>
<tr><th colspan="2">VB11 (side A)</th></tr>
<tr><td>


</td><td>


</td></tr>
<tr><th colspan="2">SM21 (side B)</th></tr>
<tr><td>


</td><td>


</td></tr>
</table>

6.6.4 Paint layers

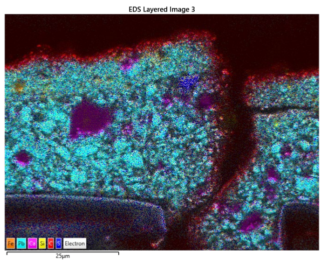
All the original paint layers identified seemed to be applied to the white ground once it had dried to touch, given the perfect separation seen at their interfaces (see cross-section samples from the central paintings in Appendix III, SEM-EDX). The identified pigments coincided with those reported for British painters between 1800 and 1900 (Carlyle, 2001), as well as with those recommended for sign-painters (Kelly, 1911, p. 46-49), landscape painters (Williams, 1880, p. 18-29) and commercially available at the time of the banners manufacture (Winsor & Newton, 1865, p. 3-6). The size and morphology of the pigment particles were small and homogeneous, which contrasted with the coarser and larger particles seen in the ground layers. This suggested the industrial processing of the paints and the possible hand grinding of the ground layer mixture in comparison. The industrial manufacture of the paints was also highlighted with the identification of extenders such as barium sulphate and calcium carbonate, as well as the detection of traces of magnesium in all the paint mixtures. This last one was interpreted as magnesium carbonate, which has been linked to the production of commercial oil paints made by the company of Winsor & Newton between the late nineteenth to early twentieth centuries (Otero et al., 2017a; Otero et al., 2017b; Townsend, personal communication, 2020). However, not all pigments were identified on every banner, thus the main results of pigment identification are reported separately in this section, with the full spectra and single elemental maps included in Appendix III, Technical Analysis.

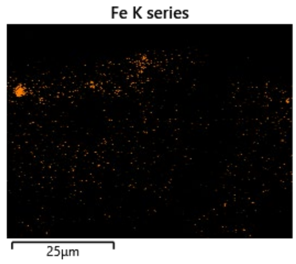
6.6.4.1 The Glasgow Typographical Society banner

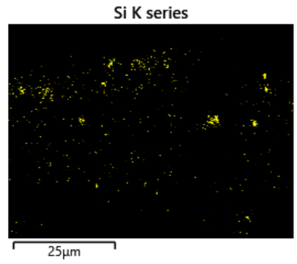
Two colours were analysed on sample TS40: beige on its side A and red on its side B.

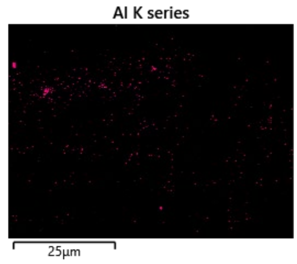
The beige paint layer seen on top of cross-section sample TS40 showed a predominant content of lead, carbon and oxygen, interpreted as lead carbonate by its white appearance under optical microscopy. The coloured brown, red and yellow particles also seen in the optical microscope, were located in the single element maps as Fe containing pigments, interpreted as iron oxides; particularly iron-manganese oxide (umber pigment) and red and yellow ochre (complex). The association reported by Eastaugh et al. with silico-aluminates (clay) and quartz (2004, p. 903), was evident in the single element maps of Si and Al, which coincided with the position of Fe particles in said sample (Table 6.32). However, some of the silicon particles might also be contamination from the polishing cloths, as they are adjacent to the sample cracks in the respective elemental map rather than within the mixture. As they were consistent over a range of samples, it could be because of the method of preparation followed. Traces of magnesium were also detected in EDX spectrum 31 of the beige paint layer, potentially relating to the addition of magnesium carbonate extender.

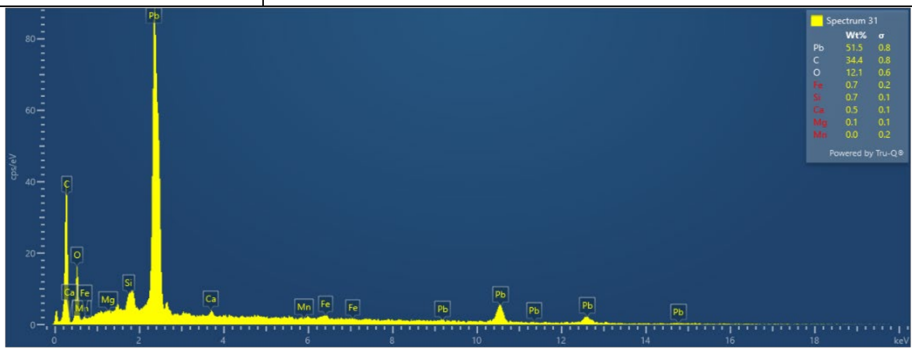
Table 6.32. Elemental map of paint sample TS40 (side a), showing the single element maps of iron (Fe), silicon (Si) and aluminium (Al), and EDX spectrum 31 of the beige paint layer.







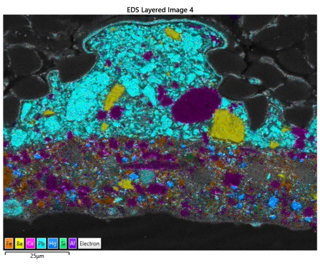


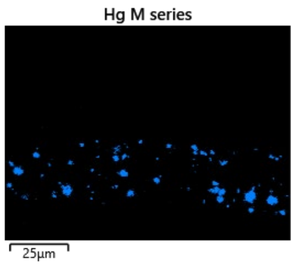


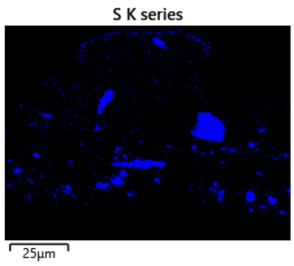
The red paint layer of side B showed a complex matrix formed by several pigments and either impurities or extenders. The two red pigments identified were vermilion and red ochre (Table 6.33). The first red pigment was identified as the synthetic version of cinnabar or mercury (II) sulphide dry-process type (α-HgS) due to the evenness of their particles (average particle size 6 μm), as mineral cinnabar is said to be coarse grinded with larger angular particles produced by crushing (>6 μm) (Eastaugh, et al., 2004, p. 735). A content of chrome (Cr) was additionally detected in the single element map (see Appendix III), which was interpreted as chromate of lead, an adulterant reported by Townsend et al. to be added in the nineteenth century to vermilion paint (Townsend, et al., 1995, p.69). Vermilion has also been previously identified in painted banners by George Tutill and George Kenning & Son (Macdonald, et al., 2004, p. 227).

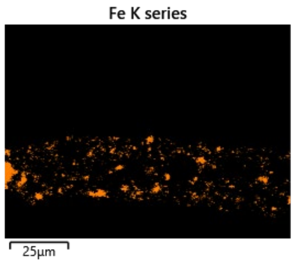
The second red pigment was seen in the individual element map as iron (Fe) particles, interpreted as red ochre (complex), also previously identified in a George Kenning & Son banner (Macdonald et al., 2004, p. 227). Red ochre is composed primarily of the iron (III) oxide hematite with the association of silico-aluminates (clay), quartz, gypsum (calcium sulphate) and baryte (barium sulphate) as impurities (Eastaugh, et al., 2004, p.903) (see single element maps for Si, S, Ca, and Ba in Appendix III, Technical Analysis). However, the presence of calcium and barium sulphates, along with the clay and chrome contents, could also indicate the addition of the first two as extenders and of the last two as adulterants of the red pigment, as all have been reported in that regard for nineteenth century oil paints (Carlyle, 2001, p. 154; Townsend et al., 1995, p. 69). Additionally, the matrix showed particles of lead that were interpreted as lead carbonate due to the white colour seen under optical microscopy (see section 6.2 Optical microscopy). This indicates the addon of lead white to the red paint mixture. Traces of Mg were also interpreted as magnesium carbonate from spectrum 32 (Table 6.33), suggesting its possible presence as an extender.

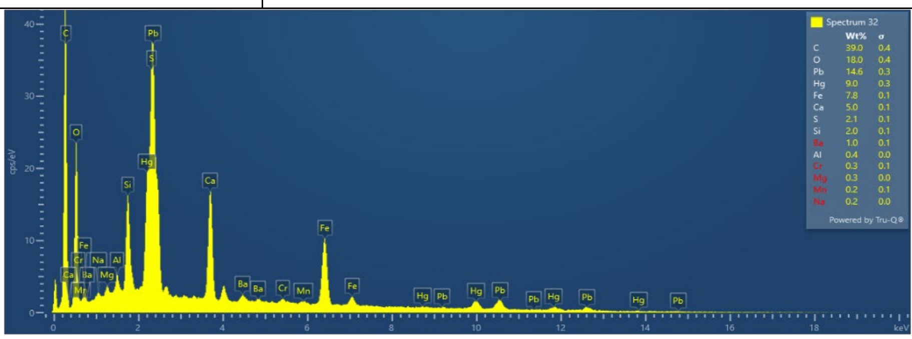
Table 6.33. Elemental map of paint sample TS40 (side B), showing the single element maps of mercury (Hg), sulphur (S) and iron (Fe), and the EDX spectrum 32 of the red paint layer.









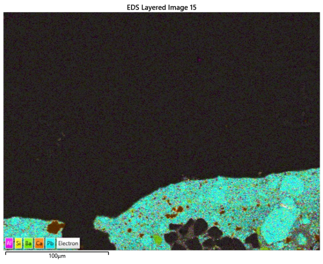


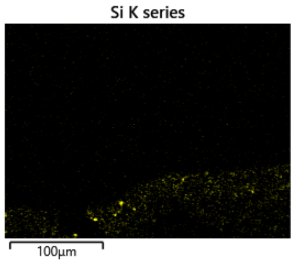
6.6.4.2 The Glasgow Upholsterers Society banner

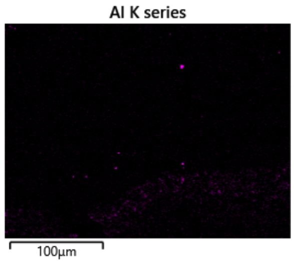
Two colours were analysed on sample GU09: light-blue on its side A and light-yellow on its side B.

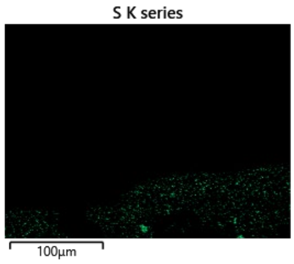
The main pigments identified in the light-blue mixture of side A were lead carbonate and synthetic ultramarine pigment or sulphur-sodium silico-aluminate ($Na_7Al_6Si_6O_{24}S_3$) (Eastaugh et al. 2004, p. 584). Such pigment has been previously identified in a Tutill banner dating 1884 and in an anonymous 1830 example (Macdonald, 2004, p. 227). Particles of the white pigment were identified with point analysis EDX (see full sample spectra in Appendix III), whilst the blue pigment was interpreted through the single element maps (Table 6.34), as the particles were too small for remote identification at the scanned resolution. According to Eastaugh et al. (2004, p. 585), synthetic ultramarine has generally more finely divided particles than lazurite, the mineral form of ultramarine blue, which corresponded with this sample. Two other elements were identified from the single element maps, barium (Ba) and magnesium (Mg), interpreted as the extenders barium sulphate and magnesium carbonate that have been reported for commercially produced oil paints (Otero et al., 2017a; Otero et al., 2017b; Townsend, personal communication, 2020).

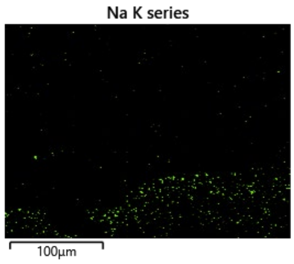
Table 6.34. Elemental map of paint sample GU09 (side A), showing the single element maps of silicon (Si), aluminium (Al), sulphur (S) and sodium (Na), plus EDX spectrum 18 of the light-blue paint layer

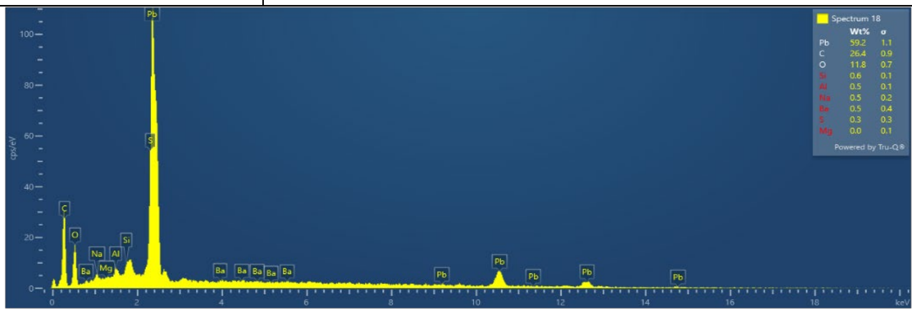






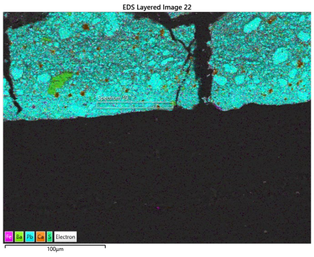


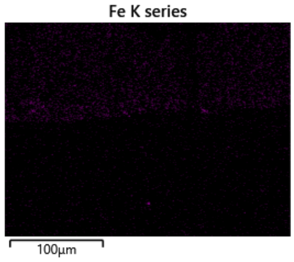


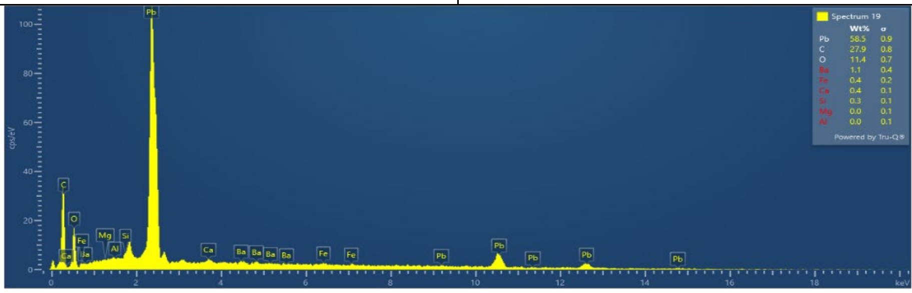


The main pigments identified in the light-yellow mixture of side B were lead carbonate and yellow ochre (complex). The first one was punctually identified in spectrum 83 (see Appendix III) and the second one was interpreted from the single element maps (Table 6.35). It is reported that yellow ochres are primarily composed of iron oxide hydroxides, with the association of other minerals like quartz and clays (Eastaugh et al., 2004, p. 905). Given that the colour is a light-yellow, the amount of coloured pigment is less than the lead white pigment bulk. Other particles like barium sulphate were also seen in the single element maps and punctually identified, whilst traces of Mg from the single element maps and EDX spectrum 19 were interpreted as magnesium carbonate, similarly as sample TS40 (see Appendix III for full sample spectra).

Table 6.35. Elemental map of paint sample GU09 (side B), showing the single element maps of iron (Fe), and EDX spectrum 19 of the light-yellow paint layer







6.6.4.3 The Grain Millers of Glasgow banner

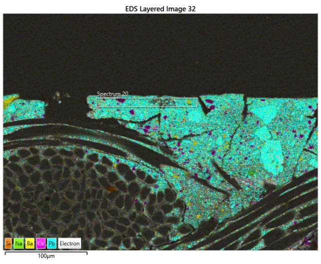
Two colours were analysed on sample MG10: greyish blue on its side A and greenish yellow on its side B.

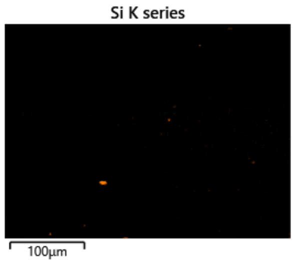
The main pigments identified in the greyish-blue mixture of side A were lead carbonate and synthetic ultramarine blue. Coinciding with sample GU09, the small particles of the blue pigment prevented punctual identification and thus they were only interpreted from the single element maps of sulphur, sodium, silicon, and aluminium (Table 6.36). The same extenders seen in the previous samples were also identified in the mixture, both by punctual identification and single element maps as: barium sulphate, calcium carbonate and magnesium carbonate.

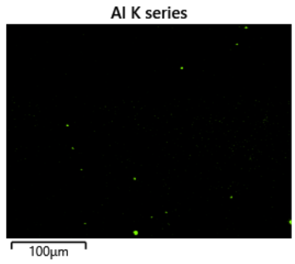
Additionally, some small black particles were seen scattered throughout the paint layer under optical microscopy. These were interpreted from the EDX spectrum 20 of the blue paint as bone black pigment, due to the identification of Ca, P, and S (Table 6.36). Bone black pigment is essentially calcinated bone (complex) (Eastaugh et al., 2004, p.773), composed of 84% calcium phosphate or hydroxyapatite ($Ca_{10}(PO_40_6(OH)_2)$) and about 10% carbon (CAMEO, 2022). As a bone-related product, it also has a sulphur content associated to the organic content of collagen, which varies with species (Nehlich and Richards, 2009, p.

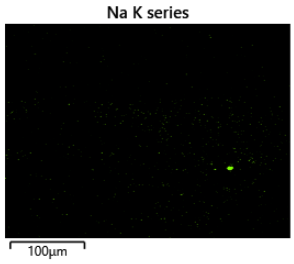
59). Although the particles on sample MG10 were too small for remote punctual identification, the same composition was punctually identified in larger particles of scroll sample VB11 (see Appendix III), reiterating the use of such black pigment in both banners. These results contrasted with another black pigment particle punctually identified in sample VB12 layer ii (see Appendix III). As only carbon was detected the interpretation was a carbon-based black, possibly chars or vegetable/vine black due to the particle size that was deemed larger than that of flame carbons (Eastaugh et al., 2004, 770, 774).

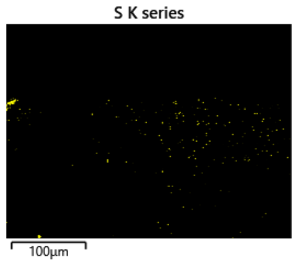
Table 6.36. Elemental map of paint sample MG10 (side A), showing the single element maps of silicon (Si), aluminium (Al) and sodium (Na), and EDX spectrum 20 of the greyish-blue paint layer

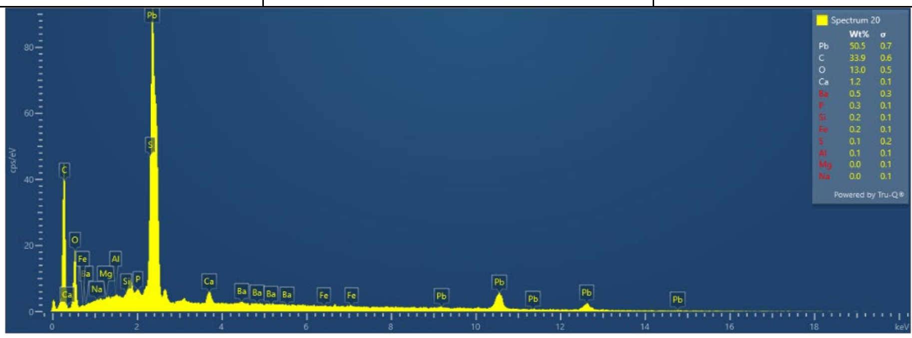






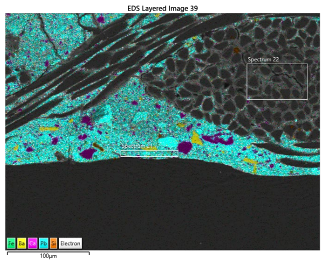


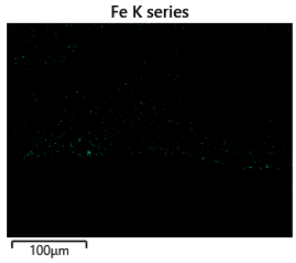


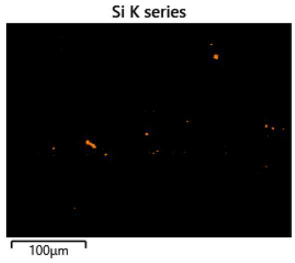


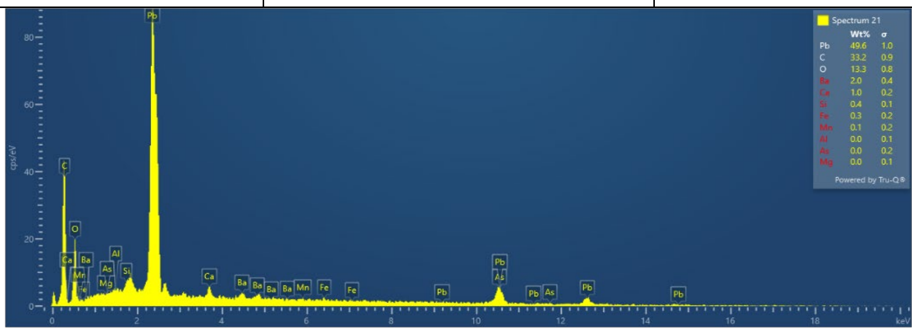
The main pigments identified in the greenish-yellow mixture of side B were two types of iron oxides within a lead carbonate matrix, yellow ochre, and iron-manganese oxides (umber pigment), both interpreted from the single element maps and EDX spectrum 21 of the paint layer (Table 6.37). Alike sample GU09, the small particles of yellow ochre were seen scattered throughout the lead carbonate matrix with quartz particles, which appeared to be largely associated with yellow ochre than other types of iron oxide pigments in the polarised light microscopy images published by Eastaugh et al. (Eastaugh et al., 2004, p. 902-909). The manganese (Mn) content was evident in EDX spectrum 21, and its presence relates to umbers, which are very fine-grained sedimentary rocks with associated minerals like amorphous silica and clay (Eastaugh et al., 2004, p. 909), both of which were highlighted by the Si and Al content in the sample.

Table 6.37. Elemental map of paint sample MG10 (side B), showing the single element maps of iron (Fe), silicon (Si), and EDX spectrum 21 of the greenish-yellow paint layer









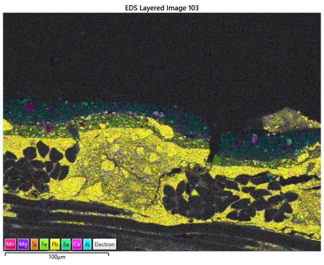
6.6.4.4 The United Kingdom Coachmakers/National Union of Vehicle Builders, Glasgow Branch banner

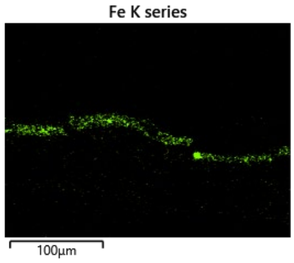
Two original colours were analysed on sample VB12: red in its side A and beige in its side B. However, as explained in Chapter 2, the banner was renovated in 1942 and thus two further layers of similar colour were analysed on both sides.

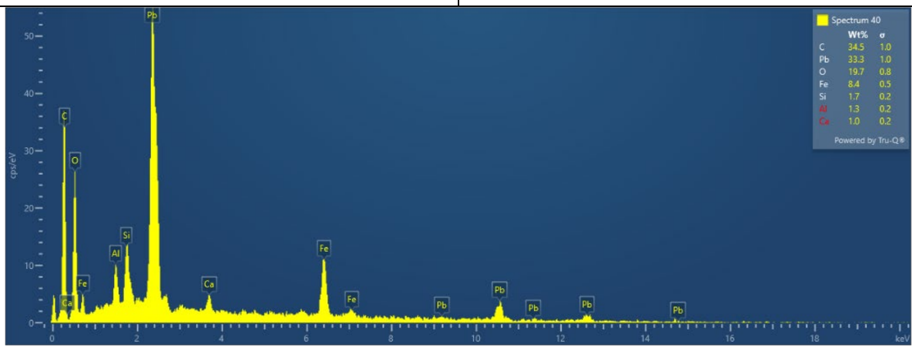
The main pigments identified in the original red mixture of side A were red iron oxides with associated silico-aluminates or clay, interpreted as red ochre (Table 6.38). In addition to that, lead containing pigments were both punctually identified and seen in the single element maps (see Appendix III), interpreted as lead carbonates due to the white appearance under optical microscopy. The only extender identified in spectrum 40 of the original red layer was calcium carbonate. Unlike the other samples and even the two paint layers of sample VB11 side B, no magnesium was detected, thus indicating the absence of magnesium carbonate, and potentially suggesting a different paint source.

Due to the visual characteristics of the added red paint layer, of translucent appearance without discernible particles under the optical microscope, it was classified as a coloured glaze and included in the following section 6.5.5. Coloured glazes.

Table 6.38. Elemental map of paint sample VB12 (side A), showing the single element maps of iron (Fe), and EDX spectrum 40 of the red paint layer

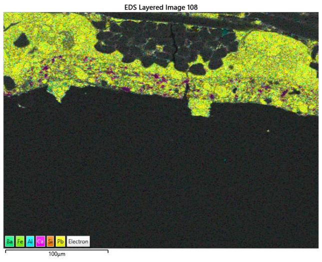


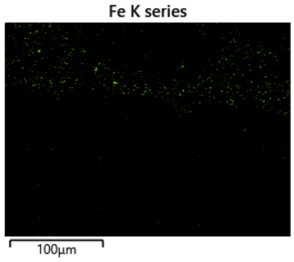


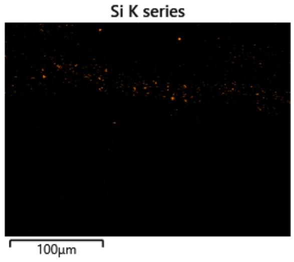


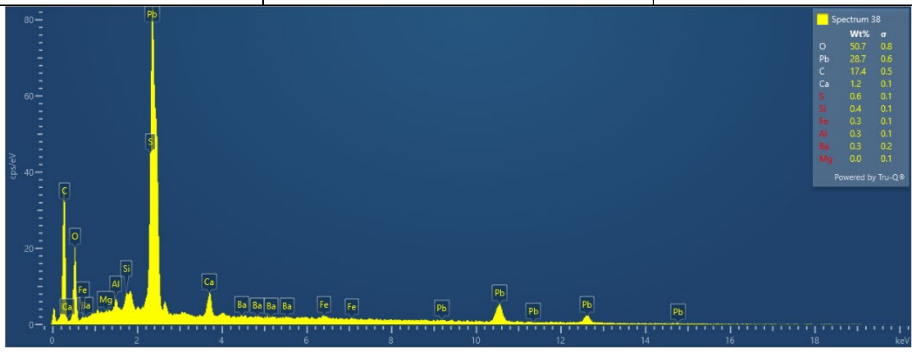
The main pigments identified in the original beige mixture of side B were lead carbonate and red and yellow ochres with associated silico-aluminates, along with barium sulphate and potentially magnesium carbonate as extenders (Table 6.39). These results were equivalent to those of samples TS40, GU09 and MG10, where the red and yellow iron oxides were all associated with clay and quartz particles and showed evidence of the same extenders in the paint matrix. This could potentially indicate a similar source or mixture of the paint, especially since the added beige layer of the renovation showed a slightly different composition in EDX spectrum 37 (see Appendix III). The added beige layer had iron oxides, not a trace of silicon, and aluminium content that could potentially be related to aluminium stearate as plasticiser, as has been found on a 1950s oil painting made with commercially produced paints (Izzo, 2010, p. 186-190).

Table 6.39. Elemental map of paint sample VB12 (side B), showing the single element maps of iron (Fe), silicon (Si), and EDX spectrum 38 of the beige paint layer







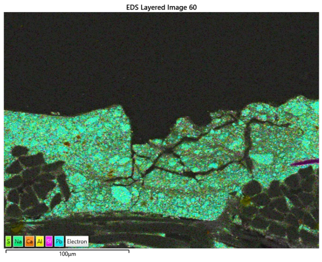


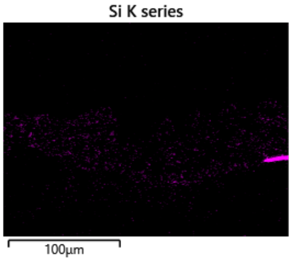
6.6.4.5 The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner

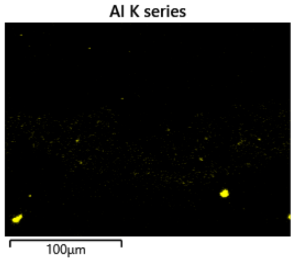
Two colours were analysed on sample SM16: blue on its side A and turquoise blue on its side B.

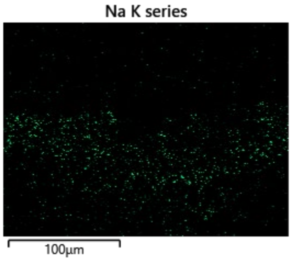
The main pigments identified in the blue mixture of side A from the single element maps were lead carbonate and sulphur-sodium silico-aluminate or synthetic ultramarine blue (Table 6.40). Having found the same pigment in samples GU, MG and SM, makes this the most common blue in the five analysed banners, used continually by Kenning manufactures from a timespan of at least three decades. Differently from the previous samples, only two extenders were found within the paint mixture, calcium carbonate and possibly magnesium carbonate, but not barium sulphate. Similarly as with all the previous cases, the identification of calcium and magnesium carbonates were made by the lack of coincidence between Ca an S in the single element maps, thus discarding them as calcium or magnesium sulphates. The lack of barium in the paint layer could be interpreted as a disuse of barium sulphate by the manufacturer or a different manufacture.

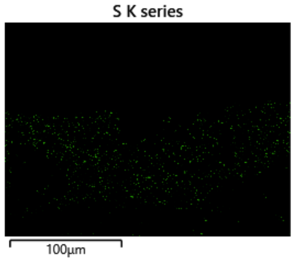
Table 6.40. Elemental map of paint sample SM16 (side A), showing the single element maps of silicon (Si), aluminium (Al), sodium (Na) and sulphur (S), plus EDX spectrum 23 of the blue paint layer.

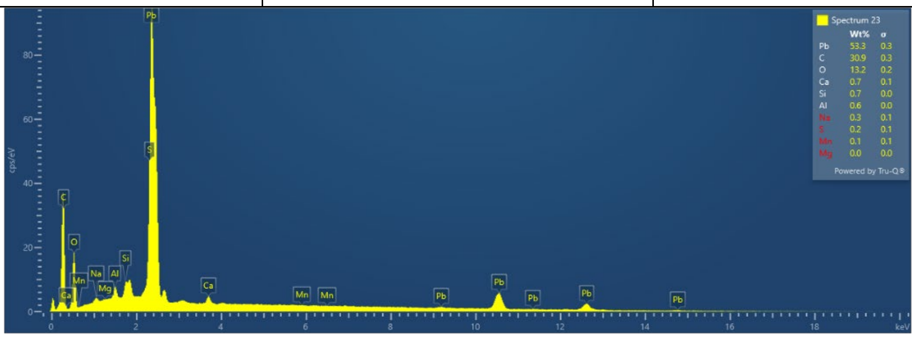






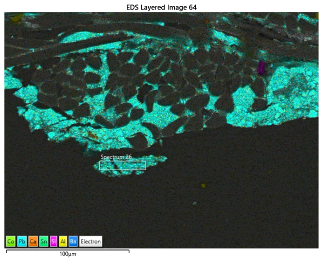


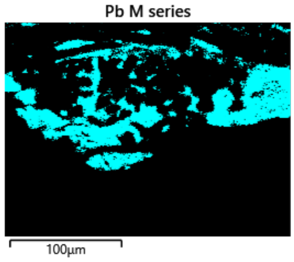


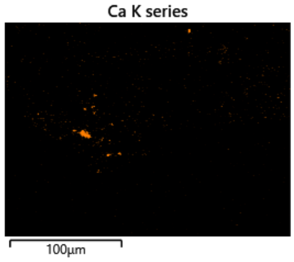


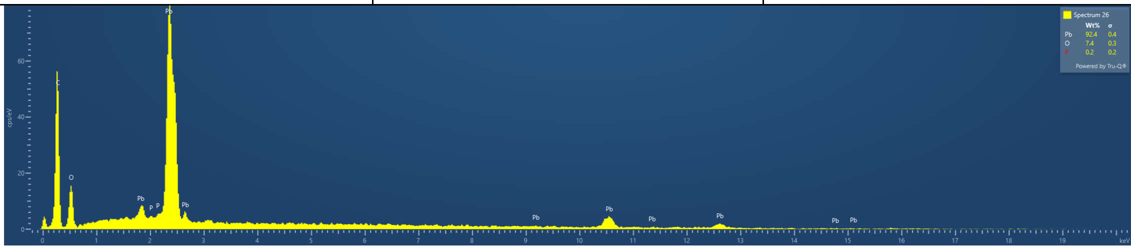
The only pigment identified in the turquoise mixture of side B was lead carbonate (Table 6.14, spectrum 26). Although the sample showed colour under OM, the exposed area for scanning only contained ground layer, not paint. This means the sample should have been polished further to expose the turquoise paint layer.

Table 6.41. Elemental map of paint sample SM16 (side B), showing the single element maps of lead (Pb) and calcium (Ca), plus EDX spectrum 26 of the supposed paint layer







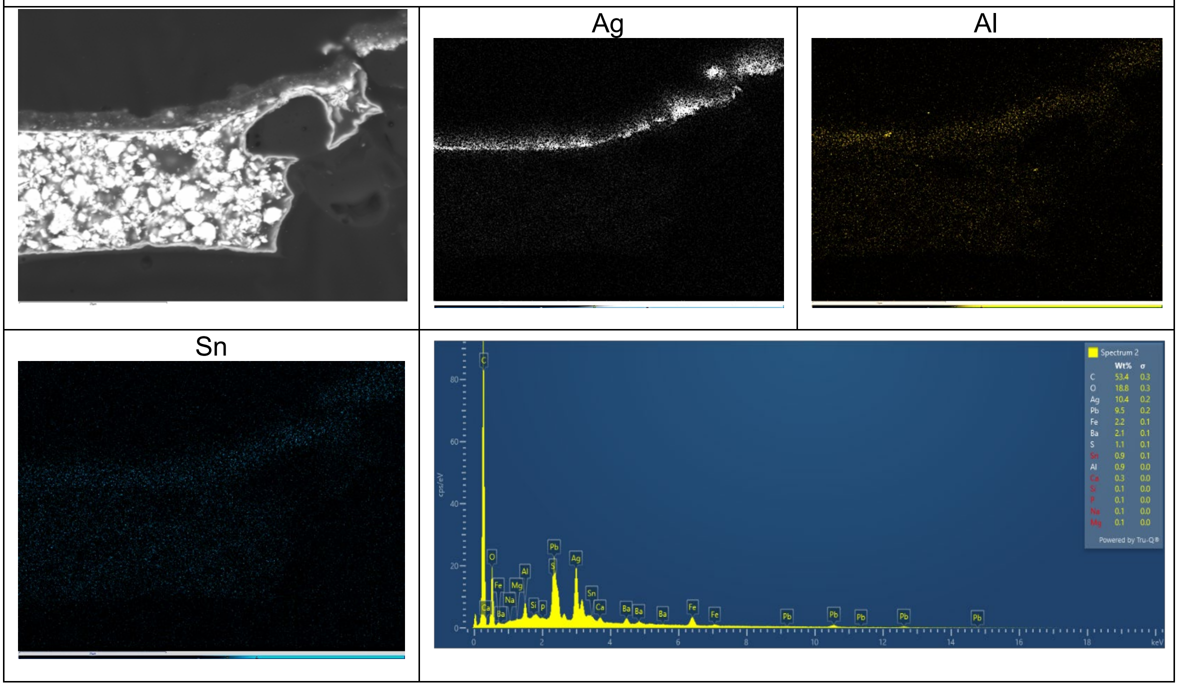


6.6.5 Coloured glazes

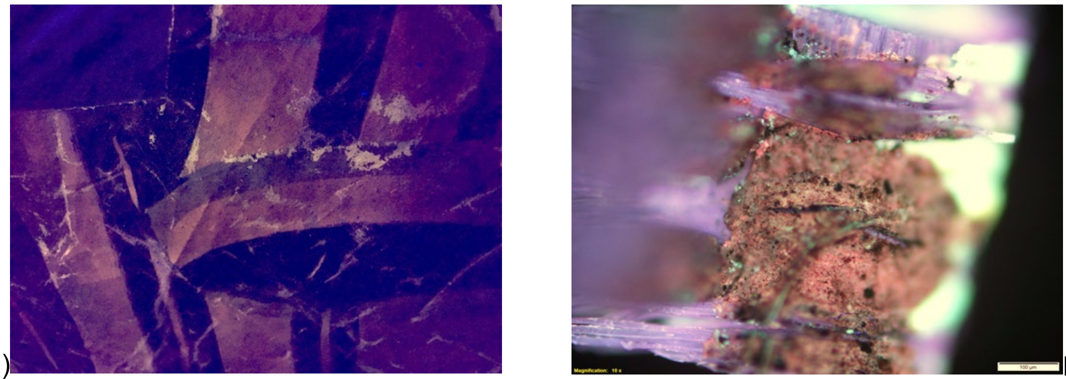
Three different coloured glazes were analysed on samples TS08, VB12 and SM21, all of which suggested the presence of lake pigments in the mixture. The layers were classified as coloured glazes given the translucency seen under the optical microscope and the almost indiscernible particles in the mixture, in opposition to the paint layers of opaque and discernible particle appearance.

Sample TS08 showed a scarlet red colour glaze. EDX spectrum 2 (Table 6.42) detected aluminium (Al) and tin (Sn) in the red layer, both of which have been reported in the formulation of eighteenth- and nineteenth century red lake pigments (Kirby, Spring and Higgit, 2007, 69-95). Bone-ash, another material related to the presence of lake pigments (Kirby, Spring and Higgit, 2005, 71-87), was interpreted from the same spectrum due to the contents of potassium and calcium that suggested the presence of calcium phosphate in the mixture. Further components were detected which have been also reported as bases of lake pigments: barium sulphate and calcium carbonate, (Eastaugh et al., 2004, p. 809), reaffirming said interpretation. Due to time and budgetary constraints, no HPLC was conducted for identifying a potential red dyestuff in the mixture, but both macroscopic and microscopic inspections with UV fluorescence showed the characteristic bright-orangey hue reported for madder (Figure 6.43 a, b) (Macbeth, 2012, p. 295). Additionally, some iron oxide particles with associated clay were detected and interpreted as possibly red ochre and/or brick dust, both reported as madder lake adulterants by Townsend et al. (Townsend et al., 1995, p. 69). Both madder and cochineal have been identified as the dye used in tin-base substrate lake pigments (Emmerling et al., 2013).

Table 6.42. BSE image of paint sample TS08 (side A), showing the single element maps of silver (Ag), aluminium (Al) and tin (Sn), and EDX spectrum 2 of the red glaze layer. Note how the Sn and Al coincide on the same layer (lake pigment glaze).



It is important to highlight that the tin (Sn) content was only found in association with the coloured glazes above stated, never within the fibres of the silk textiles (neither with SEM-EDX or XRF). Since tin is one of the most common weighting metals for silk textiles and is also seen as mordant of textile dyes, a generalised presence in the elemental mappings of the samples would have suggested either. However, the localisation of Sn was limited to the glaze layers, indicating a potential lake pigment substrate. This reaffirms the historical recommendation mentioned in Chapter 3 against the use of weighted silk textiles for banner making.

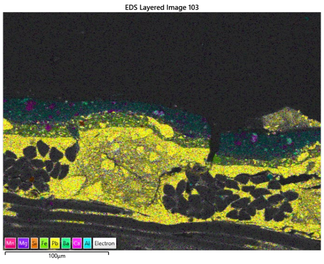


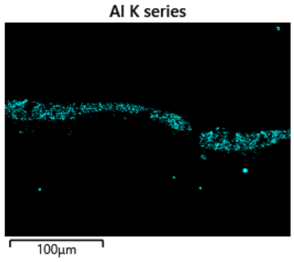
a) b)

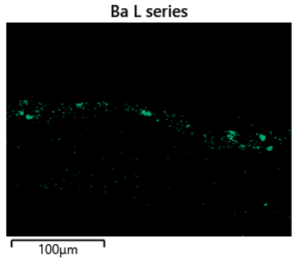
Figure 6.43. UV fluorescence images of red glaze over the scrolls of TS banner showing a similar bright orangey fluorescence as that of madder; a) macroscopic inspection; b) photomicrograph at 10× under Olympus microscope with UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm).

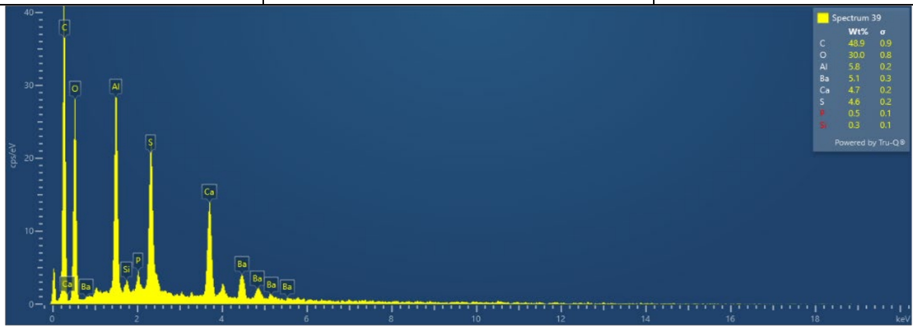
The second potential lake pigment was located in the red overpaint of the VB banner (side A) (Table 6.43). The added second red layer's EDX analysis detected aluminium and barium content in the matrix. In this case, these contents could be linked to the use of hydrated alumina with added barium sulphate, as it has been suggested as a lake base by Eastaugh et al. (2004, p. 809) and similarly identified in red glazes on metal leaf by Emmerling et al. (2013, p. 423). Nevertheless, this material was not applied by George Kenning & Son company but by the member of the society who carried out the "renovation" of their banner in 1942 (see Chapter 2). Hence it is not considered to be related to the manufacturing technique of Kenning's companies, albeit of a different substrate than that of sample TS08.

Table 6.43. Elemental map of paint sample VB12 (side A), showing the single element maps of aluminium (Al), barium (Ba), and EDX spectrum 39 of the red glaze layer.





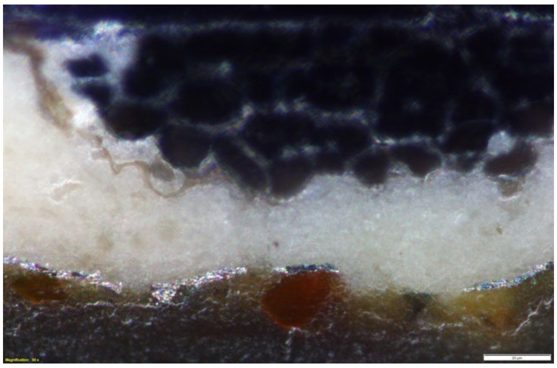
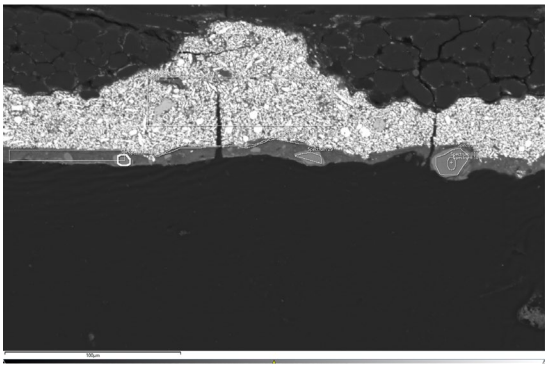


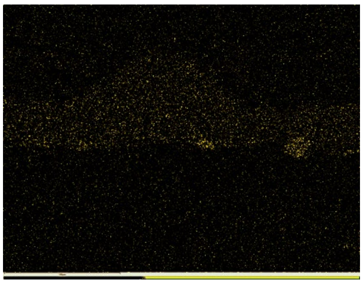
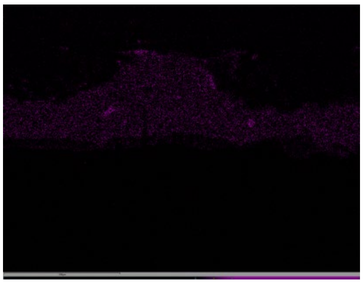
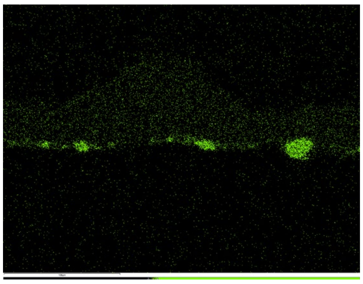


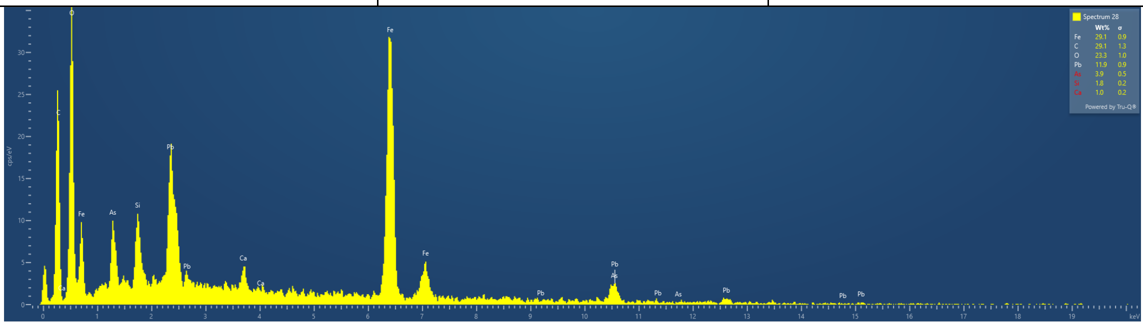
Finally, a third glaze was identified in scroll sample SM21, this time yellow in colour. Although the layer showed a similar transparency as the two previous examples and evidence of potassium alum as lake substrate in the single element maps and EDX spectra (see Appendix section 9.3.3.5), this yellow glaze showed some peculiar pigment particles. These were punctually identified through EDX in spectra 28, 188 and 190, finding in all cases an iron (Fe) and arsenic (As) content (Table 6.44).

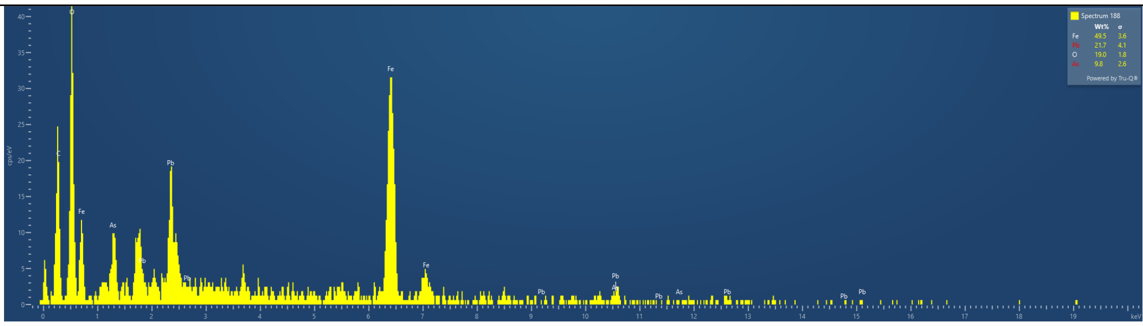
These peculiar particles of orange colour appeared translucent under OM and were either big (>20µm) with rounded edges, or medium sized (10µm) with a shard-like appearance (Table 6.44, OM and BSE images). They visually resembled those reported by van Loon et al. for artificial orpiment or arsenic sulphide (van Loon et al., 2017), although the associated sulphur was not detected in sample SM21 (Table 6.44, S single element map). Likewise, van Loon et al. do not report an additional iron content, such as that detected in the banner sample. Since orpiment has been reported as an adulterant/additive in nineteenth century yellow ochre paints (Townsend et al., 1995, 69), that is a possible interpretation of said pigments in the yellow glaze. However, further research would be needed to confirm.

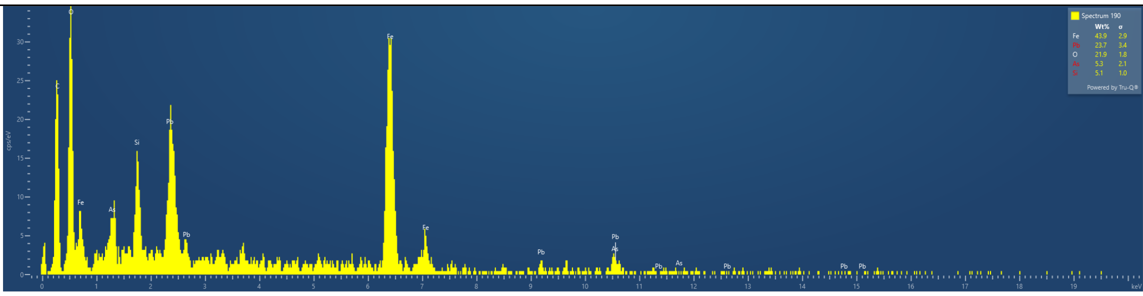
Table 6.44. OM image at 50X and BSE image of paint sample SM21 (side B), plus single element maps of arsenic (As), sulphur (S) and iron (Fe), with corresponding EDX spectra 28, 188 and 190 of supposed artificial orpiment particles in the yellow glaze layer.

OM	BSE
	

As	S	Fe
		







A summary table of all the SEM-EDX results with the interpreted materials divided in scrolls and central paintings is presented in Tables 6.45 and 6.46 as follows.

Table 6.45. Summary of SEM-EDX results of the full cross-sections from the metallic scrolls of the five Kenning banners of Glasgow Museums.

Banner / Sample	Ground	Ground extender	Metal leaf	Pigments	Paint extender
The Glasgow Typographical Society / TS08	Lead white (with barium sulphate)	None	Silver	Red lake pigment (tin and alum based) Barium sulphate Red ochre †Clay	Calcium carbonate
The Glasgow Upholsterers Society / GU08	Lead white (with barium sulphate)	Calcium carbonate	Silver	None	None
The Grain Millers of Glasgow / MG26	Lead white (with barium sulphate)	Calcium carbonate	Silver	*Vermillion *Red ochre *Red lead	None
The National Union of Vehicle Builders, Glasgow Branch / VB11	Lead white	None	Aluminium	Bone black	None
The Scottish Tin Plate Braziers and Sheet Metal Workers' Society / SM21	Lead white (with barium sulphate)	Calcium carbonate	Aluminium	Yellow lake pigment (alum based) Yellow ochre **Artificial orpiment Barium sulphate	Calcium carbonate

(*) Mixed within the first layer of ground, not over the metal leaf. (†) Possible adulterant reported by Townsend, Carlyle et al. (1995). (**) Possible interpretation although inconclusive. (_) Punctually identified with EDX, the rest were interpreted from the acquired elements.

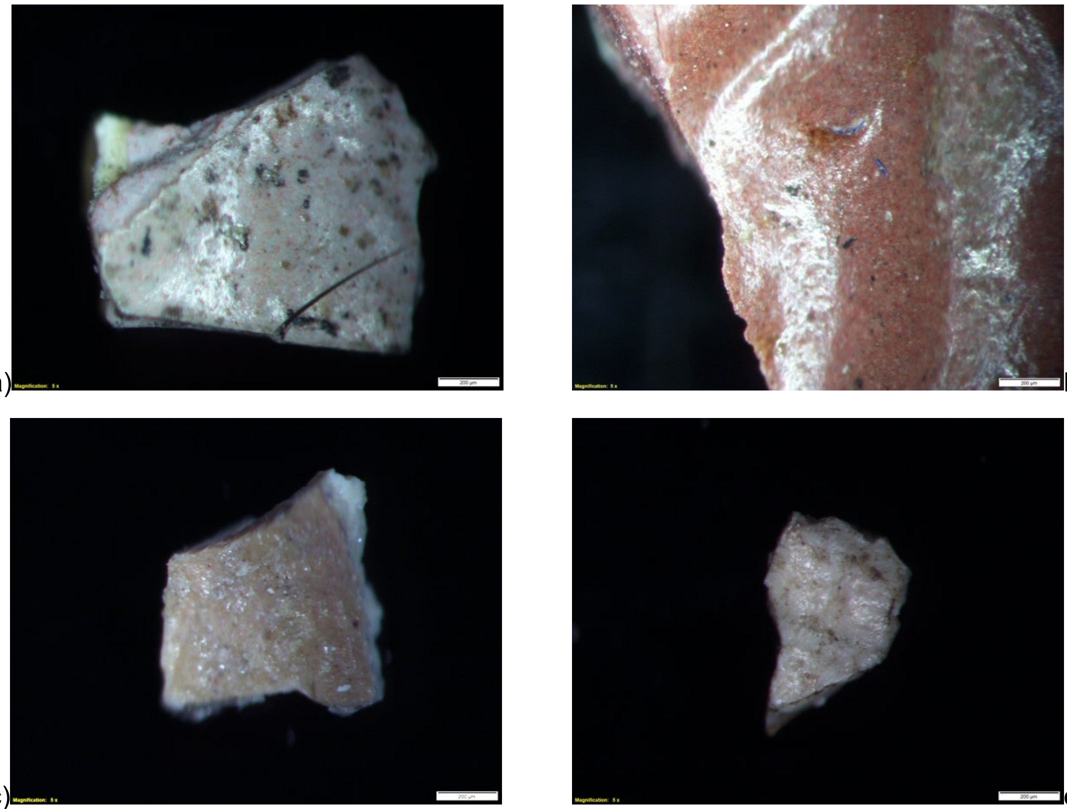
Table 6.46. Interpretation of SEM-EDX results of the full cross-sections from the central paintings of the five Kenning banners of Glasgow Museums.

Banner / Sample	Ground	Ground extender	Pigments	Paint extenders
The Glasgow Typographical Society / TS40	Lead white (with barium sulphate)	Calcium carbonate	Lead white Barium sulphate Yellow ochre Umber Red ochre †Clay Vermillion †Lead chromate	Calcium carbonate Magnesium carbonate *Calcium sulphate
The Glasgow Upholsterers Society / GU09	Lead white (with barium sulphate)	Calcium carbonate	Lead white Barium sulphate Synthetic ultramarine Yellow ochre Red ochre †Clay	Calcium carbonate Magnesium carbonate
The Grain Millers of Glasgow / MG10	Lead white (with barium sulphate)	Calcium carbonate	Lead white Barium sulphate Synthetic ultramarine Bone black Red ochre †Clay Yellow ochre	Calcium carbonate Magnesium carbonate
The National Union of Vehicle Builders, Glasgow Branch / VB12	Lead white	None	Red ochre †Clay Umber Yellow ochre *Red lake pigment (alum based) *Barium sulphate	Calcium carbonate *Calcium sulphate
The Scottish Tin Plate Braziers and Sheet Metal Workers' Society / SM16	Lead white (with barium sulphate)	Calcium carbonate	Lead white Artificial ultramarine	Calcium carbonate Magnesium carbonate

(*) Only in red paint layer. (†) Possible adulterant as reported by Townsend, Carlyle et al. (1995). (_) Punctually identified with EDX, the rest were interpreted from the acquired elements.

6.7 GC-MS results of four Kenning banners of Glasgow Museums Collection

Four ‘paint samples large’ were selected for binding media identification with GC-MS: TS19, GU29, VB30 and SM31 (Figure 6.44) (see Appendix II Sampling Protocols for location).[47] Sample GU29 was additionally divided in two, due to the possibility of physically separate with a scalpel the paint, GU29_A, from the ground layer, GU29_B, in an attempt to identify the binder of each layer separately. Therefore, a total of five samples were sent to Art, Analysis & Research (AA&R) for binding media analysis.



a) b) c) d)

Figure 6.44. Microphotographs of paint samples large (front) before GC-MS analysis, seen under Olympus BX41 microscope under dark field-cross polarisers at 50×; a) TS19, b) GU29, c) VB30, d) SM31. *Samples were obtained from either an area of paint and ground accumulation next to the seams or localised impastos, both previously damaged.

According to AA&R, all 5 samples analysed by GC-MS gave similar results, indicating the presence of a drying oil with palmitate/stearate ratios consistent

[47] As the budget only allowed the analysis of five samples, the ‘paint sample large’ taken from the *Millers* banner was substituted by the separated sample of the *Upholsterers* banner. The reason for that was the proximity of both banners manufacture (1884), likely to contain similar binding media. In return, the separate analysis of ground and paint layers of sample GU29 was deemed as more significant to the interpretation of Kenning’s technique.

with linseed oil. These results are in accordance with the characterisation of early twentieth century artists' oil paints by Izzo (Izzo, 2010, pp. 183,199), which included paintings from similar periods as the banners of George Kenning & Son. The azelate/suberate ratios suggested that the oil may be partially heat-bodied in all cases. This coincides with the previous GC-MS results published in Rogerson and Lennard's study and performed by Eastaugh (Rogerson and Lennard, 2004).

All of the chromatograms included a noticeable peak for methyl oleate (from monounsaturated oleic acid), which was interpreted by AA&R as a possible indication of incomplete drying of the oil or a relatively young paint film. Given that this peak was particularly pronounced in ground layer sample GU29_B, it can be re-interpreted that this layer could have incomplete drying of the oil, given its insulation from the atmosphere on both sides by the lead-containing paint layers. This could have significantly slowed the incorporation of oxygen into the reactions involved in the curing and ageing of the linseed oil in the ground (van der Berg and van der Berg, 1999, p.248-50). Contrastingly, the peak for methyl oleate in the two other samples is likely to be indicating a relatively young film, as would be expected in oil paints of less than 150 years old (van der Berg and van der Berg, 1999, p.251-52).

Additionally, all samples contained a minor amount of a natural resin, suggested by AA&R to possibly be pine resin, but with certain differences perceived in its detection. Samples from the three George Kenning banners (TS19, GU29_A and GU20_B) showed the same three peaks associated with *Pinaceae* resins (Dehydroabietic acid, methyl ester; 7-oxo-dehydroabietic acid, methyl ester; and 15-hydroxy-7-oxo- deydroabietic acid, methyl ester), suggesting the use of a similar resin in their technique. Given that no varnish was detected in any of those samples, the identification suggests that the resin was mixed within the paint and ground layers. For the samples of the two George Kenning & Son banners (VB30 and SM31), differences in their results suggests changes in their technique, similarly to the interpretation of results obtained with SEM-EDX for both banners. Sample VB30 showed the least evidence of resin of all the samples in the analysis, having only detected one associated peak with *Pinaceae* resins (Dehydroabietic acid, methyl ester). Given that it was the only banner with an identified varnish layer, such peak can be interpreted in this case as coming from the varnish residues on the paint sample (Figure 6.45). Thus, is likely that the paint and ground layers only have partially heat-bodied linseed oil in the mixture, otherwise a similar result as that obtained in the remaining samples would have been expected. Furthermore, this banner has a full overpaint that gave no added material, thus inferring it has a similar binder as the original paint, minus the added resin. Finally, sample SM31 gave an additional fourth peak associated with *Pinaceae* resins, not seen in the George Kenning examples (Dehydroabietic acid, dimethylated derivative). This possibly suggests the use of a slightly different resin in its technique. However, problems of interpretation have been recently detected when attempting GC-MS differentiation of resins from *Pinaceae* species in European artworks (Dietemann et al., 2019). Given that the family includes four subfamilies of resinous trees, there are many similarities amongst the species that preclude their distinction after ageing, only being able to separate resins extracted from *Laricoideae* subfamily (e.g., larch turpentine). The remaining subfamilies give a similar identification for colophony, making the use of pine resin as label a little misleading as it leaves out other potential sources like spruces of firs (Dietemann et al., 2019, p. S71).

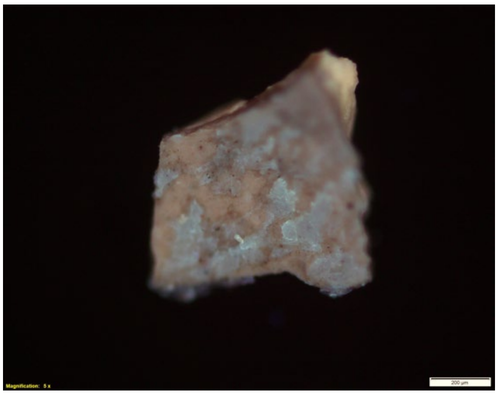


Figure 6.45. Microphotograph of paint sample large VB30 seen under Olympus BX41 microscope at 50× through UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm), before GC-MS analysis.

7 Discussion

"Style is defined by those characteristic features of a painting that can be appreciated on its surface by the unaided eye (…) Technique, by contrast, constitutes the methods and materials used to produce the style."
Rica Jones from her essay 'Painting a Face All Red at the First Sitting: Ramsay's Technique for Portraits, 1735-60', see Jones (2013)

7.1 Introduction

Based on the research presented in the previous chapters of this thesis, this chapter addresses the main research question, as set out in section 1.2, as to whether an identifiable technique was followed by the companies of George Kenning and George Kenning & Son for the manufacture of the five painted banners in the Glasgow Museums Collection.

The materials identified in all five cases were: the main textile components (i.e., ground fabric, sewing thread, pole loop and fringe), the size layer, the binder for both paint and ground layers, the white metal leaves, the ground and paint extenders, and the main pigments of their palette. These offer a basis for finding equivalences between banners, and for evaluating information gathered from the historical sources and the reconstructions. To support comparative analysis, a total of 145 samples were gathered during the course of this study from the five Kenning banners from the Glasgow Museums Collection. The full list of samples and their location per banner is included in Appendix II. 137 of those sample were documented microscopically and made available for further research, to be handed over to Glasgow Museums for their safe storage. A final set of 80 samples was analysed using the instrumental techniques outlined in Chapter 4.

7.2 Dataset for three banner-making companies

The discussion presented in this chapter takes account of the observations and data gathered from the five Kenning banners in the Glasgow Museums Collection combined with inspection of another five banners by George Kenning, and George Kenning & Son companies that form part of the People's History Museum

Collection and the Edinburgh Museums Collection, as indicated in Table 7.1. It considers relevant entries from the National Banner Database concerning the George Kenning and George Kenning & Son banners listed in Chapter 2 (Tables 2.3 and 2.5). The discussion also considers photographs of banners made by the company of George Tutill between 1883 and c.1916, the same period during which the five Glasgow Museums Collection banners were made. These photographs are included in the publications of Gorman (1973; 1985), Emery (1998), Clark (2004), and Ravenhill-Johnson (2013) and were used as visual comparison throughout this research. In addition, the discussion considers the analytical results from four George Kenning & Son banners and six Tutill banners reported in studies by Rogerson and Lennard (2005), Macdonald et al. (2005) and Smith, Thompson and Hermens (2014), as indicated in Tables 7.2 and 7.3.

Table 7.1. Identification of the ten Kenning banners studied

Banner title	Maker	Year	Depository	Level of study
Leith Shipwrights	George Kenning	c.1873	Edinburgh Museums	Photography and visual examination
The Glasgow Typographical Society	George Kenning	1883	Glasgow Museums	Identification of textile, binding media, size, pigments and metal leaf
The Glasgow Upholsterers Society	George Kenning	1884	Glasgow Museums	Identification of textile, binding media, size, pigments and metal leaf
The Grain Millers of Glasgow	George Kenning	1884	Glasgow Museums	Identification of textile, binding media, size, pigments and metal leaf
Mersey Quay and Railway Carters Union	George Kenning	c.1889	People's History Museum	Photography and visual examination
Leith Lodge of Free Gardeners	George Kenning	c.1890	Edinburgh Museums	Photography and visual examination
United Kingdom Society of Coachmakers/National Union of Vehicle Builders, Glasgow Branch	George Kenning & Son	1914	Glasgow Museums	Identification of textile, binding media, size, pigments and metal leaf

Table 7.1 (continued) Identification of the ten Kenning banners studied				
Banner title	Maker	Year	Depository	Level of study
The Scottish Tin Plate Braziers and Sheet Metal Workers Society	George Kenning & Son	c.1916	Glasgow Museums	Identification of textile, binding media, size, pigments and metal leaf
Electrical Trades Union	George Kenning & Son	c.1916	People's History Museum	Photography and visual examination
National Union of Railwaymen, Hither Green Branch No. 537	George Kenning & Son	c.1916-1918	People's History Museum	Photography and visual examination

Table 7.2 Identification of the four George Kenning & Son banners studied by Rogerson and Lennard (2005) and Macdonald et al. (2005) (data from publications only)					
Banner title	Maker	Year	Depository	Level of study	Source
Electrical Trades Union	George Kenning & Son	c.1898	People's History Museum	Identification of textile, binding media and pigments	Rogerson and Lennard (2005), Macdonald et al. (2005)
National Union of General and Municipal Workers Lancashire District	George Kenning & Son	Not dated	People's History Museum	Identification of textile, binding media and pigments	Rogerson and Lennard (2005), Macdonald et al. (2005)
National Union of Railmen Paddington No 2 Branch	George Kenning & Son	Not dated	People's History Museum	Identification of textile, binding media and pigments	Rogerson and Lennard (2005), Macdonald et al. (2005)
National Union of Railmen Manchester District Council	George Kenning & Son	Not dated	People's History Museum	Identification of textile, binding media and pigments	Rogerson and Lennard (2005), Macdonald et al. (2005)

Table 7.3 Identification of the six Tutill banners studied by Rogerson and Lennard (2005)*, Macdonald et al. (2005), and Smith et al. (2014) (data from publications and raw data)

Banner title	Maker	Year	Depository	Level of study	Source
Social and Democratic Federation, Nelson Branch	George Tutill	c.1884	People's History Museum	Identification of textile, binding media, size and pigments	Rogerson and Lennard (2005), Macdonald et al. (2005)
Rolling Board and Packing Case Makers	George Tutill	c.1896	People's History Museum	Identification of textile, binding media, size and pigments	Rogerson and Lennard (2005), Macdonald et al. (2005)
Woolwich Workers Union No 207 Branch C	George Tutill	1914-18	People's History Museum	Identification of textile, binding media, size and pigments	Rogerson and Lennard (2005), Macdonald et al. (2005)
National Builders Labourers and Construction Workers Society, Edmonton Branch	George Tutill	c.1920	People's History Museum	Identification of textile, binding media and pigments	Rogerson and Lennard (2005), Macdonald et al. (2005)
Foresters' Banner	George Tutill	c.1905	People's History Museum	Identification of textile, binding media and size	Rogerson and Lennard (2005)
Loyal Orange Lodge No 77	George Tutill	1950s	Karen Finch Reference Collection, former CTCTAH (today's Kelvin Centre for Conservation and Cultural Heritage Research), University of Glasgow	Identification of textile, binding media, size, pigments and metallic paint	Smith et al., (2014)

* Another five Tutill banners and two Kenning banners were analysed in the study by Rogerson and Lennard, but unfortunately were not labelled in their publication. One of the five Tutill banners, the *Forester's Banner* (c.1905) was identified in the unpublished report *Analysis of Rubber in Banner Samples* by Paul Garside (2005), personal communication 2018. The rest remains unidentified.

7.3 Characteristics of banner construction

This combined set of banners, as listed in Tables 7.1, 7.2 and 7.3, enabled comparison of characteristic features of banner manufacture across three British banner manufacturing companies. These are respectively two Kenning companies, George Kenning (1868-1895), and George Kenning & Son (1895-1937), and George Tutill (1837-2022). The characteristic features identified for each of these three companies are summarised in Table 7.4, indicating elements of a shared banner painting tradition as well as changes in the availability of products over the years. This enabled assessment of the extent of their differences and similarities to support future attributions to either of the two Kenning companies. Table 7.5 identifies the characteristic features observed in each of the ten Kenning banners inspected to support evaluation of the technique used in their construction.

Table 7.4 Comparison of the main defining characteristics between the three banner-making companies during the period 1873-c.1916 as observed in the sample set of banners

Characteristics	Companies		
	George Kenning	George Kenning & Son	George Tutill
Branding	G. Kenning, London	G. Kenning & Son, London	G. Tutill, London
Designs offered	Custom-made layouts and designs	Custom-made layouts and designs	Standard layouts and designs Custom-made layouts and designs
Sizes offered*	12"/11", 11"/10", 10"/9", 9"/8", 8"/7", 7"/6"		
Textile construction	Multiple textile strips	Multiple textile strips Single textile	Single textile
Textile colour(s)	Dark blue	Dark blue, red, green, light blue	Red, yellow, green, blue, orange, purple, magenta, maroon
Size composition	Lead-containing protein size	Lead-containing protein size	Rubber**
Media composition	Partly heat-bodied linseed oil, pine resin	Partly heat-bodied linseed oil, pine resin	Partly heat-bodied linseed oil
Ground composition	Lead carbonate, barium sulphate, calcium carbonate	Lead carbonate, barium sulphate, calcium carbonate	Lead carbonate, barium sulphate.
Pigments	Umber, lead white, barium white, chrome green, vermillion, yellow ochre, red ochre, red lead, tin/alum-based red lake pigment, synthetic ultramarine, bone black, lead chromate, vegetable black	Red ochre, umber, yellow ochre, lead white, synthetic ultramarine, bone black, vegetable black, artificial orpiment, barium sulphate, alum-based yellow lake pigment, vermillion, Prussian blue, chrome yellow	Vermilion, lead white, Prussian blue, chrome yellow, lead red, synthetic ultramarine
Metal leaf	Silver	Aluminium	Aluminium***

* Sizes quoted in Imperial System as they were offered in their catalogues.

** "Rubber was identified using FTIR-ATR with a reasonable degree of confidence in the following four Tutill banners ranging between 1884-1918" (Garside, 2005): *Social and Democratic Federation, Nelson Branch*, *Rolling Board and Packing Case Makers*, *Woolwich Workers Union No 207 Branch C,* and *Foresters' Banner*. Personal communication, 2018.

*** Silver leaf has not yet been reported but it could also have been used during the nineteenth century production of the company, since it was the only white metal leaf suggested for silk banners before the twentieth century (see Chapter 3).

Table 7.5 Comparison of main construction's characteristics of the ten Kenning banners inspected

Banner abbreviation*	Maker	Size in feet**	Assembly***	Silk weave	Dye colour	Border colour	Loop attachment	Fringe colour	Brass tags
Shipwrights	George Kenning	9 by 6	3 strips, horizontal	Rep	Dark blue	No	Hemmed edge	Gold	No
Typographers	George Kenning	8 by 7	4 strips, horizontal	Rep	Dark blue	No	Hemmed edge	Red	No
Upholsterers	George Kenning	10 by 9	5 strips, vertical	Rep	Dark blue	No	Hemmed edge	Red	No
Millers	George Kenning	9 by 6	5 strips, vertical	Rep	Dark blue	No	Hemmed edge	Red	No
Mersey Quay	George Kenning	11 by 10	2 panels of 5 strips, vertical	Rep	Dark blue	Bright red	Hemmed edge	White, red, blue	No
Gardeners	George Kenning	10 by 9	4 strips, horizontal	Rep	Dark blue	No	Hemmed edge	Yellow, blue	No
Vehicle Builders	George Kenning & Son	9 by 8	4 strips, horizontal	Rep	Dark blue	No	Ribbon	Yellow, blue	No
Metal Workers	George Kenning & Son	9 by 7	Single fabric	Rep	Dark blue	No	Hemmed edge	n/a	Yes
Electrical Trades	George Kenning & Son	10 by 9	2 single fabrics	Rep	Dark green	Dark red	Ribbon	White, blue	Yes
Hither Green	George Kenning & Son	10 by 9	Single fabric	Twill	Bright green	Bright red	Ribbon	Green, green	Yes

* To simplify the mentioning of these banners in the text, their abbreviated name will be used as indicated in this table.

** Measures are indicated in feet as banner's sizes would be offered in Imperial measures by the banner makers. The sizes were measured in centimetres and are only approximated to sizes in feet for this table.

*** Horizontal indicates that the strips were laid horizontally next to one another, vertical indicates that the strips were laid vertically next to another. This coincided with the selvedges whenever they were identified.

7.3.1 Layouts and designs

A notable characteristic of Kenning's banner manufacturing was their bespoke design, signed in every banner inspected with at least an indication of the company as either Kenning, or Kenning & Son, and the city of manufacture, London. The evidence showed that each of the banners in this study manufactured by either Kenning company, George Kenning, or George Kenning & Son, was custom-made for their client, with the banners exhibiting variation in layout and motif (Figure 7.1). This contrasted with the banners manufactured by George Tutill, for which the images three of the sources reviewed (Gorman, 1973; 1985; Emery, 1998; Clark, 2004) showed a standard layout given by the in-house production of their silk-woven textiles in their custom-made jacquard loom (Figure 7.2). Tutill's banners also showed interchangeable motifs depending on the nature of the organisation that requested them (i.e., religious, or civil). These motifs were listed in considerable detail in the Tutill company banner catalogues (Tutill, 1861; 1895; 1930), and customers who chose them were even offered a substantial discount (Williams, 1987; Weinbren, 2006) (Figure 7.3).

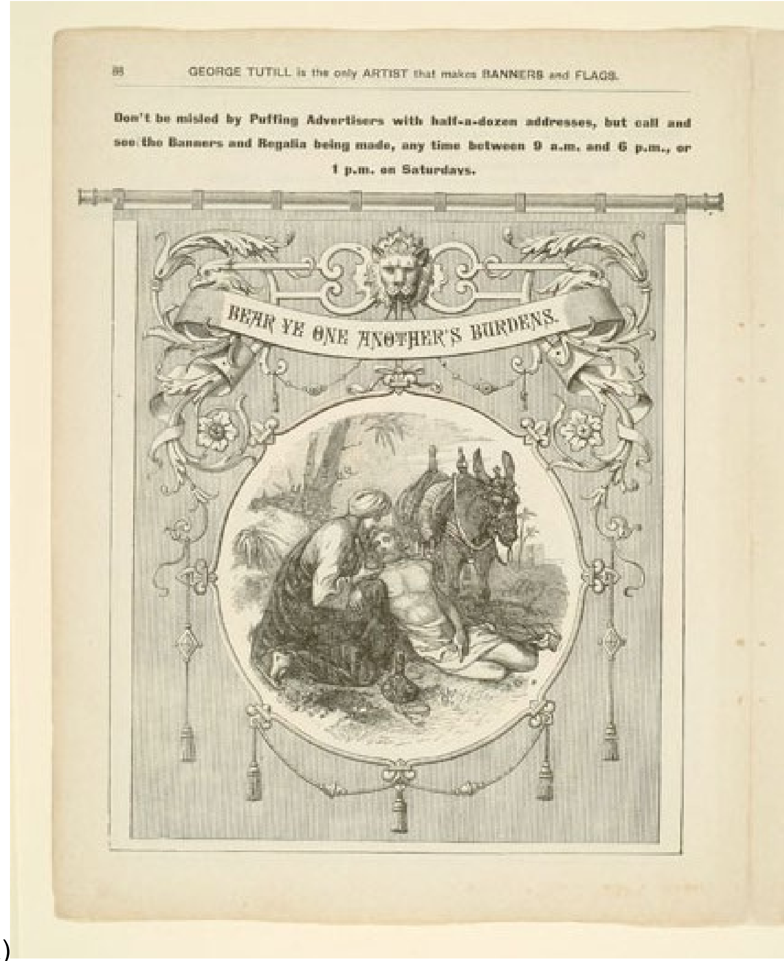
The three companies considered in this study did, however, offer similar banner sizes (Table 7.4), which suggests the standard formats of these types of objects during the period 1873-1917.

a) b) c) d)

Figure 7.1 Selection of George Kenning (GK) and George Kenning & Son (GK&S) banners to show the variety of their layouts: a) *The Leith Shipwrights* banner (GK) Image © Edinburgh Museums, b) *The Grain Millers of Glasgow* banner (GK) Image © CSG CIC Glasgow Museums Collection, c) *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* banner (GK&S) Image © CSG CIC Glasgow Museums Collection, and *The National Union of Railway Men Hither Green Branch* banner (GK&S) Image © People's History Museum Manchester.

a) b) c) d) e) f)

Figure 7.2 Selection of George Tutill banners to show their standard layouts: a) *St. Helens Sheet Glass Flatteners Trade Protection Society* banner (c1891) Image © Gorman (1973), b) *Transport and General Workers' Union* banner (c1922) Image © Gorman (1973), c) *Ipswich Dockers Union* banner (c1896) Gorman (1973), d) *Whitworth Park* banner (not dated) Image © Emery (1998), e) *Scottish National Operative Plasterers Federal Union Edinburgh District* banner (c.1900) Image © Clark (2004), and f) *Amalgamated Society of Carpenters and Joiners* banner (c1890) Image © Clark (2004).



a)

b)

Figure 7.3 Example of a standard design offered in George Tutill banner catalogue dating 1895 a) the catalogue entry (Image © People's History Museum Manchester), and b) the use in the banner of the *Broomfield Methodist Church* by Tutill (c.1911) (Image © Logan, 2012).

Evidence of the bespoke nature of Kenning's banners was found in the five Glasgow Museums Collection examples. Direct communication between clients and company was evident in the ordering of the banners for both *The Glasgow Typographical Society* and *The United Kingdom Society of Coachmakers* and verified in the minutes of each respective society. It was also evidenced on both these banners by the correspondence with their contemporary printed emblems, which informed the style of their central images as well as the imagery. For the banners of *The Glasgow Upholsterers Society* and *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society*, the adaptation of a kindred society's imagery into their design also evidenced similar communication. The motifs portrayed are an elaboration of those found in the emblems, with changes that had to be requested by the societies themselves and not initiated by Kenning's painters since the changes altered the meaning and intention of the imagery. Examples of these changes are the inclusion of the lion rampant of Scotland in the banner of the *Metal Workers*, or the added wording of SHELTER FOR THE NEEDY, UNITE to the *Upholsterers* (or Upholders) slogan of BE STEADY. These adaptations aided interpretation of the design of the two banners in the absence of primary sources regarding their commission.

The case of *The Grain Millers of Glasgow* banner suggested a slightly different approach to infer a bespoke design for their banner. Despite a lack of direct documentation concerning its commission and of any kindred society's imagery upon which the design is based, the banner showed resemblance to a description of the society's parade in a trades' demonstration (The Miller, 1883). In such article the author indicated that, due to the society's lack of their own banner, they paraded built-up models representing the evolution of grain milling, including a windmill, a watermill and an industrial mill, all represented in the *Millers* banner. Likewise, the banner portrays and image that showed resemblance to a commercial advert of a Gray roller-mill (The Miller, 1882; P. Allis & Co Catalogue, 1887). This implied communication between the clients and Kenning's company as the clients would have had to provide a description of the desired design and hand over visual aids from which to copy elements (e.g., prints or drawings), as evidenced in the resemblance of the milling machine portrayed in the banner and its advertisements.

None of these approaches were exclusive to the Kenning companies, as similar evidence has been published regarding the bespoke designs of other commercial British banner makers (Moyes, 1974; Emery, 1998). But in contrast to those made by Tutill, all the Kenning banners in the dataset were different from each other, as not even their layout was found to be shared.

7.3.2 Textile construction

There were differences detected in the textile construction of the five Kenning banners of Glasgow Museums Collection and of those additionally inspected for comparison. These were interpreted depending on the case as variation in suppliers, efficient/economic use of materials, or the changing of the company from George Kenning to George Kenning & Son. Changes in the turning of the hemmed edges towards either side A or side B of the banners were seen indistinctly in the banners of both companies, which could indicate different hands or different preferences for the same task. However, a significant difference identified was the change of stitch and method (i.e., manual to machine) for the joining of the silk textile strips of the ground panel.

All the George Kenning banners inspected during this study were consistent in their construction with multiple strips of a warp-faced plain weave silk textile or rib weave silk textile sewn together to achieve the required size, whilst the George Kenning & Son examples varied between each other (Table 7.5). Unlike two of his competitors, George Tutill and Henry Slingsby as discussed in Chapter 3, Kenning would not weave his own banner silks but procured them from external suppliers, thus relying on what was commercially available. This extended to the company of George Kenning & Son. However, two different ways of joining the strips were found: hand-sewn whip stitched seams butted edge to edge, and machine-stitched flat felled seams.

The *Typographers* and the *Millers* banners were machine-stitched using flat felled seams, whilst the *Upholsterers* and the *Vehicle Builders* were hand-sewn with a whip stitch. It is possible that the reason for this change in the case of the *Upholsterers banner* was to make the most of the width of the strips, as this banner was the widest of the five Glasgow Museums Collection banners. In the case of the *Vehicle Builders* banner, the possible reason was to achieve the requested size in an economic way by joining the strips to their maximum at the centre of the panel. Three other George Kenning examples exhibited flat felled seam joining with different methods: Edinburgh Museums Collection's *Shipwrights* was machine-stitched, Edinburgh Museums Collection's *Gardeners* was hand-sewn, and People's History Museum's *Mersey Quay* was machine-stitched. That makes the machine-stitched flat felled seam the most common way of joining used by the company of George Kenning in the banners examined for this study, between 1873 and 1889. Interestingly, the *Gardeners* banner was the only case where the flat felled seam was sewn manually, which again may indicate the adaptation of Kenning's workers to each of their banners or a particular preference of a given team/employee.

Changes in the width of the textile strips forming the ground panel were also identified in the banners of both George Kenning and George Kenning & Son companies. The banners of the *Upholsterers* and the *Vehicle Builders* had the inner strips of the textile panels stitched selvedge to selvedge, resulting in a maximum width of 59.8cm and 61.6cm for these two banners respectively. In the case of the *Typographers* and the *Millers* banners, the maximum width between the inner strips of their textile panels was 59.2cm and 59.3cm with an average seam width of 6mm and 4mm respectively (see Appendix I). The *Shipwrights* banner had a maximum width between inner strips of 56cm and a seam width of 10mm; the *Gardeners* banner had a maximum width of 60cm, plus a seam width of 4mm; the *Mersey Quay* banner had a maximum width of 59.8cm and a seam width of 6mm.

According to the Dress and Textile Specialist (DATS) (2007), the standard width for British industrial weaving between the eighteenth and twentieth centuries were 21” (53.34cm), 50” (127cm) and 63” (160cm), all of which differ from the measurements of the strips of the four Kenning examples of Glasgow Museums. DATS also report the standard widths of French industrial weaving at 24” (60.96cm), 54” (137.16cm), and 60” (152.4cm), the first of which matches reasonably in the case of the *Upholsterers* banner and almost perfectly in the cases of the *Vehicle Builders* and the *Gardeners* banners at 60cm. However, in the cases of the *Typographers* and the *Millers banners*, each silk panel had an average width of 59 cm, measured in-between the flat felled seams. Considering the hemming of the seams, which in sections included both selvedges at either side, the maximum width of each panel could possibly approach the 64 cm (25.2") reported for the loom width of contemporary Chinese silks (Kuhn et al., 2012). This comparison is relevant as Kenning advertised his banners as "made from the finest Chinese silks" (*George Kenning and Son. Summer Number [Supplement]*, 1901)). Unfortunately, the lack of primary sources mentioning invoices or inventories of the company prevented confirmation of either the provenance or supplier(s) of these "Chinese silks" textiles. The only example measuring less than either of these common widths was the *Shipwrights* banner, which could indicate availability of a narrower width in 1873 in comparison to 1883 and later. Only three of the George Kenning & Son banners examined for this study were made on single pieces of fabric, all of which measured different widths: the *Electrical Trades banner measured* 285cm including contrasting borders, the *Metal Workers* banner measured 266cm hemmed edge to hemmed edge (no selvedges were found), and the *Hither Green banner measured* 259cm selvedge to selvedge. Additionally, the three George Kenning & Son banners inspected had different types of weaves between them. The *Electrical Trades* banner had a similar warp-faced plain weave or rep fabric as the George Kenning examples; the *Metal Workers* banner had a significantly less ribbed rep fabric; and the Hither Green banner was the only one with a different twill weave fabric. This shows the increased availability of widths in the commercially available silk textiles c.1917.

The changes in sizes and type of weave seen in Kenning & Son's main silks could indicate modernisation of their outsourced producers, and/or changes in the availability of materials, motivated by a desire to meet the increasing demand for large banner silks at presumably lower production cost at a time when the official Trade Union membership in Great Britain reached six and a half million in 1918 (Davis, 2004).

7.3.3 Textile colours

Another characteristic detected in the five Kenning banners in the Glasgow Museums Collection as well as the two banners in the Edinburgh Museums Collection was the dark blue dyeing of their main silks (Table 7.5). No documentation exists concerning the commissioning and design of the five banners in the Glasgow Museums Collection, so it cannot be determined if the colour was requested by each of the societies or if it was a particular preference of the Kenning company at a time. Other contemporary banner makers produced their banners in a variety of colours, not just dark blue (Gorman, 1973; Emery, 1998; Clark, 2004). Blue is a symbolic colour for Freemasons (Masonic Lodge of Education, 2022), of whom Kenning was a dedicated member, and some of the trade societies' banners show imagery relating to Freemasonry. However, the use of blue also on banners of societies that are unrelated to Freemasonry, such as the Order of Druids and the Free Gardeners, could indicate either a more personal choice of the manufacturer rather than symbolic reason for its selection or, simply, the availability of materials.

In comparison, George Kenning & Son's banners exhibit a wider variety of colours. Although the two examples in the Glasgow Museums Collection are dark blue, entries on the National Banner Database show at least three other colours used for the main silk textiles: red, green and light blue. The *Electrical Trades* and Hither Green banners had dark green and bright green dyed ground textiles, respectively. George Tutill also offered silk textile in multiple colours as listed in Table 7.4, possibly related to the fact that he wove his own silks as discussed in Chapter 3.

7.3.4 Pole loops and fringes

Other textile-related characteristics of Kenning's banners were identified in the grosgrain ribbons used for the pole loops. These ribbons were one of Kenning's earliest specialties as described on the company profile (*George Kenning and Son. Summer Number [Supplement]*, 1901), being manufactured in-house with a specialised ribbon department before 1907 and a specialised ribbon factory in Coventry from 1907 onwards (Kenning, 1916). The set of loops on all but one of the George Kenning banners and on one of the George Kenning & Son banners measured an exact width of 2” (5.08 cm) (see Appendix I), as it would have been quoted at their time of manufacture, indicating the size of their grosgrain ribbon loom. This width was measured from both selvedges on either side of the ribbons, identified by the turns of their wefts (see Appendix I).

In terms of their materials, three of the banners analysed, the *Typographers*, *Upholsterers* and *Vehicle Builders* banners, had comparable cotton warps and silk wefts in their pole loops. Only the *Millers* and *Metal Workers* banners showed a different width and composition, which was identified as a modern man-made fibre replacement as part of a repair/restoration in the case of the *Millers* banner, and as a different quality of materials in the case of the *Metal Workers* banner to replace the undyed cotton warps for silk yarns. Correspondingly, most of the bouillon fringes of the five Kenning banners inspected showed a thick yarn core covered with thinner yarns, identified respectively as cotton and silk on three of the five Kenning banners of Glasgow Museums Collection. Only the fringe of the *Vehicle Builders* banner was identified as wool. The banners of *The Leith Lodge of Free Gardeners* and the *Mersey Quay and Railway Carters Union* both showed similar-looking fringes that could also be woollen made, but these two banners unfortunately were not analysed.

Fringes, also frequently advertised and described in the surviving company profile (*George Kenning and Son. Summer Number [Supplement]*, 1901), were likewise manufactured in-house. However, fringes were typical of other banner makers, and they do not seem to differ much between them, as seen in the published images by Gorman (1973), Emery (1998), Clark (2004) and Ravenhill-Johnson (2013). Thus, the fringes cannot be considered a defining feature of any banner-making company, but only a shared tradition in the manufacture of painted banners subject to the availability and taste of materials at the time of their production. This continues to date as modern banners also share a similar type of fringe.

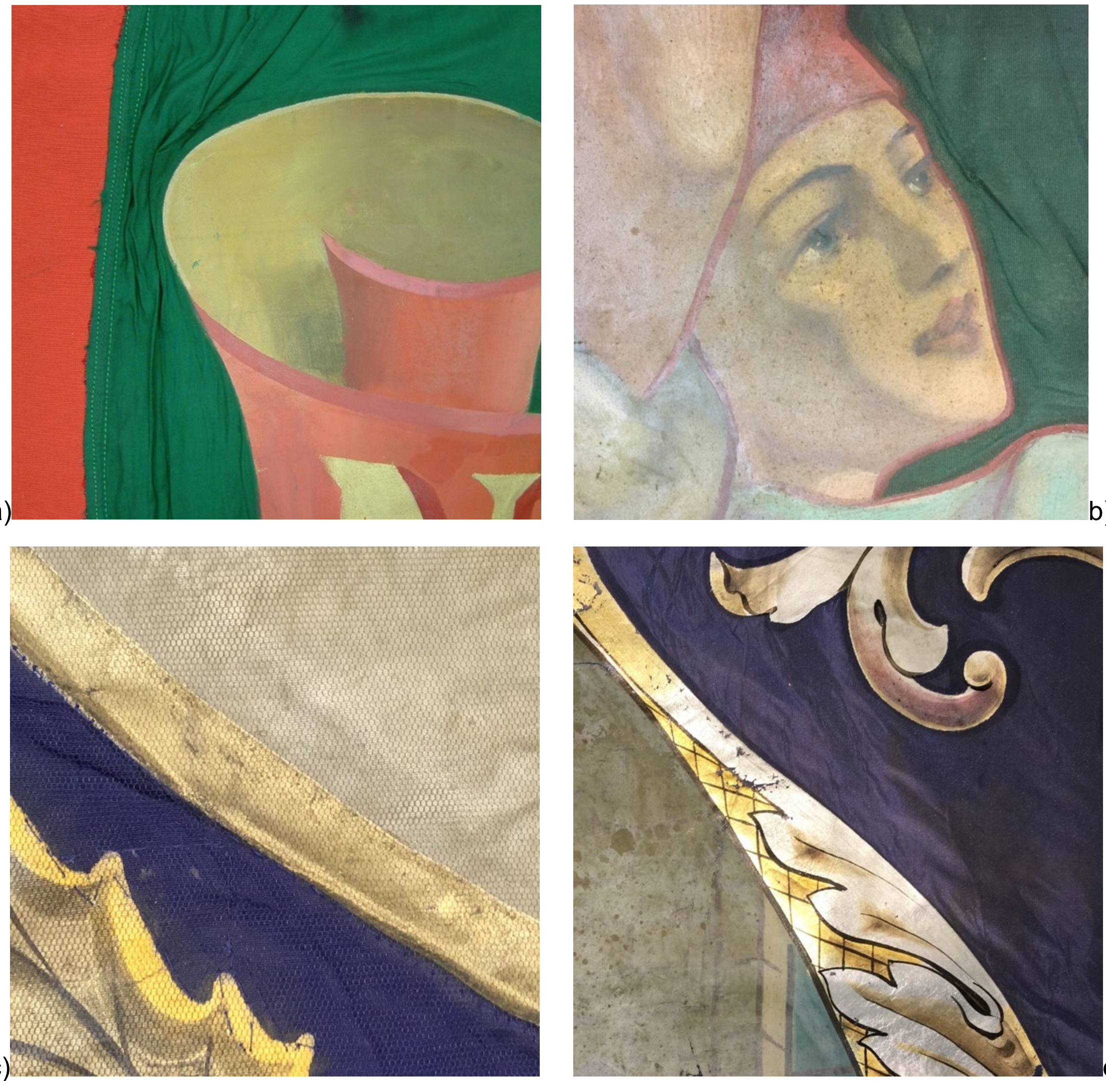
Two different means were identified for attaching the pole loops: attachment, either machine-stitched or hand-sewn, to the top hemmed edge of the banner, or attachment by enclosing the loops between two herringbone ribbons at either side of the top edge. The first of these means was seen in all the George

Kenning banners inspected and the *Metal Workers* banner. The second of these means, attachment of the loops using a herringbone ribbon, was observed on the *Vehicle Builders*, *Electrical Trades,* and *Hither Green* banners, all likely to be manufactured in house by the company of George Kenning & Son. This indicates a change of technique, which although not exclusive to all the George Kenning & Son's banners, was not seen in any of the George Kenning examples. In this regard, the means of attachment of pole loops is potentially useful in distinguishing between the companies' output. Additionally, it helped to identify later interventions made on the banners, like the reattachment of the fringes in the *Typographers* and the *Millers* banners and replacement of hanging loops identified in the *Millers*, *Upholsterers* and *Typographers* banners. The *Millers* banner was the only technically-analysed example to have man-made fibres as the warps of the hanging loops (see Chapter 6 and Appendix I for details).

Changes such as the use of woollen fringes in the banners of the *Vehicle Builders*, and possibly in the *Electrical Trades* banner, indicate a choice that could relate to the cost or size of the banner. Woollen fringes were, however, not exclusive to George Kenning & Son as two George Kenning examples, the *Mersey Quay* and *Gardeners* banners, also seemed to have them, alas not analysed. *Reconstruction 2* showed that the fringe not only had decorative purposes but added weight to the banner, increasing the draping and stretching the textile after being kept rolled. This could explain the selection of a thicker and much heavier fringe for larger banners, although further investigation is required.

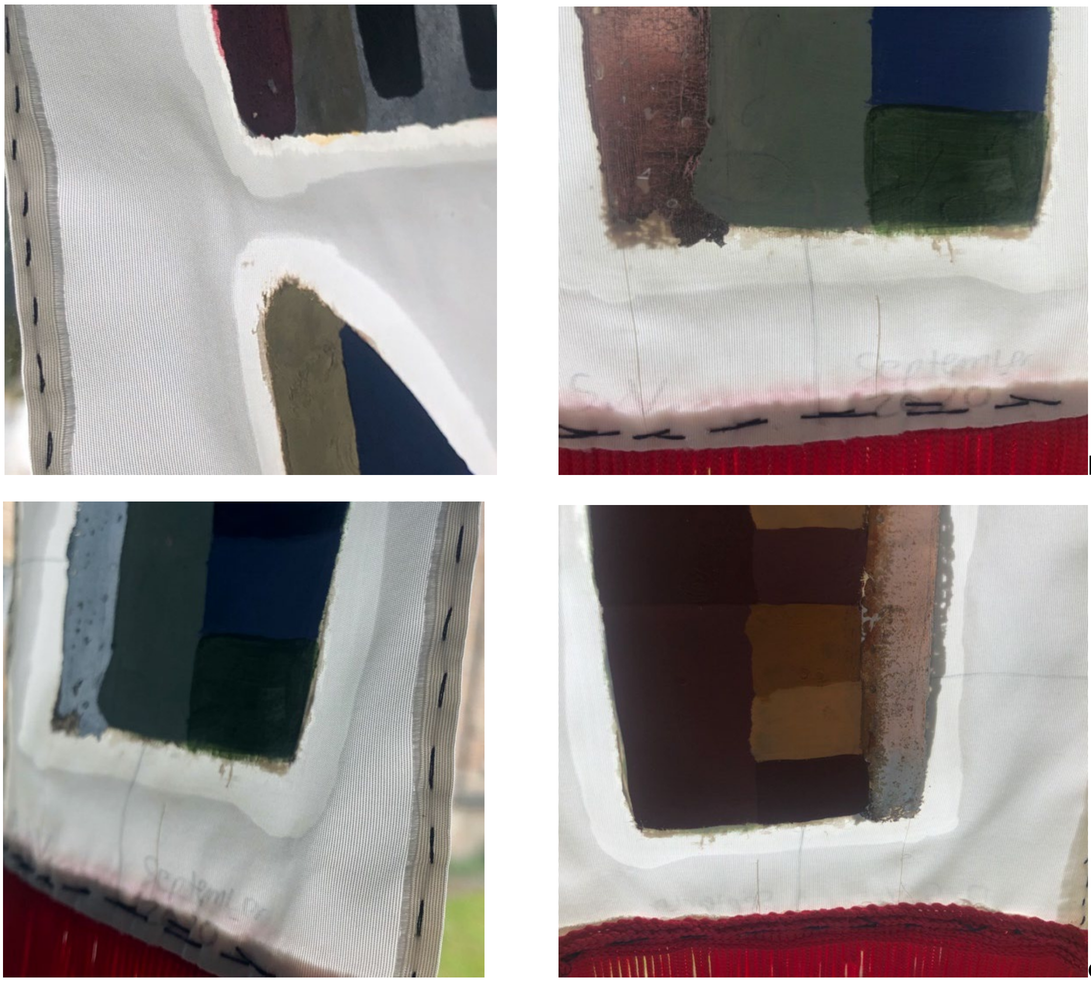
7.3.5 Stretching of the textile during production

A further characteristic was the tight stretching of the silk textiles and the passing of the design. Corresponding with Kelly's contemporary practical manual for sign painters, *The Expert Sign Painter* (1911), evidence showed that the textiles had been tightly stretched in preparation for applying their decorative layers. Characteristic distortions observed in specific areas such as the unpainted spaces between scrolls, frames and other metallic decorations were also experienced during the tight stretching and release of the *Reconstruction 2* banner, which suggested a direct relation to the production methods described by Kelly and seen in the historical photographs and films of Tutill and Kenning manufactures (see Chapter 3). Other factors such as environmental changes over time may also lead to differential dimensional changes in painted and unpainted areas of the silk. This characteristic textile deformation could be related to the physical property of secondary creep, defined as a permanent time-dependent deformation of a textile produced by being subjected to force (Ballard, 1995, pp. 35). This would require further investigation through a more systematic study. What was notorious is that textile deformation was consistently seen along the edges of the metallic scrolls, made more evident by the flatness produced by the size exceeding the decorated areas, which was applied while the banner was stretched as also experienced with *Reconstruction 2* (Figures 7.4 and 7.5). Further research is needed to clearly relate these deformations to secondary creep, which could be beneficial to understanding some of the most common structural conservation problems in painted banners that have been reported: splitting of the silk fabric at the junction between silk and painted regions; permanent deformation ("bellied") of the banner due to hanging; splitting of the textile across the weight bearing points; permanent curling and overstretching due to tight rolling; formation of horizontal fractures through the painted silk due to loss of flexibility in the paint (Lochhead, 1995; Rogerson and Lennard, 2005).



a) b) c) d)

Figure 7.4 Textile deformations between silvered areas and exposed silk seen in Kenning's banners, a) *Hither Green* banner, b) *Electrical Trades* banner, c) *Millers* banner, d) *Metal Workers* banner (Image © D.S.V.).



a) b) c) d)

Figure 7.5 Textile deformations between silvered areas and exposed silk seen in *Reconstruction* 2. (Image © D.S.V.).

Taut stretching of the textile was also implied by the finding of “a narrow band of material (…) much stronger than the fabric which is to be stretched” (Kelly, 1911, p. 106) in the *Millers* and the *Electrical Trades* banners. Concealed inside their hemmed edges were narrow bands of a textile, possibly a type of calico due to the tabby weave and unbleached/unprocessed appearance, that was identified as cotton in the case of the *Millers* banner. This added band was suggested in the only known surviving photograph from Kenning’s banner department, where a white line is seen surrounding the sides of the two stretched banners being painted (George Kenning and Son. Summer Number [Supplement], 1901) (Figure 7.6). However, this historical photograph is not sufficiently detailed to support accurate identification of the material, and another interpretation could be the addition of such a band to create a firmer edge on the banners. Such addition for a firmer edge, however, was not found as a recommendation in the late nineteenth-century and early twentieth-century sources on banner paintings that were reviewed in Chapter 3. Evidence concerning use of this approach in the context of other banner makers is necessary to relate it to Kenning companies alone or as part of a shared tradition.

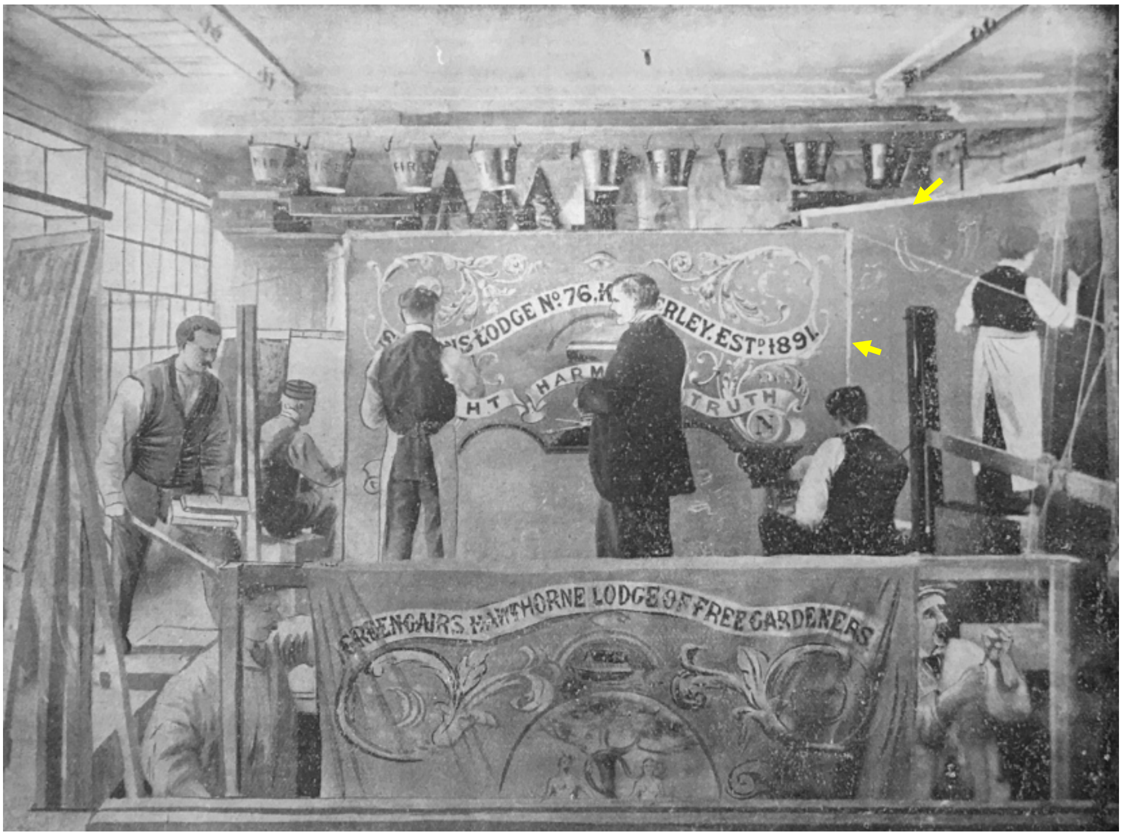
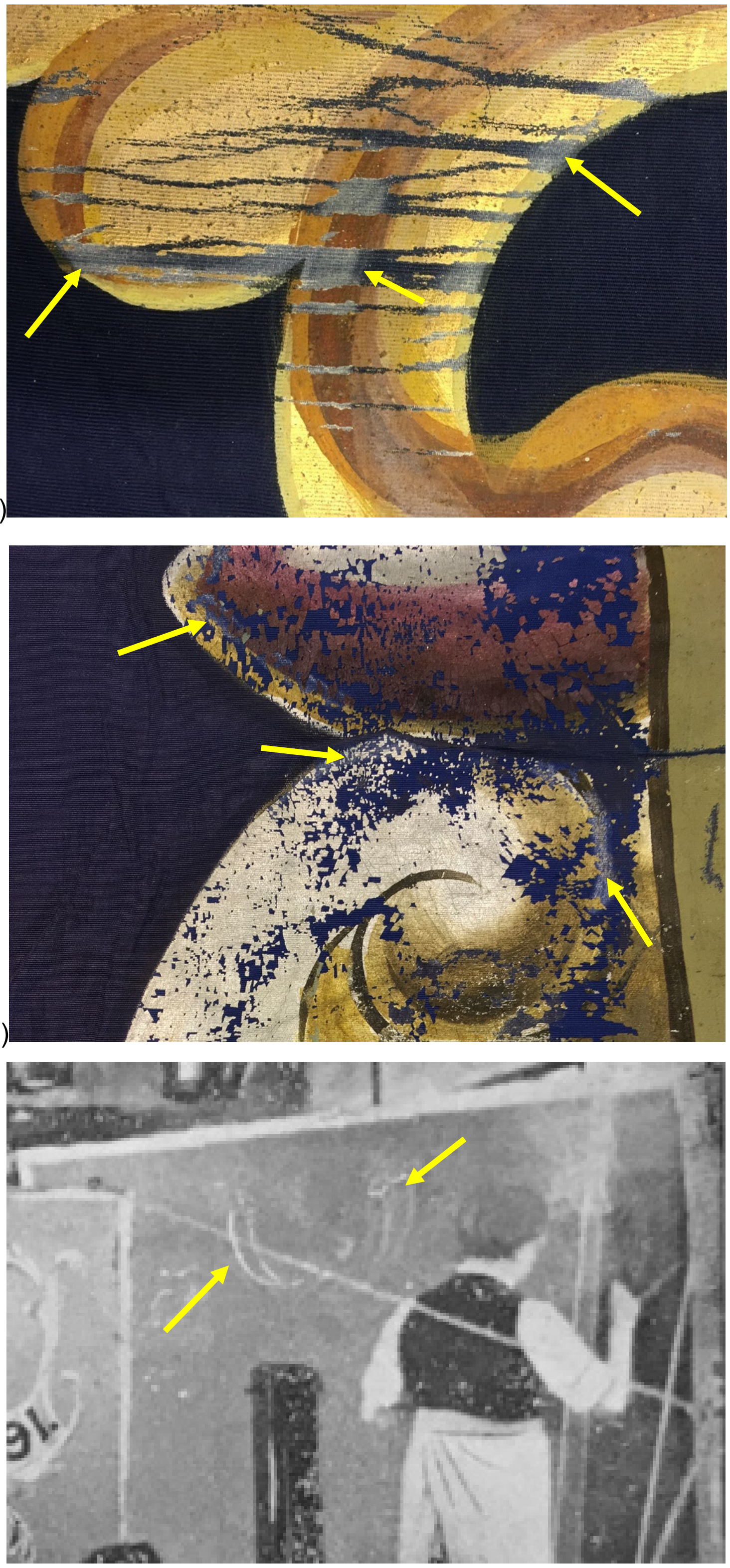


Figure 7.6 Historical photograph (originally retouched) of Kenning's banner department showing their silks stretched. Yellow arrows indicate the white line that could correspond to a different type of textile (possibly cotton calico) added as reinforcement for stretching (Image © George Kenning and Son. Summer Number [Supplement], 1901).

7.3.6 Transferring the design during production

The use of stencils to transfer the general figures to be silvered and painted was confirmed by the inversely matching designs on both sides of all but two of the single-layered painted banners. Only two of the George Kenning single-layered banners inspected, namely the *Leith Shipwrights* and *The Leith Lodge of Free Gardeners* banners, lacked perfect correspondence between sides A and B. In these two banners, the slightly different design of one side permeated to the other.

The likely method used for transferring the designs onto the silk was evidenced on three of the banners analysed, the *Typographers*, the *Upholsterers* and the *Metal Workers* banners, where evidence of unbound gypsum particles were found ingrained in the yarns beneath the ground layers. Gypsum is likely to have been used as the material for pouncing on dark backgrounds, a method mentioned in most of the historical sources discussed in Chapter 3. Visual evidence also showed the silhouetting of the general outlines in white paint, both on Kenning's historical photograph and on the paint detached areas of the *Mersey Quay* and *Metal Workers* banners (Figure 7.7). Traces of the preparatory drawing for the central paintings were detected on macrophotographs of the *Typographers*, *Millers* and *Upholsterers* banners, and a cross-section from the *Metal Workers* banner had charcoal particles encased between the ground and paint layers (see Appendix III), signalling the material mentioned in Kelly's manual (1911) and shown used in the footage of Herbert Sharpe's banner painting (Pathé, 1958), both described in Chapter 3.



a)
b)
c)

Figure 7.7 Detail of the potential white tracing of the design glancing through the damaged areas of two Kenning banners and a zoomed-in area of Kenning's historical photograph showing the process being done on a stretched banner: a) Scroll of the *Mersey Quay* banner, b) Scroll of the *Metal Workers* banner, and c) Detail from the historical photograph shown in Figure 7.6. Yellow arrows indicate the thick white tracing.

7.3.7 Composition of decorative layers

A potentially defining feature of the technique used by Kenning's banner painters relate to the selective sizing of the silk. This was noted in the Kenning and Tutill banners analysed by previous research (Rogerson and Lennard, 2005; Macdonald et al., 2005; Smith, Thompson & Hermens, 2014; Smith, 2019), but the material was not unequivocally identified. In the case of Kenning's banners, the analysis conducted for study on the banners in the Glasgow Museums Collection proved this preparatory size layer to be collagen-based. This builds on the previous work by providing more supporting evidence for the presence of some type of protein used in the manufacture of this type of painted banner.

All painted work inspected on the five banners was "well sized" before the paint [and the ground] were applied, measuring "about ¼ inch [about 0.6 cm] beyond where the paint is to go" (Kelly, 1911, p.107). The size layer was located on all the cross-section samples from the scrolls and on all but one of those from the central paintings. The size was identified as most likely to be collagen-based by its probable characterisation based on best-fit comparisons of FTIR-ATR spectra, and by its bright positive staining with SYPRO Ruby® indicating a protein (see Chapters 5 and 6). A distinguishing feature, however, was the presence of an unexpected content of lead. This was accurately located and identified using SEM-EDX on all the size layers of the scroll samples and the central painting sample of the *Typographers* banner. The remaining four central painting cross-sections did not show evidence on the backscattered electron images of a similar white film immediately on top of the yarns, but instead showed a grey material seeping into them that also contained lead. This was interpreted as seeped linseed oil from the ground layer but would require point analysis with micro-FTIR imaging to confirm. SYPRO Ruby® staining did locate a proteinaceous size layer on all samples except the central paint sample from the *Metal Workers* banner. However, the chosen analytical techniques were insufficiently sensitive to support identifying the specific type of protein used for sizing. This would require further study using proteomics or direct temperature mass spectrometry. Kelly recommends parchment glue as the sizing material (Kelly, 1911), so that could be one of the possibilities to test.

The size layer containing lead appeared on the backscattered electron images as a white film on top of the yarns, denoting the dissolution of lead into the material rather than encapsulated particles. A similar possible method was found in the historical source of Field's *Chromatography*, where the solubilisation of lead acetate into water and its application to canvases before priming is suggested to speed up the drying of oil paints in damp weather (Field, 1835, p.56-57). Thus, Kenning's method could have solubilised lead acetate into the collagen size to help speed the drying of the upper layers. If this is verified, it could be considered as a potentially defining characteristic of the company. This may also relate to the research on nineteenth-century painting materials by Carlyle, where use of "sugar of lead" or lead acetate by the artists of the period is described (Carlyle, 1999; 2001). Given that the size used by the banner maker Tutill has been identified as rubber-based, at least between 1884 and 1918, the consistent finding of a lead-based proteinaceous size in Kenning's banners could be distinctive during the period 1883-1916. However, further identification of this layer needs to be carried out for other banner makers to investigate whether the use of lead-based proteinaceous size was exclusive to Kenning during this period, or whether its use could be more widespread within the banner painting tradition. Evidence for its use by other banner makers was, however, not found in any of the historical sources reviewed in Chapter 3, so it may have been an innovation by Kenning.

The composition of the ground layers is another characteristic of Kenning's method as identified in all-but-one of the five Glasgow Museums Collection banners analysed. Kelly's manual states that "a coat of oil white lead (no turps) (…) should be used in a thin condition, and be well rubbed out" and "A goldsize is used composed of pure fat oil and white lead, nothing else, (…) bodily laid in on both sides of the frames" (Kelly, 1911, p. 107-108). Although GC-MS confirmed the use of partly heated linseed oil as the binder in all cases, variable traces of calcium carbonate and barium sulphate were found in the ground layers of the scrolls and of the central paintings of the *Typographers*, *Millers*, *Upholsterers*, and *Metal Workers* banners. The only case that had nothing but lead carbonate in both types of ground layers (scrolls and paintings) was the *Vehicle Builders* banner.

The two general types of lead carbonate pigment distinguished amongst the five banners analysed were, as described by Eastaugh et al. (2004): the type resembling the Dutch stack processes, showing fine- to medium-grained lead carbonate particles with euhedral and subhedral hexagonal shapes; and the type resembling the Cremnitz and other modern processes, having a finer particle size with rounded or “bacteroid” shape (Eastaugh et al., 2004, p. 843) (see Chapter 4 for images). The first of these types was the only type of lead carbonate used by the George Kenning company in the ground layers for both the scrolls and the central painting, also used by George Kenning & Son company for the ground layers of the central painting. The second type of lead carbonate pigment was only seen on the two George Kenning & Son banners, in the ground layers for both scrolls and the central painting for the *Vehicle Builders* banner and in the ground layer for the scrolls for the *Metal Workers* banner. This may suggest a modernisation of the manufacturing process used by supplier(s), and a preference for its usage for the ground layer under scrolls, possibly to render it better suited for gold sizing.

All polychrome decoration appeared to be carried out whilst the textile was stretched, judging by the distorted textile surrounding every applied decoration (painted or metallic) (Figure 7.5) as well as by the surviving photographic evidence discussed in Chapter 3 of banner making at the Kenning company, the Tutill company and the Sharpe studio. All polychrome decorations appeared to be applied over the previously sized and/or primed designated areas, as was evidenced by the applied size that has exceeded beyond the outline and by the distorting of the textile from that excessive size line onwards (Figure 7.8). Nevertheless, all known banners made by Kenning’s companies (or at least a statically representative sample of them) would need to be analysed in order to confirm this as a defining feature of their technique. This method of polychrome decoration does exemplify the way that Kenning’s workers applied the decoration to create the images and messages of their banners. The first of these processes was the silvering of the scrolls and frames, with the application of white metal leaves on top of the tacky ground laid out beforehand. This was corroborated with the reconstruction, where the ground layer sufficed for adhering the metal leaves, after reaching the required tackiness within 12 hours from their application as described in Kelly’s manual (Kelly, 1911, p. 108).

Contrastingly, the metal leaves applied with Japan oil gold-size in the reconstruction showed a different texture, registering the brushstroke of the applied adhesive, giving a metallic paint appearance as that indicated by Smith, Thompson and Hermens (2014).

a) b) c) d)

Figure 7.8 Images of size impregnated line exceeding the metallic scroll decorations in banners: a) *Shipwrights* banner, b) *Typographers* banner, c) *Metal Workers* banner, d) *Reconstruction 2*. The yellow arrows indicate the flattened area from the impregnated size. (Image © D.S.V.).

All George Kenning banners had silver leaf whilst all George Kenning & Son had aluminium leaf, identified with XRF for the *Typographers* banner and SEM-EDX in all five banners from the Glasgow Museums Collection. This corresponded with the period of availability of the materials as discussed in Chapter 3, showing development and a change of materials that reflect wider changes. Suggesting they were “immediately clear-sized with weak parchment size” (Kelly, 1911, p. 108), a proteinaceous layer was made visible with the positive SYPRO Ruby® staining in four of the scroll samples. This process was followed in the reconstructions, corroborating not only that a thin collagen-based coating was enough to prevent the quick tarnishing of the silver leaf (which happened after only one week in the uncoated areas) but also that it had the function of facilitating the application of coloured glazes. This practice has previously been reported for coloured glazes on metal leaf (Emmerling et al., 2013) and explained the positive staining of the *Vehicle Builders* scroll cross-section, which was still coated with size regardless of being non-tarnishable aluminium.

Evidence gathered from the dataset suggested that all paints used by both Kenning companies were commercially produced, which corresponds with the findings of Kelly (1911) and the sources for sign-painters in the late nineteenth-century and early twentieth-century sources discussed in Chapter 3. The binding media in all cases, identified by AA&R using GC-MS, was partly heat-bodied linseed oil with traces of pine resin. Pine resin could have been added to the paint by the manufacturer, as recipes at the time experimented with the addition of such materials in the mixture (Carlyle, 2001) and no added varnish was identified on four of the five banners. However, this addition could also have been made by Kenning company, as the analysis showed traces of the material in both ground and paint layers (see Appendix III for full GC/MS report). Contrastingly, the paint sample from the Vehicle Builders banner, which was the only example with an identifiable layer of varnish, showed the lowest trace of pine resin. This suggests that its varnish content did not alter the results significantly and could point to a slightly different composition (different kind of resin), which was disregarded for not having been originally applied by the manufacturer (see Chapter 2).

The pigment and extender particles of the paints were seen as homogeneously distributed and with regular small size on the backscattered electron images. This contrasted with the larger size and more heterogeneously distributed particles of the ground layer, which indicated a hand-ground mixture likely used to reduce costs as the ground was being used in greater abundance than the paints. Only one variation was detected amongst the five Kenning banners of

Glasgow Museums Collection: the ground layers of the *Millers* banner showed two qualities of ground layers superposed, with a coarse one applied first followed by a thinner/finer one applied on top. This indicates a different approach to the same task, possibly carried out by a different team. Although only identified in this banner within the study set of banners, it could be expected in other Kenning examples as presumably Kenning retained his employees for more than one banner as did Tutill (Gorman, 1973).

The variety of pigments identified using SEM-EDX (see Chapter 4), matched those which were commercially available at the time of making the banners (Townsend, Carlyle, et al., 1995; Carlyle, 2001; Townsend, 2004) and which have previously been identified in similar banners (Macdonald et al., 2004; Smith, Hermens, Thompson, 2014). In addition to this variety of pigments, other colourless materials such as calcium carbonate and barium sulphate were found repeatedly using XRF, FTIR-ATR and SEM-EDX. These are interpreted as extenders typical of commercially produced paints of the period (Townsend, Carlyle, et al., 1995; Townsend, 2004). Further, all the Kenning paints analysed using SEM-EDX had a small magnesium content, which if identified as magnesium carbonate could potentially point towards Winsor & Newton's manufacture since that has been considered a marker for their paints between the late nineteenth to early twentieth centuries (Otero et al., 2017a; Otero et al., 2017b, Townsend, personal communication, 2020) and is not yet reported for paints of other manufacturers.[48] Notwithstanding, the consistent identification of calcium, barium and magnesium within the paint mixtures potentially indicates a single supplier for Kenning's paints. This use of a single paint supplier is a custom also followed by another banner-maker, Henry Whaite of Manchester, who kept an account with the colourman Roberson (Woodcock, 1995). Another consistent finding throughout Kenning's paint layers pointing towards a single supplier, was the detection of silico-aluminates (clay) whenever red and yellow iron oxides were identified, indicating their association and possible extraction from a natural source (Eastaugh et al., 2004).

[48] The two added paint layers on the *Vehicle Builders* banner were not considered during this research since they had not been applied by George Kenning & Son but by a member of the trade society in 1942 (see Chapter 2).

An addition seen in Kenning's banners painting technique, which relates to the late nineteenth century concept of solid painting discussed in Chapter 3, was the mixture of lead carbonate paint. This addition was observed with each of the colours analysed with SEM-EDX. Its use was likely intended to speed up drying of the paint and to stabilise the layer after drying. This technique was also tested in the reconstruction, finding that the addition made the paint more easily spreadable, an advantageous quality for banner painting. Such practice was also seen in the 1958 banner painting footage (Pathé, 1958), where a lump of white paint (possibly lead carbonate) stands out from the other colours on the palettes and is seen dragged towards them repeatedly for making the mixtures to be applied.

Nonetheless, the practice of mixing lead carbonate paint with other colours is not advised for other types of paintings manuals of the period (Williams, 1880), as it produces the "dull" or pastel-like colours perceived on all Kenning and Kenning & Son banners inspected during this research. Thus, this lead carbonate mixture with paints reflects a distinctive painting practice to banner painters that does not seem to be shared by the wider painting tradition. Additionally, surviving photographs of Tutill's workshop (Gorman, 1973) show a larger lump of white on their palettes. Thus, although different from other types of painters, it seems to be a characteristic of banner painters that would need to be investigated further in other examples of this type of object.

The simplicity of the painting technique with few layers to construct the images, the spreadable quality of paints containing lead carbonate, and the characteristics of the taut, sized, ribbed silk textile that allowed ground smoothness through the firm grip on their fine valleys and its easy levelling with their peaks, resulted in a very thin covering of paint layers in the reconstruction. In contrast with a tabby weave textile, where the applied ground needs to fill the multiple spaces between the intersected yarns, the ribbed silk allows for a thinner ground application, filling the thin lines between the ribs but partly covering the valleys (Figure 7.9). This was experienced during the making of *Reconstruction 2*, particularly after scrapping the excesses as indicated in Kelly's method (see Chapter 3), partly exposing the valleys in a similar way as in the analysed banners (Figure 7.10).

Figure 7.9 Micrograph of the exposed ground of the *Metal Workers* banner showing the different accumulation in the ribs and the valleys of the weave. Image taken using a Dinolite USB microscope at 5x magnification. (Image © D.S.V.).

Figure 7.10 Detail of the exposed ground of the *Reconstruction 2* banner showing the different accumulation in the ribs and the valleys of the weave. Digital zoom of the acquired photograph. (Image © D.S.V.).

The paint applied in *Reconstruction 2* over the smooth surface of the ground layer, was capable of being extended easily and thus resulting in the need for less paint to cover wide areas (see Appendix IV for details). A combination of factors (spreadable paint, taut homogeneous support, and evenly thin ground layer) could have been the success of Kenning's technique in particular and banner painting in general, as thinner lead-containing layers enable a faster drying of the linseed oil medium and also help to roll them for transport and storage. Such speed of drying and rolling capability was accomplished with the making of the reconstruction, matching the minimum time of 27 days calculated for the *Typographers* banner (see Chapter 2). The thickness of the three George Kenning banners analysed was 258µm for the scrolls and 327µm for the central paintings; whilst the thickness of the two George Kenning & Son's banners analysed was 239µm for the scrolls and 232µm for the central paintings (Table 7.6). Given that the measurements of the two George Kenning & Son banners are closer to 80% of thickness reported by Macdonald et al. for the George Tutill banners analysed (300 µm), it could support their observation that Kenning & Son banners have thinner paint layers (Macdonald et al., 2013, p. 226). As both George Kenning's and Tutill's banners have thicker paint layers than those of Kenning & Son's, it could indicate a development in practice. However, the measures are too few to determine whether or not these differences are significant.

Table 7.6 Variability of banner thicknesses identified in the five Kenning banners in the Glasgow Museums Collection

Banner abbreviation	Metallic scroll	Central painting
Typographers	204.51µm	213.81µm
Upholsterers	284.63µm	393.30µm
Millers	284.97µm	374.67µm
*Vehicle Builders**	238.74µm	234.19µm
Metal Workers	239.78µm	231.15µm

* The central painting measure for the Vehicle Builders banner excludes the added paint layers applied in 1942 as part of a renovation.

7.3.8 Additional elements, pole, and storage boxes

Another consistent similarity identified in four of the five Kenning banners from Glasgow Museums Collection were the hanging poles with their respective metallic end caps and fittings to attach the side poles when parading the banners (Figure 7.11). The four poles showed a similar conifer wood and almost the same thickness of 6cm (see Appendix I), only varying in length according to each of the banners. All four poles shared a similar group of metallic elements. Although these elements were not analysed due to budgetary and accessibility restrictions, the macroscopic inspection detected the visual characteristics and corrosion products usually seen in brass and iron objects, thus inferring their composition. Given that similar manufacture, size, and overall appearance was seen throughout the four examples, it was interpreted that such elements could also have been an in-house manufacture of Kenning's companies, as they had the facilities and specialists required for such produces. Another possible interpretation could be that they procured such elements from the same supplier, in which case the exact same end caps and fittings would have to be found on another commercial manufacturer's banners.

Two original storage wooden boxes were found belonging to the banners of the *Metal Workers* and *Hither Green*, both made by George Kenning & Son Co. In both cases, the construction, measurements, type of hinges and locks suggested a similar manufacture, possibly also done at their facilities. Unfortunately, these boxes are not usually kept with their banners, so further comparisons and findings are not likely. Image of the *Metal Workers* box is included in the respective documentation sheet of Appendix I, but the image of the *Hither Green* banner box was not possible to acquire due to the COVID-19 restrictions.

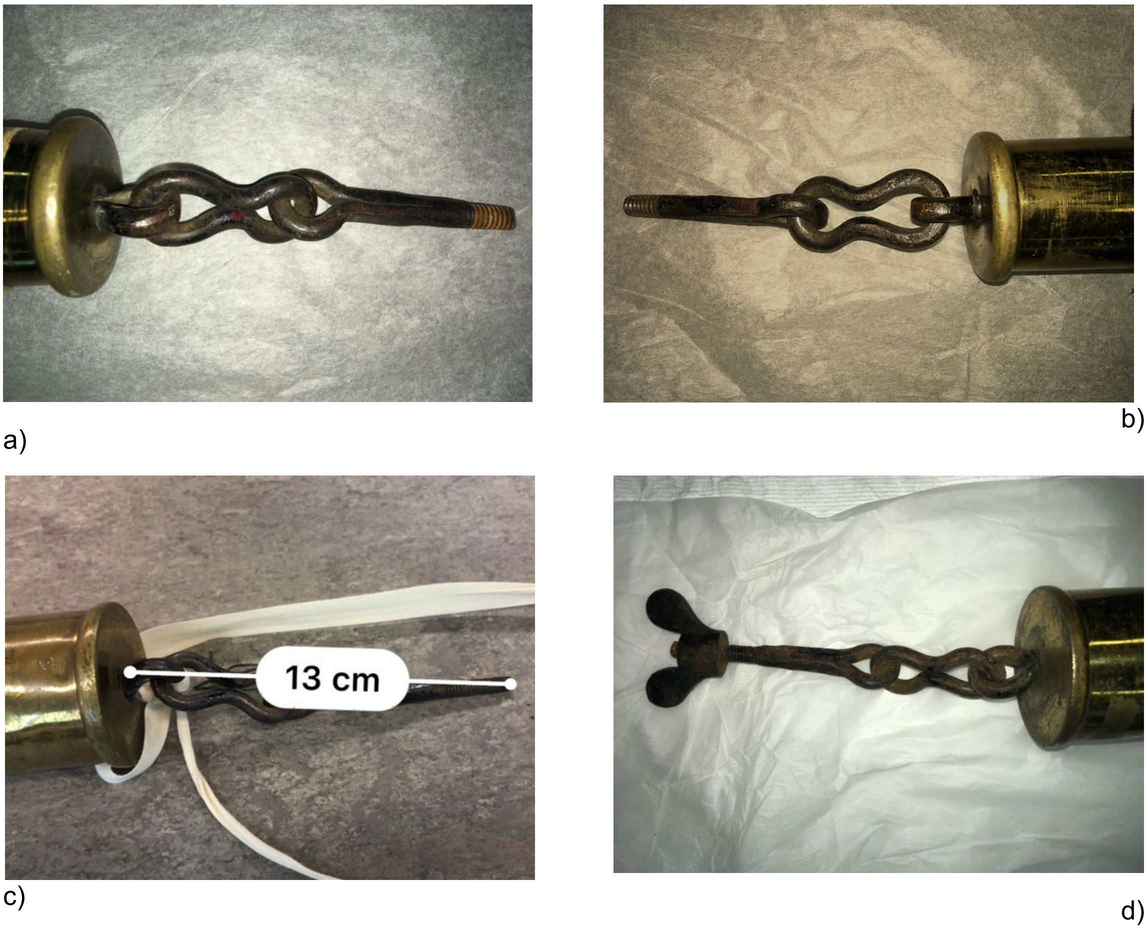


Figure 7.11 Details of the apparent brass pole caps and the apparent cast-iron fittings of four banners of Glasgow Museums Collection: a) *Typographers* banner, b) *Millers* banner, c) *Vehicle Builders* banner, d) *Metal Workers* banner. (Image © D.S.V.).

7.4 Summary

George Kenning was an entrepreneur who found in painted banners a profitable niche in the market and sought a way of producing them. Whether he had personally selected the production technique to be used or had the fortune of hiring the right specialists to do that for him, he was ultimately responsible for choosing and maintaining what was the best way of producing this type of object for his business interests. His son Reginald followed his steps, boosted their advertisement, and seemed to simplify their production. From the economic use of materials to the indication of the affordable prices on their adverts, it is assumed that they both found ways of reducing costs driven by commercial concerns, which allowed their companies to stand out from his competitors. They also seemed to have adapted to changes in the resources available in the market, making use of newly available materials (i.e., aluminium leaf) whilst maintaining the essence of a well-established established technique (i.e., lead carbonate-containing paint, ground, and size layers). The characteristics identified and described in this chapter represent changes in practice over time, which indicate the evolution of Kenning's technique and begin to distinguish his production from that understood via previous analysis to be used by other banner makers.

8 Conclusions

The research presented in this thesis on the historical contextualisation and material characterisation of five Kenning banners from Glasgow Museums Collection expands our knowledge about commercially manufactured British double-sided painted silk banners between 1865 and 1917. This period span from when George Kenning started his second sole company until the year of manufacture of the most recent Glasgow Museums Collection banner examined for this study, the banner of the *Scottish Tin Plate Braziers and Sheet Metal Workers' Society* at a point when the Society changed their name and started their way towards a national merger. The information gained from this study addresses the scarcity of contextual research on such type of banners, the organisations that commissioned them and the limited study of their makers, considered important gaps in the research of British trade and society banners since the National Banner Survey.

The conclusions of the research are ordered in line with both the aim of the research and the research question of this thesis, highlighting the significant findings and future research directions.

8.1 Historical contextualisation of the five Kenning banners of Glasgow Museums Collection and their organisations

The archival research on these five banners and their organisations allowed the exact dating of the *Typographers* and *Vehicle Builders* banners, chiefly due to the safekeeping of their societies' minutes by the Special Collections of Strathclyde University and The Mitchell Library, Glasgow, respectively. For the case of the *Upholsterers* and *Millers* banners, the dating was only done to the year, thanks to the periodicals available at the time, finding of an accurate banner description in the first case, and the listing of the society amongst the attendees to the demonstration in the second case. The dating of the banner of the *Metal Workers* was unfortunately only approximated, due to the lack of primary sources related.

8.2 Historical contextualisation of Kenning's companies

A clear distinction was made between the six companies related to George Kenning in general and the two companies related to the banners of this research in particular: George Kenning (1865-1894) and George Kenning & Son (1895-1955). Banner production by both companies was invariably carried out in the city of London, starting at their Little Britain headquarters between 1869 and 1931, and continuing later in their factory at Eagle Wharf Road from 1932 until the change of address change resulting from a merger with Spencer & Co. in 1955 (Regalia Folder, Freemasonry).

The information gathered on the companies under the name of George Kenning becomes particularly important for the potential dating of uncontextualised banners, which can now be associated with specific periods identified for the company: George Kenning Co. 1865-1895, George Kenning & Son Co. 1895-1937, George Kenning & Son Ltd Co. 1937-1955, George Kenning & Spencer Ltd Co. 1955-1962, and Toye, Kenning & Spencer Co. 1962-to date. The contextualisation can also be narrowed down in relation to the opening years identified for their branches, sometimes mentioned on their banners: Liverpool opened 1870, Glasgow opened 1873, Manchester opened 1878, London Queen Street opened 1894, and Coventry opened 1907. These dates helped answer the specific questions of when and where the five Kenning banners in the Glasgow Museums Collection were made. Given that all the Kenning banners inspected, either physically or by the means of photographs, showed clear evidence of branding, the attribution of unsigned banners becomes difficult to substantiate unless the absence corresponds to a material loss associated with use or damage. This resolved the specific question of who made the five Kenning banners in the Glasgow Museums Collection.

Previous research into painted banners detected similarities in style between examples of George Kenning & Son's banners and those of other British manufacturers. These were corroborated by the study presented in this thesis. Such similarities indicate a shared tradition between the commercial manufacturers of painted banners for trade societies and unions during the Victorian and Edwardian period.

The commercial success of Kenning's companies was evident in the stability of his London headquarters, which remained for over 70 years at Little Britain and succeeded for over 20 more years in their purpose-built factory at Eagle Wharf Road. Such success was evidently boosted by his links with Freemasonry, self-advertising the business in his widely circulated journal *The Freemason*, using his personal relations within the Masonic fraternity for positioning his business amongst the brethren and possibly also amongst related trade and friendly society clientele. The potential link between the clientele and Freemasonry is thus a future research direction to explore, which contribute to the already established link between these types of entrepreneurships and friendly societies in Britain.

8.3 Historical contextualisation of banner making in Britain in the nineteenth and early twentieth centuries

The manufacture of trade union and friendly society banners by Britain's leading banner-making companies, George Tutill, George Kenning and George Kenning & Son, seems to have followed the technical tradition of double-sided painted silk textiles documented in art technological sources (Cennini, c.1390; Thompson, 1988; de Mayerne, 1646; Fels, 2001; Pacheco, 1866; Palomino de Castro y Velasco, 1714; Bowles, 1770; Gibson, 1870; Moore, 1880; Kelly, 1911). The manufacturing stages identified from the extant primary sources of the companies largely agreed with those from the historical sources for painted silk banners. The method was very consistent throughout the years, only varying in the materials used for sizing and painting in accordance with the technical developments of each period. It comprised of five basic stages: the taut stretching of the silk textile, the outlining of the areas that were to be painted or gilded on either side, the selective application of size onto those areas, the application of thin ground layers, and the application of thin paint layers and metal leaf decorations.

The pursuit of flexibility and durability in double-sided painted silk banners was very much in the minds of the manual writers of each period researched during this study, indicated for example by discussion about the need to apply thin layers of ground and paint to enable the rolling of the banners and to prevent their flaking over time. This property of flexibility proved to be particularly important for the banner painter, considered as a different specialty by Cennini (c.1390) (Thompson, 1988), De Mayerne (1646) (Fels, 2001), Pacheco (1866), and for the late nineteenth-century to early twentieth century sign painting authors (Gibson, 1870; Moore, 1880; Kelly, 1911). It was also found to be correspondingly important to the companies of both Tutill and Kenning in the manufacture of their banners, in addition to issues of practicality and speed of production.

According to Tutill's patent and Kenning's company profile, the priority for their painting technique was to allow the rolling and unrolling of their banners without producing the cracking of their paint layers.

However, insufficient primary sources have been found directly related to the manufacture of these type of banners, which limits the interpretation of the materials and techniques that may have been used in their making. Therefore, it is crucial to carry out further studies into the contextualisation and technical analysis of surviving examples of British double-sided painted banners in order to understand variations in their manufacturing techniques.

Although significant research has been conducted on the company of George Tutill, there remain some assumptions that have not been substantiated as well as gaps in the understanding of the manufacturing technique used by his company. This is notable considering the extended time in which the company was active and the technological changes that happened throughout. The research presented in this thesis provides more clarity about the original sources used by Gorman, as well as significant evidence that points towards the use of commercial paints by Tutill's City Road banner making company. The importance of such findings is also related to Kenning's production, as the evidence found showed similarities in the approach to entrepreneurship and banner manufacturing between Kenning and his closest competitor Tutill over the years. Suggested future research directions on Tutill's manufacturing relate to the possibility of having used commercially produced paints, the deliberate addition of paint driers to speed up their banner production, and the identification and mapping of the rubber-based size layer in more examples and across a wider period.

8.4 Material characterisation of the Kenning banners in the Glasgow Museums Collection

Considering the information gathered from the review of historical sources and the period of technical developments in which the commercial manufacturers of banners were active (Townsend, 2004), the use of commercially manufactured paints was expected in the making of the five banners selected from the Glasgow Museums Collection for this study.

Previous research in nineteenth- and early-twentieth-century oil paints identified a range of materials associated with their commercial manufacture (Izzo, 2010; Van De Laar & Burnstock, 1997, pp. 1-16; van den Berg, Burnstock, & Schilling, 2019, pp. 329-342). These include zinc and aluminium stearates as dispersion agents, extenders like calcium carbonate, barium sulphate and aluminium hydroxide, as well as additions of triterpenoid resins and waxes. Townsend indicated that the presence of magnesium carbonate as an extender is seen as a trademark of Winsor & Newton paints (Townsend, 2020), which was a possible interpretation of the analytical results through SEM-EDX in the five Kenning banners from the Glasgow Museums Collection. However, accurate identification of that and other additives reported as indicative in the commercial manufacture of oil paints is still required. Future research directions include the use of micro-FTIR to map and identify these materials.

It was evident from the research literature regarding the analysis of materials and deterioration in painted banners that more research is needed on the constituents, their interactions, and the determination of the agents of deterioration in order to improve the conservation of such important objects (Thompson et al., 2017, pp. 66,70). The research presented in this thesis thus addressed the need to gain a clearer understanding of the making of painted banners as highlighted by Thompson et al. (Thompson et al., 2017, p. 70) by contributing a more in-depth examination and interpretation of the results to aid with the understanding of the interactions between interfaces and surfaces. The information gathered contributes to helping conservators to preserve these socially significant cultural objects more effectively as proposed by previous researchers (Smith, Thompson, and Lennard, 2017, p. 264).

Another future research direction that was not addressed by the research presented in this thesis is the identification of important constituents such as the dyes that were used in the silk textiles, the possibility of adding metallic driers or siccatives to deliberately speed up the drying process of the oil, and their potential relation with the occurrence of metal soaps as reported by Rode (2003) and Smith, Thompson and Hermens (2016). The remaining textile samples from the five Kenning banners in the Glasgow Museums Collection offer the potential for further analysis using high performance liquid chromatography for the identification of their blue dyes, and the unembedded paint samples can potentially be used for detecting siccatives and metal soaps by means of SEM-EDX and FTIR Imaging respectively.

A particular omission in the material research of painted banners is the discontinuity in the flexural behaviour study started by Rogerson and Lennard (Rogerson and Lennard, 2005, pp. 17-18). This requires investigation with further examples needed for the study of other makers, including the two companies at the centre of the present study, George Kenning, and George Kenning & Son. Artificial ageing of reconstructions should thus be considered as a future research direction to shed light on the degradation of the selected painted banners. Some characteristic effects, such as the textile distortions at the interface between painted/silvered decorations and silk textile, could be a consequence of their tight stretching and subsequent release and of their maintenance as flexible painted textiles, but will require systematic study to consider the physical properties involved (i.e., creep, elastic recovery, elongation, tensile modulus, yield point) (Ballard, 1995).

The need for increased and improved documentation of the painted banners in museums collections remains a future research direction recognised since the National Banner Survey. Given that the accurate use of banners as historical evidence requires their historical contextualisation (Nick Mansfield, 2008, p. 134), further research is still needed into the dating and provenance of many of the British banners in museum collections. This need has been hinted at by Hughes and Palmer in the case of Glasgow Museums, since “Glasgow Museums provides a home for a wonderful but little-documented collection of banners, dating from early precursors of trade union groups to modern disputes and peace protests, charting the history of the City's social conscience" (Hughes & Palmer, 2016, p. 41). Although the present research contributed to the contextualisation of five Kenning examples in their collection, the vast collection of banners at Glasgow Museums still requires ongoing study.

The scientific methodology chosen for the five Kenning banners in the Glasgow Museums Collection proved to be appropriate for the research objectives of this study. However, the quality and depth of information was enhanced when a particular sample was investigated using a range of complementary analytical techniques. Unfortunately, such an approach proved difficult to undertake at this point due to the limited access to the banners and other restrictions imposed during the COVID-19 emergency.

A total of fifty-nine embedded samples, including cross-sections of embedded isolated materials[49], were inspected using an Olympus BX41 optical microscope, under four different settings (i.e., bright field no-filter, dark field crossed-polarisers, U-M11011v2 filter and U-MWB2 filter), before and after staining with SYPRO® Ruby and with Nile Red. Additionally, a total of nine cross-sections were inspected under a Zeiss Axioscop optical microscope with settings for fluorescein and rhodamine fluorescence. The results showed the possibilities and limitations of both fluorescent staining techniques for the detection and mapping of proteinaceous and lipidic materials in paintings and painted textiles including double-sided painted silk banners. The method previously used by Smith, Thompson and Hermens (2014) was further tested on the five Kenning banners in the Glasgow Museums Collection and formed a key focus of the research presented in this thesis. The outcomes can be used as a reference for the interpretation of further fluorescent staining results of this particular type of painted banner, with the proven method allowing for a better understanding of their complex layering system.

The results from SYPRO® Ruby staining proved that it is a useful product for identifying the proteinaceous materials, animal glue (collagen) and undyed silk (fibroin), within cross-sections of one-sided painted silk textiles and reconstructions of double-sided painted silk banners. It is less useful for

[49] The count includes the set of eight textile samples previously impregnated with cyclododecane.

identifying silk that has been dyed with a compound with similar auto-fluorescence. The results corroborated the reported specificity of the fluorescent stain for proteinaceous materials, acting as a null test for the other amino-containing material tested, polyurethane.

The results from Nile Red staining were deemed inconclusive due to the many variables involved in its fluorescence phenomena and the unexpected positive staining of the acrylic embedding resin. A different-coloured fluorescent stain branded as BODIPY® 493/503, has recently been tested in conjunction with SYPRO® Ruby blot stain by Magrini et al. for mapping proteinaceous and lipidic binders within cross-sections of paint reconstructions (Magrini et al., 2013, p. 198). While their results are promising, further tests are still required before it can be applied to historical samples. The high cost of the stain makes it unsuitable for small batches at the present time.

The mapping and identification of proteinaceous layers on ten historical samples (i.e., size layer and protective metal leaf coating) proved challenging but by making modifications to the imaging parameters (e.g., adjusting camera exposure) it was possible to distinguish between these materials. The dimmed fluorescence previously reported for naturally aged fluorescent materials (Sandu, Roque, et al., 2012, p. 321), also dimmed the positive staining of the collagen size in the cross-sections. However, the naturally aged silk showed an even weaker orange fluorescence than that of the collagen, thus still allowing both materials to be distinguished through visual inspection.

Identifying materials in the five double-sided painted silk banners manufactured by the companies of George Kenning and George Kenning & Son formed a preliminary step in accomplishing the main objective of the research presented in this thesis, which is to characterise the manufacturing technique followed by both companies in the making of their banners and to find any significant differences that could help in distinguishing between them. The focus of this research was on comparative analysis of the banners and the reconstructions through the use of several complementary analytical methods.

Similarities detected between the materials in the three George Kenning examples analysed suggest a continuity of technique maintained by George

Kenning company for the manufacture of their banners. Correspondences between the banners of *The Glasgow Upholsterers Society* and *The Grain Millers of Glasgow*, both manufactured in 1884 for the Franchise Bill demonstration, confirmed their contemporaneous manufacture.

Slight differences detected between the two banners manufactured by George Kenning & Son and the three George Kenning banners suggest evolution in the technique adopted by the company of George Kenning & Son. The substitution of silver leaf for aluminium leaf was interpreted as a material update, as this advantageous non-tarnishing metal became available in leaf form from the twentieth century onwards as substantiated in Chapter 3. Changes in the composition of their ground layers and the transition from silver to aluminium could indicate a change in the supply chain or a decision by the company to reduce their expenses. These possibilities would need to be researched further.

The most extensive changes detected were seen in the George Kenning & Son banner for *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society*. These changes included a different textile construction, being the only Kenning banner in the Glasgow Museums Collection to be manufactured on a single piece of fabric, as well as more variations in the number of preparative layers (i.e., size and ground). The simplification of the technique seen in the absence of a proteinaceous coating over the metallic leaf of the *Metal Workers* banner, also shows pragmatism in the manufacture of these utilitarian objects.

The technical results contribute to the material knowledge of British commercial banners to date. In the case of the George Kenning & Son company, this represents a significant increase in knowledge. In the case of the George Kenning company, this represents completely new knowledge as no systematic study of Kenning banners had been previously published on the materials used in their banners. These results helped answer the specific questions of what materials are the five Kenning banners of Glasgow Museums Collection made and how were they made. Some of the previous results published in 2004 by Rogerson and Lennard (2005) and Macdonald et al. (2005) were also corroborated, such as the identification of partially heat-bodied linseed oil as the binder for both paint and ground, along with many of the pigments previously detected on commercially manufactured painted silk banners. A significant new addition to the list was the recently available chrome green, which aligns with the pigments reported for British paintings of the time (Townsend, 2004, Carlyle, 2001).

Finally, the detection of a lead-containing size layer on most of the samples analysed is an important finding that could be interpreted as a distinguishing characteristic of Kenning's companies. This lead-containing size has not been reported or shown in cross-sections of either painted banners or easel paintings to date. As stated before, this relates to the extensive research on nineteenth-century painting materials conducted by Carlyle, which repeatedly mentions the liking and use of "sugar of lead" or lead acetate by the artists of the period (Carlyle, 1999; 2001). Thus, it would need to be further researched and preferably recreated in a historically informed reconstruction, given its potential importance.

8.5 Paving the way to improved banner conservation

The study presented in this thesis establishes an initial response to the main research question as to whether there is an identifiable technique followed by the George Kenning and George Kenning & Son companies for the manufacture of the five painted banners in the Glasgow Museums Collection. There is still much to learn about both these banners and other banners manufactured by George Kenning's companies, and this research has also identified further paths to investigate.

The research has made it possible to identify characteristics to support accurate attribution of George Kenning banners and to distinguish between banners made by two of his companies, George Kenning, and George Kenning & Son, and those made by George Tutill.

The improved understanding of Kenning's manufacturing technique and materials provides a solid background for further research into the conservation of Kenning's banners and other similar examples. This further conservation research would benefit greatly from the making and artificial ageing of reconstructions such as those made for the research presented in this thesis.

9 Appendices

9.1 Appendix I. Documentation of Glasgow Museums Collection's Kenning banners[50]

9.1.1 I.1 The Glasgow Typographical Society banner

Side A (side of fringe attachment)

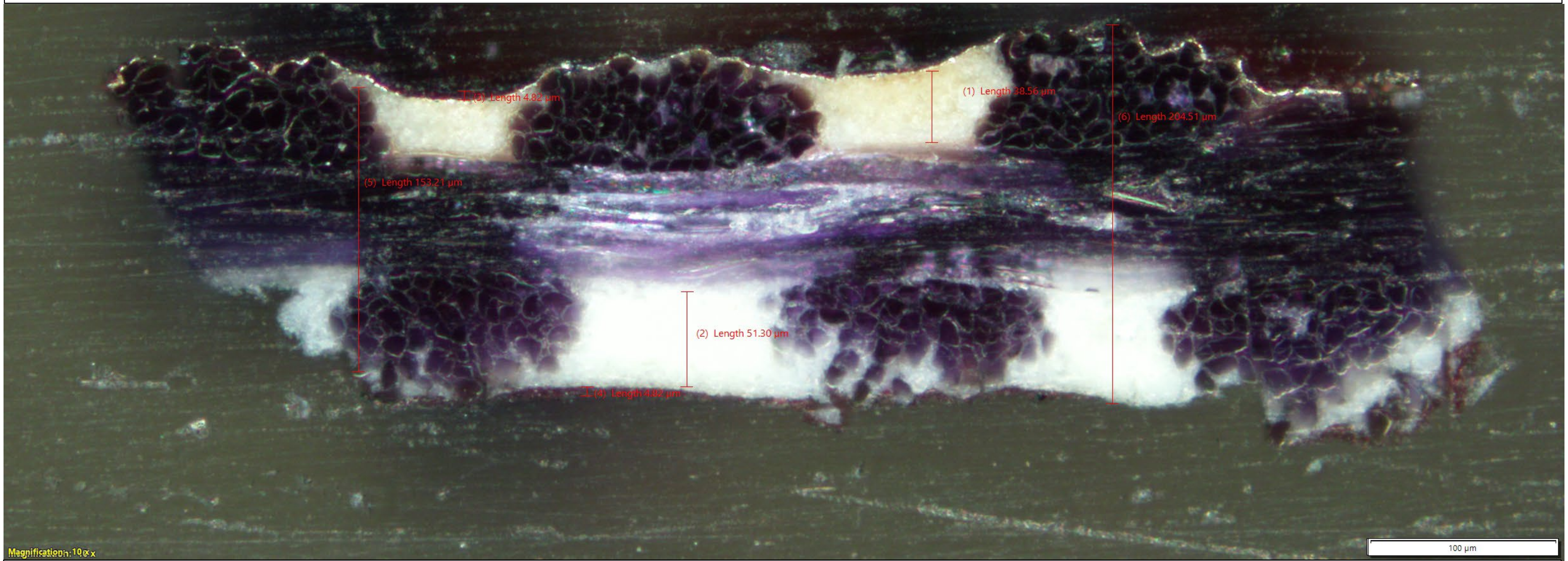
Side B (side opposite to fringe attachment)

Title	Banner of The Glasgow Typographical Society	
Maker	George Kenning (Signed on both sides under lower scroll as G Kenning London)	
Date of making	1883. Stated in the society's minutes: by 26th September 1883 the banner had been requested for the laying of the foundation stone of Glasgow City Chambers, to be held on 6th October of the same year.	
Technique	Oil paint; coloured glazes; silver, brass and gold leaf on silk.	
Description	Dark blue banner with a red fringe at the bottom edge, painted on both sides of a single layer of fabric with the following layout: an upper scroll indicating the name of the society on either side, a central scene depicting typographers' workshops on side A and on side B, two young men in togas grasping a laurel wreath. A lower scroll indicates the date of institution of the society on either side. It includes its hanging top pole with brass ends.	
Exact wording	Side A	Upper scroll: "GLASGOW TYPOGRAPHICAL SOCIETY," Lower scroll: "INSTITUTED 1817."
	Side B	Upper scroll: "GLASGOW TYPOGRAPHICAL SOCIETY,"

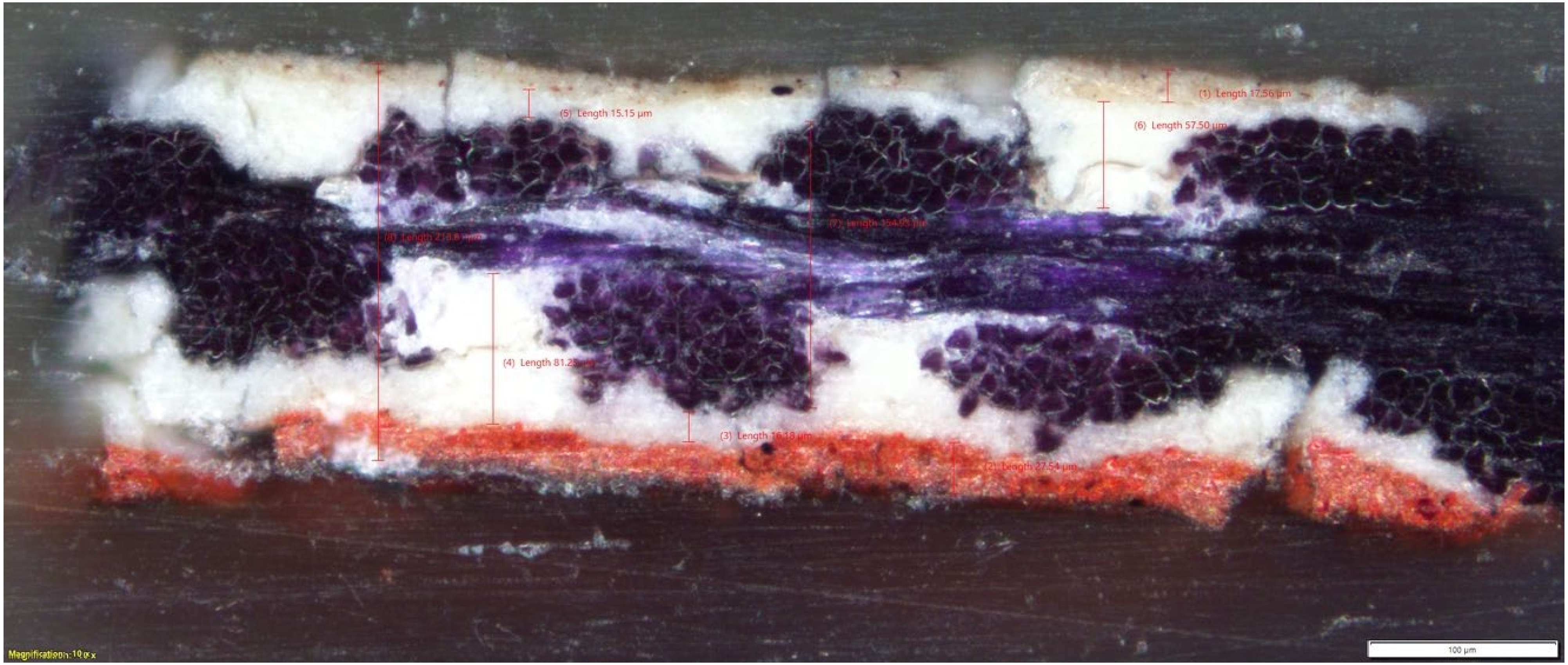
[50] Due to the large number of images in this appendix, the numbering of figures is not sequenced but restarts with each banner. Only the figures referred in the text are numbered. The numbering does not keep relation with that of the chapters. The figures in this appendix are excluded from the thesis list of figures. The micrographs included are the photographic record of: all the fibre samples identified in Chapter 6, selected paint samples (unembedded), and the two representative cross-sections of each banner (metal scrolls and central paintings).

		Central scene: “LET THERE BE LIGHT.”/ “I AM THE LIGHT OF THE WORLD”/ “UNION IS STRENGTH”/ “KNOWLEDGE IS POWER” Lower scroll: “INSTITUTED 1817.”	
Dimensions	Height 2,410 mm (including loops/pole and fringe)	Width 2,250 mm (not including pole)	
Owner	Glasgow Museums	Date of acquisition	1973
Inventory number	PP.1973.14.1	Location	Glasgow Museums Resource Centre, Pod 12
General assessment of condition	The banner is in poor condition, mostly due to the fragile state of the textile. Side A appears more deteriorated than side B. It has ingrained soiling all over, distributed as alternated horizontal bands coinciding with the pole’s width. Side A is also more soiled than side B, indicating this surface was probably more exposed to atmospheric pollutants or dust. Bloom is evident in the dark colours of the painted scenes. The metal leaf scrolls show tarnishing on both sides, more acutely on the lower scroll of side B. The fringe has discoloured from the left side to the centre (viewed from side A), due to surface abrasion and possible dye bleed. There was no sign of light damage. The banner has five long horizontal splits in the central scenes, with the fraying of both warps and wefts, as well as associated paint losses. There are two long patches stitched along the sides of the painted scene and two at the bottom, both applied from side A. The bottom edge has been repaired with five pieces to which the fringe has been reattached. Further paint losses are associated with machine stitched repairs and the formation of creases.		
Photography	Digital photography – Side A, normal light/ Side B, normal light/ Detail images of the textile construction, painting technique and scrolls layering sequence (including transmitted light, raking light and UV images). Dino-Lite detail images (20x)– textile weave, preparation, painting technique, layer sequence, craquelure and tarnishing on the scrolls.		
Examiner/Date	Daniel Sanchez Villavicencio/August 2018		
Place and conditions of examination	Glasgow Museums Resource Centre, Research Room. Banner examined flat over an examination table using both natural illumination and fluorescent tubes light (daylight).		

Cross-sections micrographs (crossed polarisers, 100x)



Sample TS08: Cross-section from lower silvered scrolls with measurements (Side A on the top)



Sample TS40: Cross-section from central painting with measurements (Side A on the top)

<table>
<tr><th colspan="4">Textile</th></tr>
<tr><td>Description</td><td colspan="3">The banner is made of a single layer of fabric. It is constructed from 4 horizontal strips of dark-blue dyed rep weave fabric sewn together, with an added repair of 5 irregular pieces of a different blue dyed rep weave fabric attached to the original bottom strip. The strips were machine stitched along the selvedges (according to the selvedge found inside the top hemmed edge, Figure 10) with a flat felled seam, joined horizontally with the warps parallel to the pole. It has no added borders. It has 13 pole loops attached to the top, 10 possibly made of dark-blue dyed silk grosgrain ribbon, which are thought to be original, and 3 of a different fabric indicating later replacement. A thick bullion fringe is attached to the bottom edge, possibly made of red dyed silk and undyed cotton.</td></tr>
<tr><td>Materials

*Not analysed</td><td colspan="3">Ground fabrics: dark-blue dyed silk (original), *dark-blue dyed cotton and dark-blue dyed man-made (later repair)
Sewing threads: blue dyed silk (originals) and *black dyed cotton (later additions)
Pole loops: dark-blue dyed silk and undyed cotton (originals)
Fringe: red dyed silk and undyed cotton
Guide tapes: n/a
Corner reinforcements/Eyelets: *dark-blue dyed man-made/brass*
Ground textile fibres analysed with FTIR-ATR</td></tr>
<tr><td rowspan="3">Dimensions</td><td rowspan="3">Fabric: Each panel measures (H x W):
1. 587 x 2250 mm (top)
2. 592 x 2250 mm
3. 591 x 2250 mm
4. 490 x 2250 mm (bottom)</td><td rowspan="3">Pole loops:
1. 60 x 190 mm
2 –11. 50 x 190 mm
12. 55 x 190 mm
13. 60 x 190 mm
(Numbered left to right from side A)</td><td>Fringe: 100 x 2250 mm</td></tr>
<tr><td>Thickness (min./max.)</td></tr>
<tr><td>153.21µm/154.93 µm (digitally measured)</td></tr>
<tr><td rowspan="3">Weave</td><td colspan="3">Fabric (original): warp-faced plain weave (also called rib or rep fabric)
Average thread count: 56 warps/cm by 30 wefts/cm (Figure 1)</td></tr>
<tr><td colspan="3">Pole loops (originals): warp-faced plain weave (also called grosgrain ribbon)
Average thread count: 50 warps/cm by 14 wefts/cm (Figure 2)</td></tr>
<tr><td colspan="3">Fringe: 2 ply “Z” twist (also called thick bouillon fringe)
Average braid count: 28 braids/15 cm (Figure 8)</td></tr>
</table>

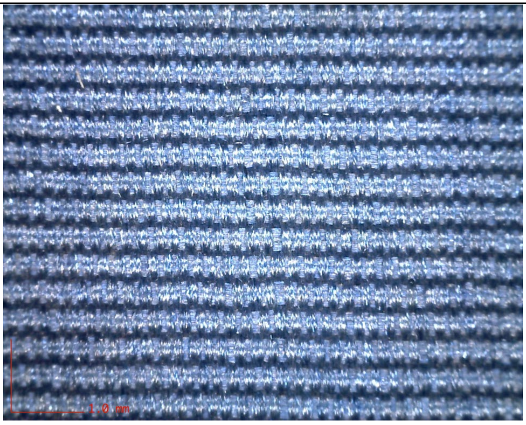


Figure 1. Typographers' banner DinoLite detail of the banner's weave (20x)

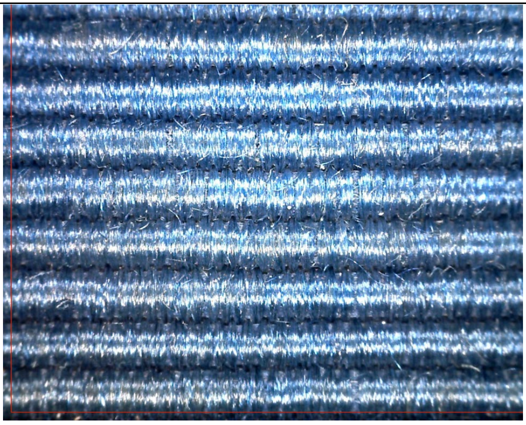
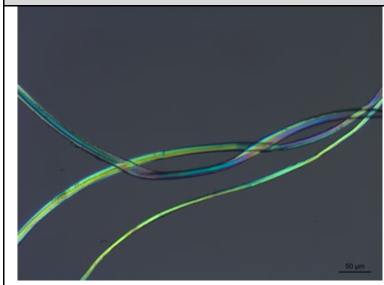
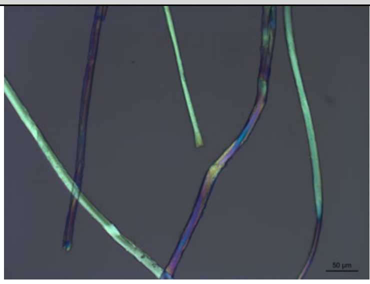


Figure 2. Typographers' banner DinoLite detail of the loop's weave (20x)

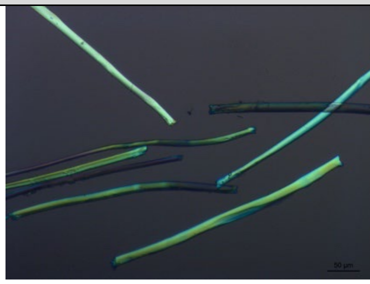
Micrographs of textile fibres (crossed-polars, 200x)



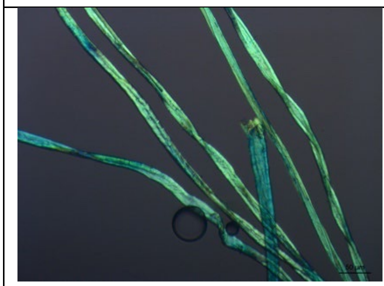
Sample TS01: warp silk fabric



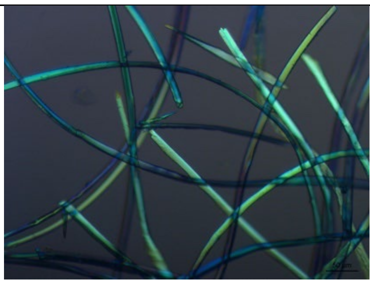
Sample TS02: weft silk fabric



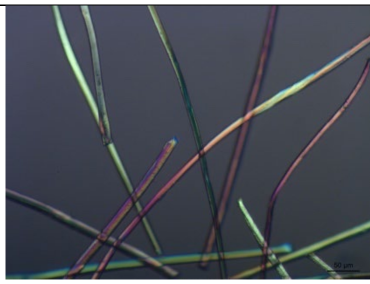
Sample TS03: silk stitching thread



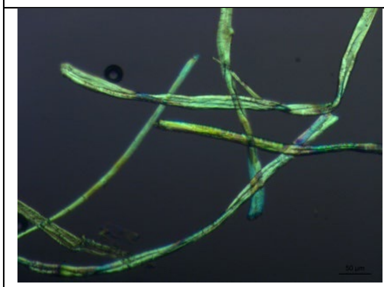
Sample TS04: weft cotton loop



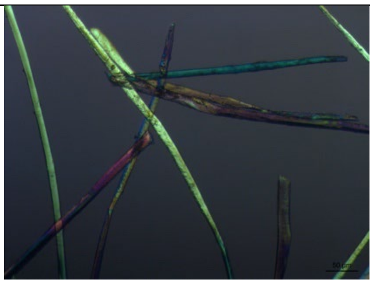
Sample TS05: warp silk loop



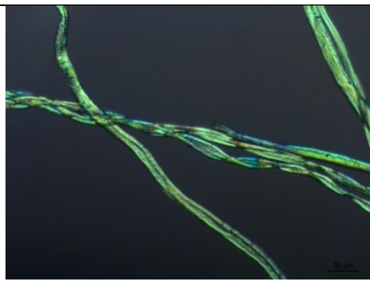
Sample TS06: silk coating of fringe (not faded)



Sample TS07: core cotton fringe (not faded)



Sample TS25: silk coating of fringe (faded)



Sample TS26: core cotton fringe (faded)

Construction	The four strips of silk are sewn together along the selvedges, with machine-stitched flat felled seams and blue dyed threads (Figure 5). The seams have an average width of 6 mm, with the selvedges likely to be concealed inside for added strength. Each line of stitching was made separately, as they are irregular and not entirely parallel to each other. The panel is finished with hemmed edges folded towards side B (opposite to the fringe attachment). Both left and right edges were hand-sewn with a running stitch, using blue dyed thread and with a turning of an average width of 14 mm (Figure 4). The top edge is machine-stitched with a flat felled hem and blue dyed thread, with an average width of 10 mm. The 10 original pole loops appear to be attached to the top hemmed edge from side B, sewn with the same hem stitch (Figure 3). There are some failed stitches on small sections of 2 of the pole loops (Figure 9). The bottom edge has been replaced and the original fringe reattached to the replacement from side A (Figure 8).

Figure 3. Typographers' banner detail of loop stitches, side A

Figure 4. Typographers' banner detail of right hemmed edge, side A

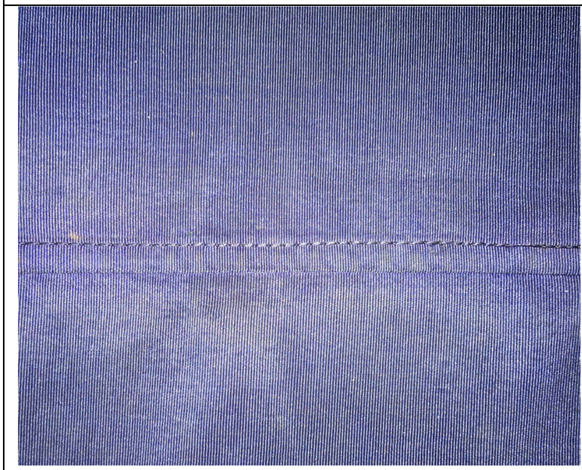


Figure 5. Typographers' banner detail of flat felled seam, side A

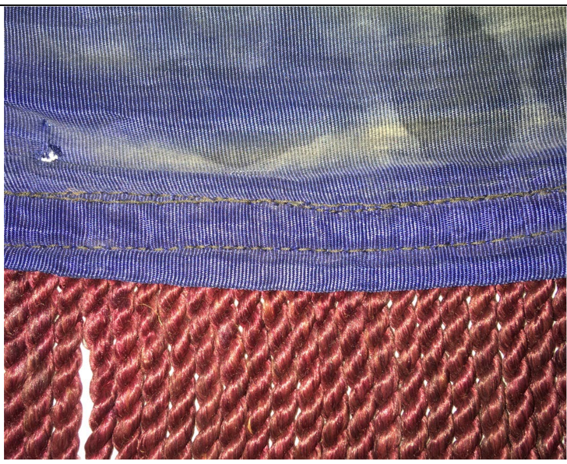
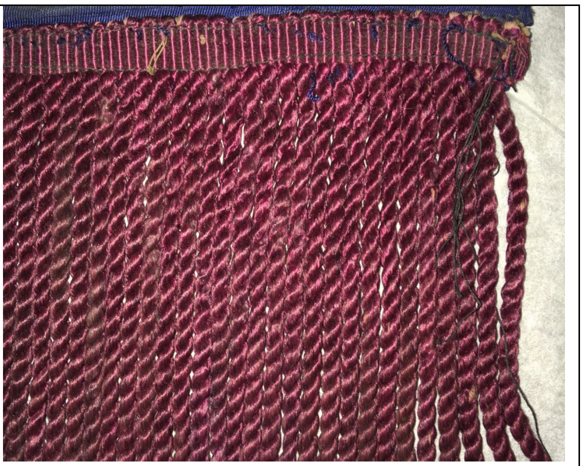


Figure 6. Typographers' banner detail of bottom hemmed edge, side B

 Figure 7. Typographers' banner detail of left eyelet, side B	 Figure 8. Typographers' banner detail of right-side fringe, side A
 Figure 9. Typographers' banner detail of loop missed stitches, side B. Indicates that the machinist missed the edge of the turning	 Figure 10. Typographers' banner detail of selvedge on top hemmed edge, side B

Repairs	Bottom additions The lower section of the banner is repaired using 5 irregular shaped pieces of what appears to be a synthetic rep weave fabric (not identified), sewn by hand with a black dyed thread. The large pieces follow the same orientation of the original silk strips (ribs perpendicular to the pole), while the eyelet has been repaired and the weave alignment is different (Figure 7). Patches surrounding the central painting Other 4 patches which are recorded in Figures 11-14, were machine-stitched from side A, puncturing the paint on both sides of the central scenes. These patches are not aligned with the original silk strips. The narrow and long patch on the left has a different tabby weave and is possibly made of cotton (Figure 11). The narrow and long patch on the right appears to be synthetic rep weave fabric (Figure 12). Replacement loops The 3 replacement pole loops are stitched from side B over the top hemmed edge. Loop #12 has a similar blue dyed silk grosgrain ribbon, whilst loops #1 and #13 have a similar fabric as the longer patch. A thick black dyed thread is used for the repairs and to reinforce each of the 13 pole loops, suggesting they were all part of the same treatment.

Figure 11. Typographers' banner, left side patch, side A

Figure 12. Typographers' banner, right side patch, side A

Figure 13. Typographers' banner, lower left-side patch, side A

Figure 14. Typographers' banner, lower right-side patch, side A

Condition	Soiling There is ingrained soiling on both sides, distributed as alternated horizontal bands that coincide with the pole's width. The soiling is accumulated on the lower third of side A. The fringe shows discolouration from the left side to the centre, possibly due to the abrasion of the red dyed silk or the fading of the dye (Figure 15). There are some red stains in the lower third of the banner, which could be indicating dye bleed from the fringe. Creasing/distortion The banner shows distortion overall, with several creases surrounding both painted and silvered decoration, potentially formed during its original preparation, as it was also seen in the reconstruction 2 (see Appendix IV). The pattern of soiling and overall distortion indicates the tight rolling of the banner on its own pole, with side A facing out. Structural Condition The textile has multiple splits on the central painted part and some along sections of the scrolls, which impede the object from being hung. The warps and wefts along the splits are fraying (Figure 16). The bottom repair appears narrower than the original banner panel, and the long vertical patches seem to be pulling the upper and lower sections adding to the general distortion.

Figure 15. Typographers’ banner detail of fringe discolouration, side A

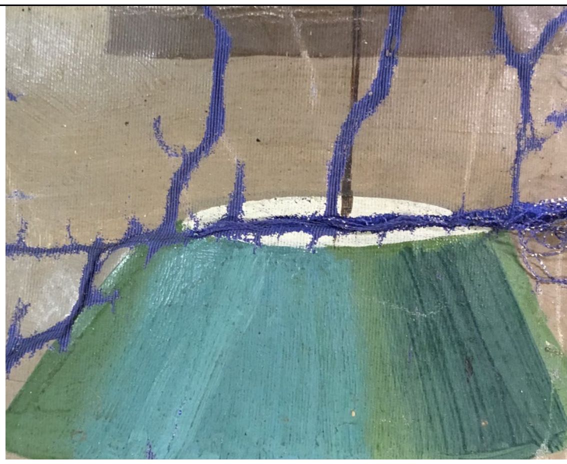
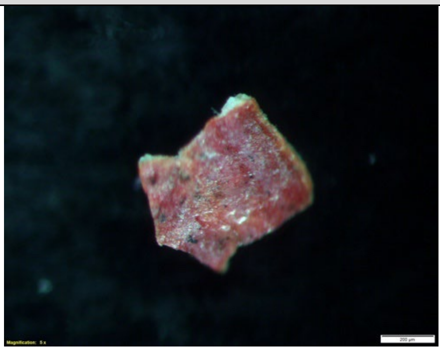
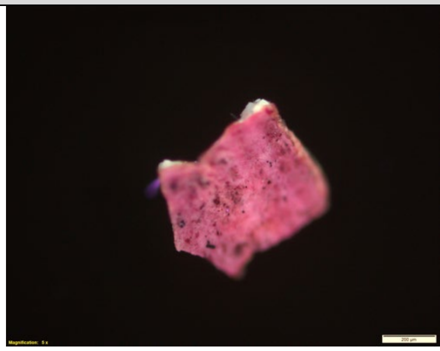
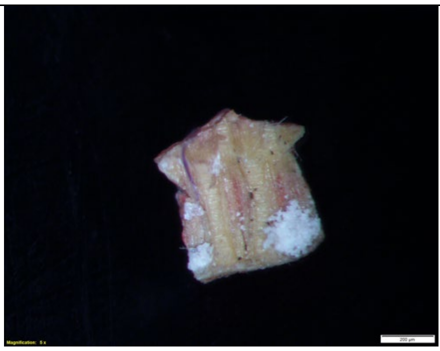
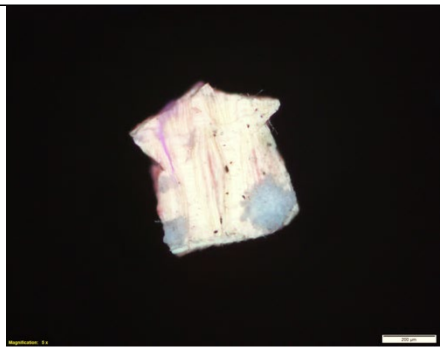
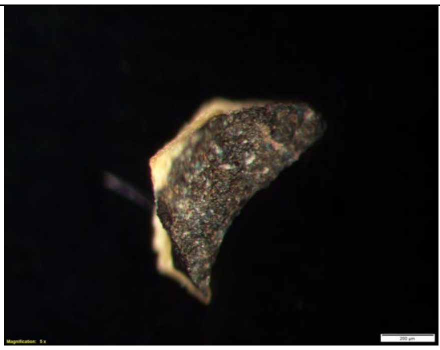
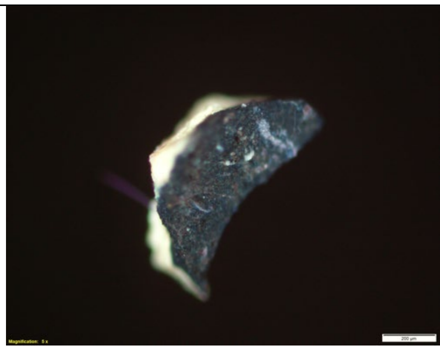
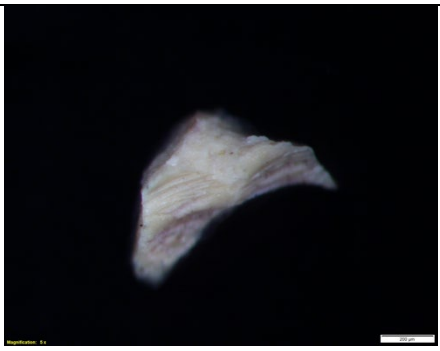
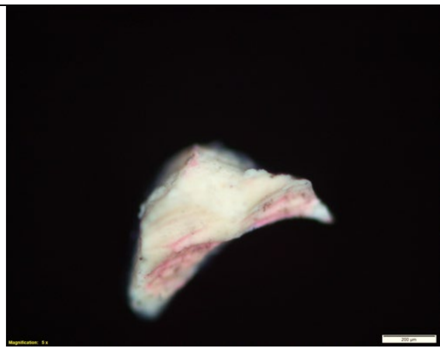
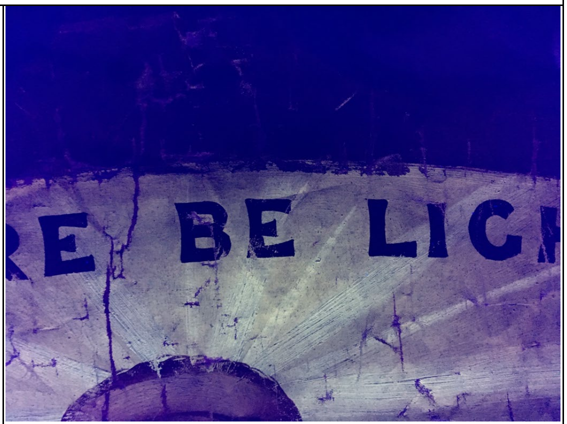
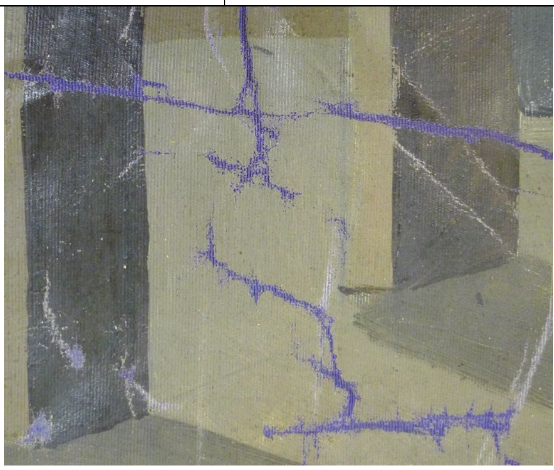
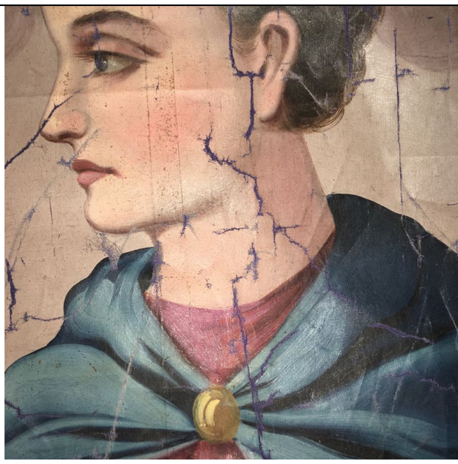


Figure 16. Typographers’ banner detail of split with fraying of weave, side A

Painting	
Description	Side A: Two scenes separated by a dark red coloured band, depicting on the upper section a composing room with three illuminated long tables, two square tables and seven workers in aprons along three large windows. On the lower section there is a machine room, with an old hand press, a Wharfedale press and a Web printing machine (STA, 1883), with five workers in aprons distributed along three windows. A grey coloured scrollwork is placed symmetrically on the left and right side.
	Side B: Two young male figures wearing togas of contrasting colours, holding a laurel wreath with their right hands and standing in front of a fiery altar. A representation of the "all seeing eye" overseeing an opened book is placed on top. Two scrolls, one pink and one golden, flank the figures on their top and bottom sections.
Layers on each side* *Numbered by order of application	1. Size layer (seen in the unpainted areas of the scene, impregnating the textile and impeding the seeping of the paint) 2. White ground 3. Thick paint applied as background or base colour 4. Thick paint applied as contrasting colour 5. Thin translucent paint applied as shadows 6. Thin paint applied as finishing lines **** Only for the floral garland: 1. Size layer (seen as an external outline impregnating the textile) 2. Thick paint applied as background colour and thick paint applied as contrasting colour (in areas where the design overlaps with the gilt frame, the paint is applied directly over the metal leaf, without the previous application of white ground) 3. Thin translucent paint applied as contrasting colour and finishing lines *****Only for the lateral scrollwork: 1. Size layer (seen in the unpainted areas of the scene, impregnating the textile and impeding the seeping of the paint) 2. Grey paint (without previous white ground) 3. Black paint
Thickness	Ground side A 57.50 µm; ground side B 81.25 µm; paint side A 17.56 µm; paint side B 27.54 µm; central painting both sides 213.61 µm (measured digitally)
Preparatory drawing	Seen around the contour of the fingers and limbs of the two young figures on side B, and surrounding the straight lines of the machine room, tracing the perspective of the design (Figure 39). The lines could have been potentially drawn over the white ground with a black charcoal or graphite, as seen in the historical film of banner painters (Pathé, 1958).
Palette	Side A: Light brown, dark brown, white, bright green, dull green, dark red, pink, brown (translucent), red (translucent), grey.

	Side B: Light brown, dark brown, white, bright green, dull green, dark red, pink, brown (translucent), crimson red (translucent), pale yellow, red, light blue, dark blue (translucent)
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size and golden coating) (FTIR/SYPRO RUBY); lead white, red ochre, lead white, yellow ochre, umber, vermillion, chrome yellow, chrome green, barium sulphate, calcium carbonate, magnesium carbonate (extenders) (XRF/SEM-EDX).
Micrographs of paint samples showing appearance of paint (front) and ground (back) (50x)	
 Sample TS32: front, crossed polarisers	 Sample TS32: front, UV filter
 Sample TS32: back, crossed polarisers	 Sample TS32: back, UV filter
 Sample TS35: front, crossed polarisers	 Sample TS35: front, UV filter
 Sample TS35: back, crossed polarisers	 Sample TS35: back, UV filter

<table>
<tr><td>Appearance under UV light</td><td colspan="2">Each pigment shows a different response to the UV radiation (presence or lack of fluorescence), highlighting the absence of any coating. The light colours have a strong pale-yellow fluorescence, regularly associated with the presence of lead white, which could indicate the presence of this white pigment in the mixture (Figures 17-20)</td></tr>
<tr><td colspan="2">
Figure 17. Typographers' banner detail of the centre scene, side B</td><td>
Figure 18. Typographers' banner detail of pale-yellow fluorescence on centre scene, side B, UV light</td></tr>
<tr><td colspan="2">
Figure 19. Typographers' banner detail of thistle on frame, side B</td><td>
Figure 20. Typographers' banner detail of pale-yellow fluorescence on thistle, side B, UV light</td></tr>
<tr><td>Structure</td><td colspan="2">The paintings on both sides are constructed in a very simple way over a white ground (Figure 27), with few layers overlapped and an efficient use of paint. In all cases there is a thick application of paint as base and a thick application of paint on top to create contrast; with thinner and translucent layers applied over or smudged within, to produce the volumes and shadows (Figure 24). The brushstrokes are very evident, highlighting the thickness of the paint when applied (Figure 22). On the side A scene, the lighter shade of brown is applied over the entire thin white ground and is used as a half tone for the rest of the figures and furniture. The thick addition of contrasting colours, both lighter and darker than the background, generate the forms in a very effective manner. The shadows and details like facial features are added with thinner layers of paint. There is evidence of wet-on-wet application of paint but only on localised areas (like the lamps on the composition room and the fire over the altar. Figures 23 and 25). The scene on side B is more colourful than side A but is also constructed with the overlapping of thick layers of paint that separate the figures from the background. The lighter shade of brown is applied over the white ground but is not being used as a half tone. Each figure is constructed from its own base colour, going from the lighter to darker tones. There is more smudging of the colour to achieve a more realistic volume on the two male figures (Figure 24), the "All-seeing-eye" and the altar. The paint of the floral garland seems to be applied directly onto the apparent size without any white ground (Figure 26).</td></tr>
</table>

Condition	There is an evident distortion on the paint layer on both sides, associated to the creasing of the textile (Figure 22). The thicker layers of paint on both sides of the banner have a good attachment to the ground and therefore to the textile. The thinner layers of paint seem to have a lesser adherence. This is particularly noticeable in the brown tones, which show many losses delaminating on a small scale (micro flaking), distributed throughout the surface. All paint losses are associated to the formation of splits and folds in the textile, as well as to the direct abrasion caused during its previous repair (application of patches). Both sides of the banner show a similar craquelure pattern, formed by a horizontal breakage of the film along the spaces between the ribs of the weave, mostly noticeable under magnification (Figure 27). The thicker layers of paint show in addition a diagonal breakage of the film (Figure 28). Bloom is evident over the different colours on both sides, particularly over the darker tones. There are small white protrusions scattered around every colour, that seem to be coming from the white ground. There is no evidence of a general coating on the painted areas, but there is ingrained soiling overall, more acute on side A.
 Figure 21. Typographers' banner detail of preparatory drawing, centre scene side A	 Figure 22. Typographers' banner detail of distortion and brushstroke texture on centre scene, side A, raking light
 Figure 23. Typographers' banner detail of wet-on-wet application of paint, side B	 Figure 24. Typographers' banner detail of shadowing and scumbles, side B

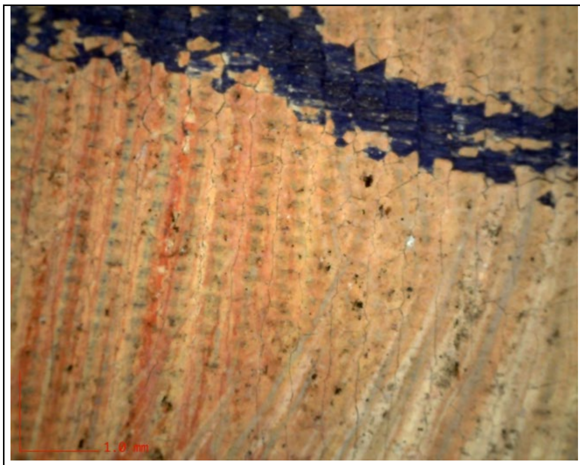


Figure 25. Typographers' banner DinoLite detail of wet-on-wet application of paint, centre scene, side B (20x)

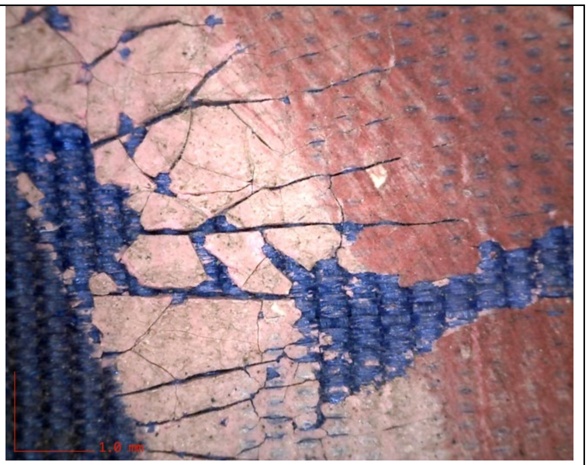


Figure 26. Typographers' banner DinoLite detail of paint applied without ground, lower-right frame, side B (20x)

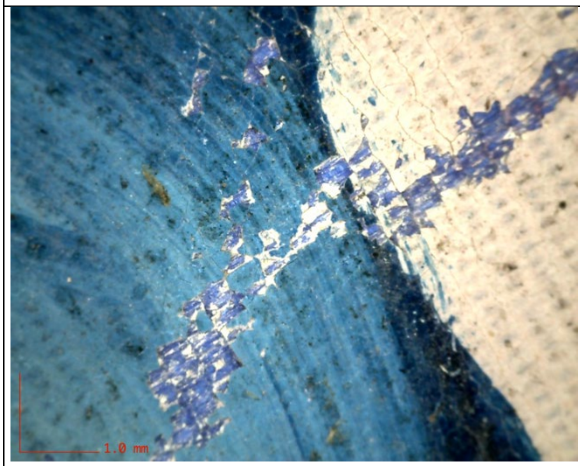


Figure 27. Typographers' banner DinoLite detail of parallel cracks and white ground, centre scene, side B (20x)

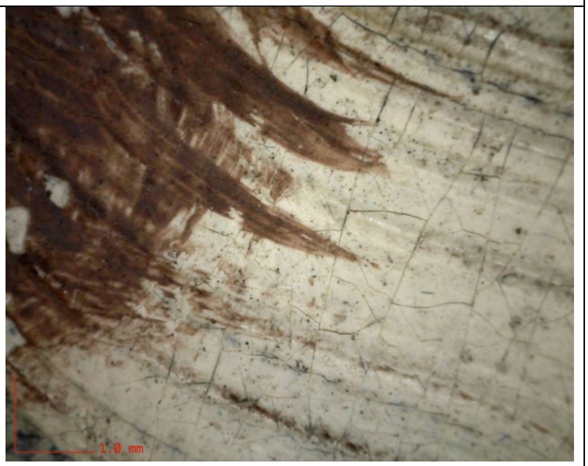


Figure 28. Typographers' banner DinoLite detail of diagonal cracks on thicker paint, "All-seeing-eye", Side B (20x)

Silvering	
Description	Upper scroll (also called ribbon)*: Golden coloured composite scroll with black block capitals lettering, distributed along three arched bands. Each band is separated by a returning band and finished on both ends with a roll. All sections without lettering are decorated with alternated vertical bands of red and gold.
	Lower scroll (also called ribbon)*: Golden coloured simple scroll with black block capitals lettering, formed by a regular band with two returns and one roll at each end. All sections without lettering are decorated with alternated vertical bands of red and gold. *Same on sides A and B
Layers on each side* *Numbered by order of application	1. Size layer (seen as an external outline impregnating about 1 cm of the textile) 2. White ground 3. Metal leaf 4. Coloured coating 1 (golden) 5. Coloured coating 2 (red) 6. Coloured coating 3 (brown) 7. Black paint (lettering and finishing lines)
Thickness	Metal leaf approximately 1-2 μm; ground side A 38.56 μm; ground side B 51.30 μm; silvered scroll both sides 204.51 μm (digitally measured)
Preparatory drawing	Inferred (not seen) by the restricted application of the silver leaf on the shapes and their perfect matching on both sides. Potentially made with the method of pouncing suggested by Kelly (Kelly, 1911).
Palette	Golden (translucent), black, red (translucent), brown (translucent).
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size, golden coating and silver isolation layers) (FTIR/SYPRO RUBY); lead white, barium sulphate (ground), silver (metal leaf), tin-alum based lake (red coating) (SEM-EDX); rest not analysed.
Appearance under UV light	Golden coloured coating shows a weak fluorescence, with a mottled appearance of green over dark purple (Figures 31 and 32). Green colour is associated with the presence of drying oil and/or terpenic resin as binder, the dark purple colour could be associated to oxidation products (silver sulphates in case the main metal is silver). Black paint also shows a greenish fluorescence, suggesting the presence of drying oil and/or terpenic resin as binder. Red bands have a strong orange fluorescence colour, regularly associated with the presence of shellac (Figures 29 and 30). Exposed ground has a very strong pale-greenish fluorescence, regularly associated with the presence of lead white bound in linseed oil.

Figure 29. Typographers' banner detail of upper left-side scroll, side A

Figure 30. Typographers' banner detail of orange fluorescence, side A, UV light

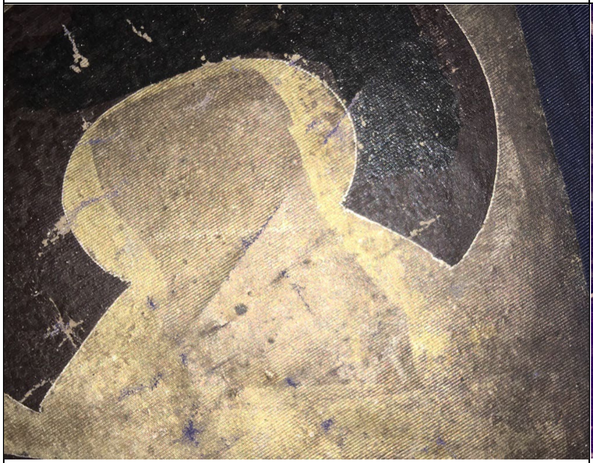


Figure 31. Typographers' banner detail of C in SOCIETY, side A

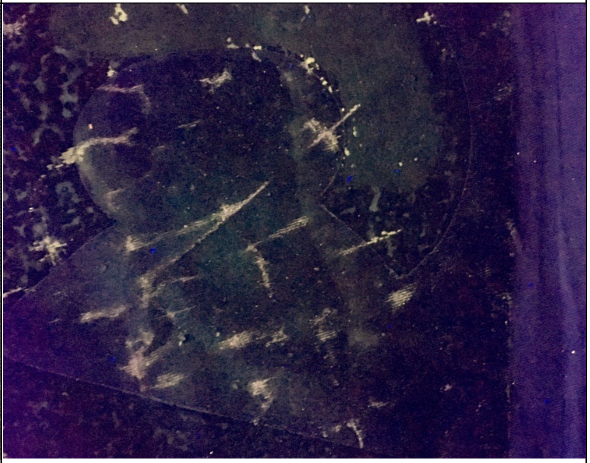


Figure 32. Typographers' banner detail of green fluorescence, side A, UV light

Structure	There is a darker outline suggesting impregnation of the textile of about 1 cm exceeding both scrolls (Figures 33 and 34), indicating the probable application of size for impeding the spread of the oily ground, as recommended by Gibson and Kelly (Gibson, 1870; Kelly, 1911). Layer 1 A layer of white ground is applied on top, potentially used as gold-size to adhere the metal leaf, as reported by Kelly for oil gilding silk banners (Kelly, 1911). Layer 2 On top of the metal leaf, there is a golden coloured coating to make it appear as gold leaf. Layer 3 On top of this golden coating there are bands of a red coloured coating, shadowed in sections with brown coloured coating on top. Layer 4 The black lettering and finishing outlines are applied over all the previous layers.

Figure 33. Typographers' banner detail of darker outline under upper scroll, side A

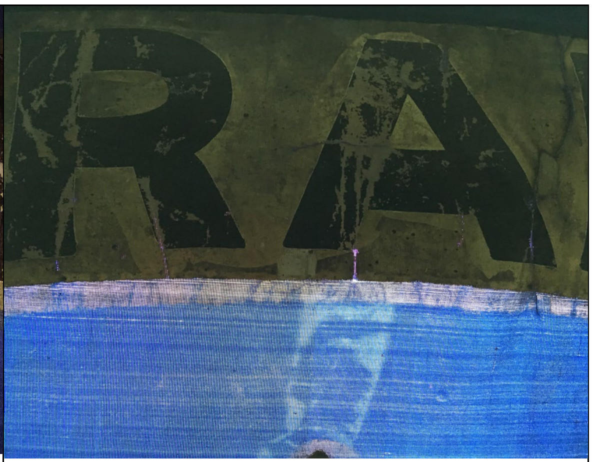


Figure 34. Typographers' banner detail of size outline, side A, transmitted light

Condition	The silvering is in a fair condition, although it has tarnished severely, particularly on the lower scroll of side A (Figure 40). It has a very firm attachment to the textile and only minor losses associated with the formation of creases in the textile. It has a very fine and homogeneous craquelure pattern of parallel lines, mostly noticeable under magnification, formed along the spaces between the ribs of the weave (Figure 35). There are localised paint loses on the black paint of the letters. The major losses occur on the raised parts of the weave (ribs) and are accumulated on the upper scroll of side A (Figure 36). The paint detaches along with the silver leaf, exposing the white ground. Additionally, there is an untarnished outline around each of the letters and next to the red bands (Figure 38), potentially formed after the drying of the black paint and red coloured coating, which seemed to have shrunk pulling the golden coloured coating towards them (Figure 39). There is a wide and jagged contour surrounding the letters of the upper scroll of side A, showing the "original" tone of the golden coloured coating (Figure 37). There is also soiling over both sides, intensified on the lower third of side A.

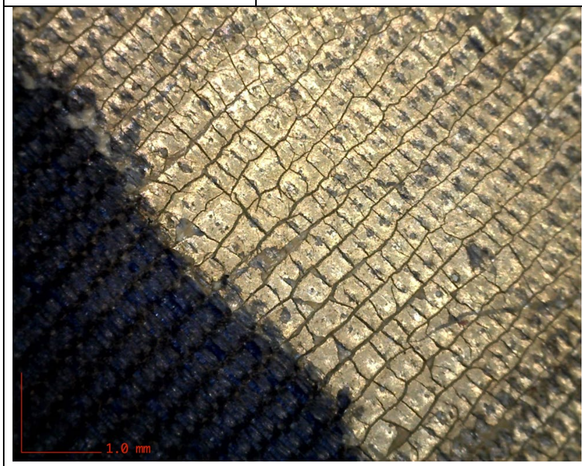


Figure 35. Typographers' banner DinoLite detail of the parallel craquelure, upper scroll centre, side B (20x)

Figure 36. Typographers' banner DinoLite detail of delamination over the textile ribs, upper scroll centre, side B (20x)

Figure 37. Typographers' banner detail of jagged contour showing "original" golden coating, upper scroll side A

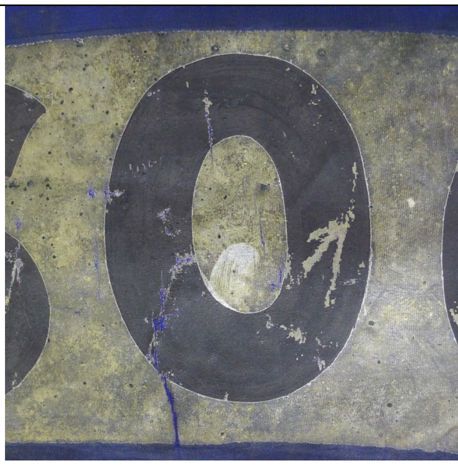


Figure 38. Typographers' banner detail of untarnished line surrounding letters, upper scroll side B

Figure 39. Typographers' banner DinoLite detail of untarnished line surrounding the L in GLASGOW, upper scroll left side, side A (20x)

Figure 40. Typographers' banner detail of the severely tarnished and soiled lower scroll, side A

Gilding	
Description	Frame: Golden coloured frame formed by two concentric circles, with a roll at each quadrant and scrollwork decoration with spiralling shapes on both sides (left and right). A floral garland of thistles, roses and shamrocks is applied over the outer circle (see painting table for technical information).
	Side B central scene scroll (also called ribbon): Golden coloured simple scroll with black Roman capitals lettering, formed by a regular band with one return and one roll at each end. All returns are painted pink and the rest without lettering have alternated vertical bands of a brown coloured coating, finished with dark brown and beige outlines on top.
Layers on each side* *Numbered by order of application	1. Size layer (seen as an external outline impregnating the textile) 2. White ground 3. Adhesive (also called gold-size) 4. Metal leaf 5. Coloured coating (brown) ****Only for the central scene scroll on side B: 1. Size layer (seen as an external outline impregnating the textile) 2. White ground 3. Possible gold-size 4. Metal leaf 5. Black paint (translucent), coloured coating (brown) and pink paint 6. Brown and beige paint (applied along the perimeter as finishing)
Thickness	Not measured.
Preparatory drawing	Inferred (not seen) by the restricted application of the metal leaf on the shapes (Figure 44) and the neat line of possible gold-size along the central scene scroll (Figure 43). Potentially made with the method of pouncing suggesting by Kelly (Kelly, 1911).
Palette	Brown (translucent), black (translucent), pink, brown, beige.
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size) (FTIR/SYPRO RUBY); lead white, barium sulphate and calcium carbonate (ground) (SEM-EDX); rest not analysed.
Appearance under UV light	The metal leaf shows a dark purple colour in the undecorated areas, highlighting the absence of any type of coating. The decorative brown lines appear darker and not transparent under the UV radiation, reportedly related to the lack of fluorescence of brown pigments (Cosentino, 2015). The exposed ground has a very strong pale-yellow fluorescence, regularly associated with the presence of lead white.
Structure	There is an outline of about 1 cm of this unknown substance which has impregnated the textile and extends beyond the gilded area (Figures 41 and 42), indicating the possible application of size under the gilding to impede the spread of the oily ground, recommended by Gibson and Kelly (Gibson, 1870; Kelly, 1911). A thin layer of white ground is applied on top of the sized textile only on the sections that were gilded, suggesting the use of a preparatory drawing (not seen) due to the accuracy of the design. A thin, transparent and glossy coating is seen over the white ground, which could indicate the application of gold-size. Over the leaf, lines of a brown coloured coating are

	applied free-handed in two consistencies, thick and thin, to create contrast between them (Figure 46). The central scene scroll has a similar layout, applied over the same white ground as that of the paint and possibly a layer of gold-size to adhere the metal leaf. The black lettering and brown lines are painted over the leaf, and the pink paint, brown and white outlines are applied on top, invading the adjacent painting background (Figure 45).
Condition	The gilding has a firm attachment to the white ground and the textile, with only minor losses and slight tarnishing in localised areas of the lower third of the banner. The tarnishing is more acute on side A than on side B. It shows a very fine and homogeneous craquelure pattern, mostly noticeable under magnification, going along the spaces between the ribs of the weave and also perpendicularly to them, forming a net (Figure 43). The losses occur in the raised parts of the weave, exposing the ground as it delaminates and the textile because of further abrasion. All losses are associated with the formation of creases in the textile, as well as the handling during previous repairs. The areas with the most losses are situated on side A, along the stitches of the patches. There is soiling on both sides, intensified on the lower third of side A.

Figure 41. Typographers' banner detail of impregnated outline, upper frame side A

Figure 42. Typographers' banner detail of impregnated outline, side A, transmitted light

Figure 43. Typographers' banner DinoLite detail of parallel cracks and paint overlapping, central scene, side B (20x)

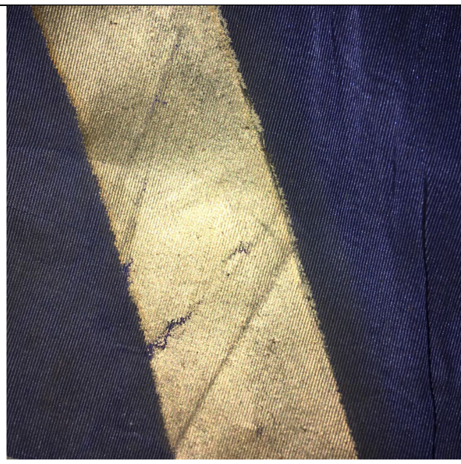
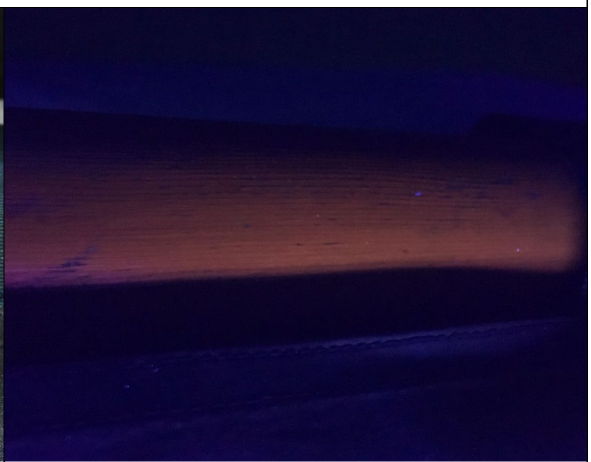


Figure 44. Detail of localised application of golden leaf, right frame, side A

 Figure 45. Detail of paint overlapping golden leaf, scene scroll side B	 Figure 46. Detail of brown colour coating applied concentrated and diluted, side B

Pole	
Description	Top hanging wooden pole, maroon stained and varnished, with one decorative brass end cap at each end. The brass ends have cast iron pins screwed at each side, both with wingnut fittings (Figure 49). These indicate the use of side poles, now missing. The length of the pole is too close to that of the banner, so it is likely that is not the original pole.
Dimensions	2255 x 40 mm
Inventory number	Same as banner
Materials* *Not analysed but inferred by their appearance	Pole: conifer wood (due to the pattern associated with the formation of tree rings) with possible shellac varnish End caps and fittings: brass and cast-iron
Appearance under UV light	The varnish has a strong orange fluorescence colour, regularly associated with shellac (Figures 47 and 48).
 Figure 47. Typographers' banner detail of pole coatings, side A	 Figure 48. Typographers' banner detail of orange fluorescence, side A, UV light
 Figure 49. Brass cap and cast-iron pins	
Condition	The coating (varnish and maroon stain) has areas of abrasion exposing the wood. The end caps are slightly loose, and all the metal parts show a bit of tarnishing.

9.1.2 I.2 The Glasgow Upholsterers Society banner

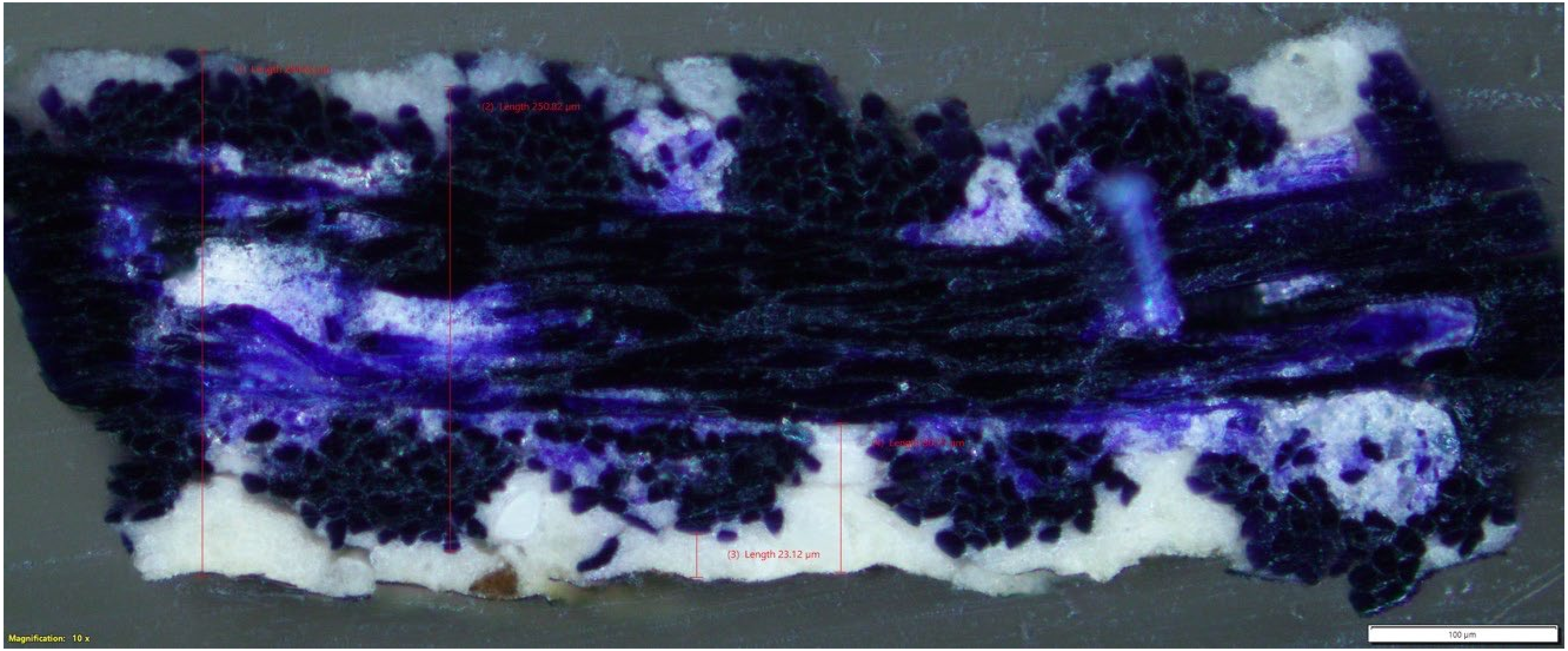
Side A (side of fringe attachment)

Side B (side opposite to fringe attachment)

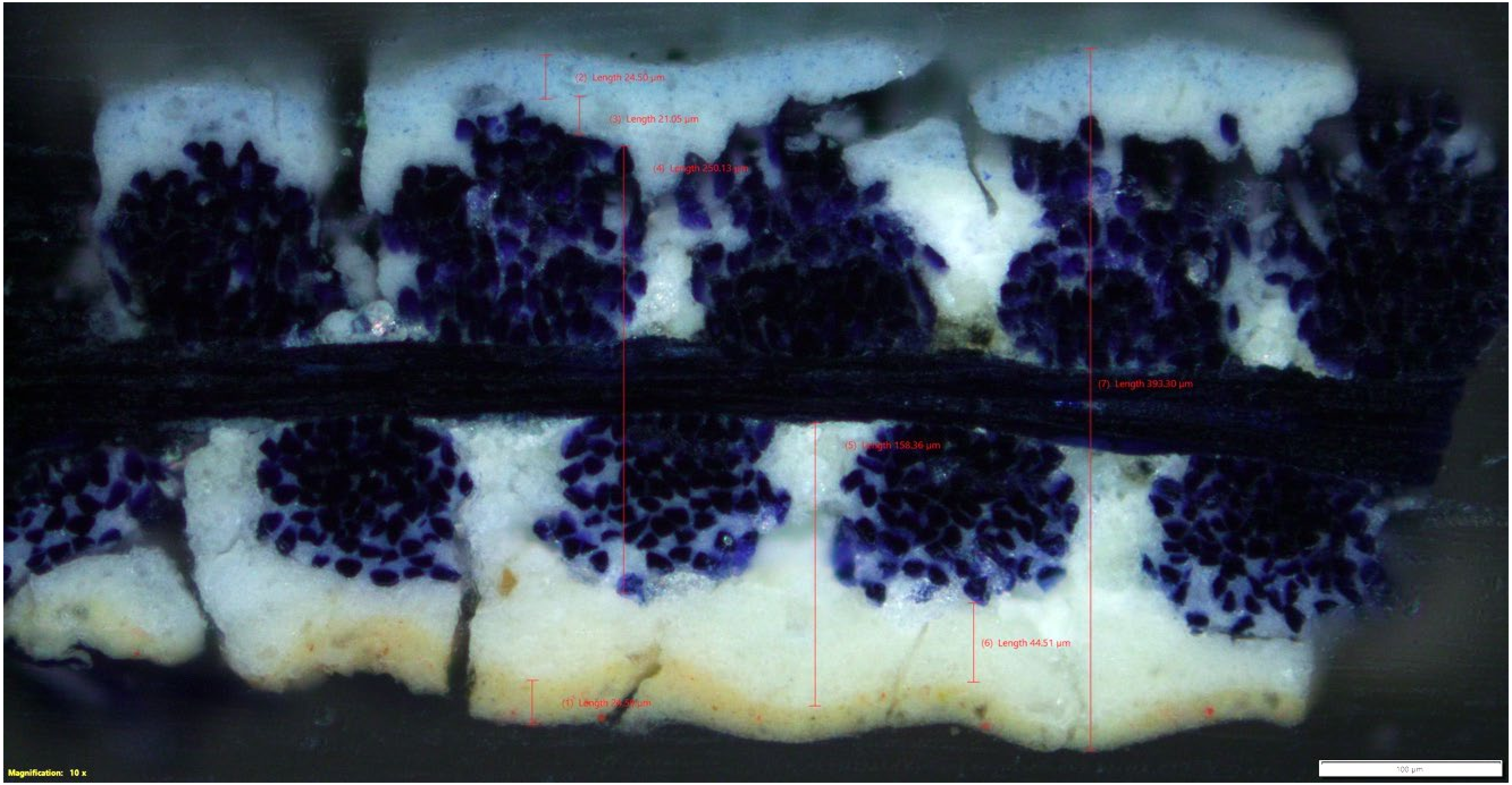
<table>
<tr><td>Title</td><td colspan="4">Banner of The Glasgow Upholsterers Society</td></tr>
<tr><td>Maker</td><td colspan="4">George Kenning (Signed on side A central painting lower left, as G Kenning London)</td></tr>
<tr><td>Date of making</td><td colspan="4">1884. Described in detail on an article from the Glasgow Herald dating 8th September 1884: first use of the newly made society’s banner for the Franchise Bill Demonstration on 4th September 1884.</td></tr>
<tr><td>Technique</td><td colspan="4">Oil paint, coloured glazes, silver and gold leaf on silk</td></tr>
<tr><td>Description</td><td colspan="4">Dark blue banner with a red fringe on the bottom edge, painted on both sides on a single layer of fabric with the following layout: an upper scroll indicating the name of the society on the front and the title “SONS OF SAINT PAUL” on the back. A central scene depicting on the front the City of Glasgow coat of arms, flanked by Saint Andrew on the right and Saint Paul on the left; and on the back, a central scene depicting the coat of arms of the Society of Upholders. The lower scroll on the front indicates the date of institution of the society and the lower scroll on the back contains their motto. It includes its original hanging top pole with brass ends and two guide tapes.</td></tr>
<tr><td rowspan="2">Exact wording</td><td colspan="2">Side A</td><td colspan="2">Upper scroll: “GLASGOW UPHOLSTERERS SOCIETY”
Central scene: “LET GLASGOW FLOURISH.”
Lower scroll: “INSTITUTED 1864”</td></tr>
<tr><td colspan="2">Side B</td><td colspan="2">Upper scroll: “SONS OF SAINT PAUL”
Lower scroll: “SHELTER FOR THE NEEDY, UNITE AND BE STEADY.”</td></tr>
<tr><td>Dimensions</td><td colspan="2">Height 2,620 mm (including loops/pole and fringe)</td><td colspan="2">Width 2,914 mm (not including pole nor lateral ties)</td></tr>
<tr><td>Owner</td><td colspan="2">Glasgow Museums</td><td>Date of acquisition</td><td>1967</td></tr>
<tr><td>Inventory number</td><td>PP.1973.4.1</td><td>Location</td><td colspan="2">Glasgow Museums Resource Centre, Pod 12</td></tr>
</table>

General assessment of condition	The banner is in poor condition, mostly due to the fragile condition of its paint layer. Side A appears more deteriorated than side B. It has localised ingrained soiling on the lower half, more evident on the front. Bloom is evident in all the paint colours on both sides, more acutely on the front. The lower silver leaf scrolls on both sides have tarnished. Both fringe and the original loops show a mottled discolouration due to surface abrasion. It has two long vertical splits in the central scene, running along the seams of two of the inner selvedges. There are five horizontal splits on both sides of the paint with associated paint losses, more extensive on side A scene. There is a long patch stitched along one side of the painted scene, applied from side B. Two of the hanging loops are torn and repaired with black electrical tape. The paint on side A is significantly more damaged than side B, with persistent dry powdery delamination.
Photography	Digital photography – Side A, normal light/ Side B, normal light/ Macro images of the textile construction, painting technique and scrolls layering sequence (including transmitted light, raking light and UV images). Dino-Lite images (20x) – textile weave, preparation, painting technique, layer sequence and tarnishing on the scrolls.
Examiner/Date	Daniel Sanchez Villavicencio/September 2018
Place and conditions of examination	Glasgow Museums Resource Centre, Research Room. Banner examined flat over an examination table using both natural illumination and fluorescent tubes light (daylight).

Cross-sections micrographs (crossed polarisers, 100x)



Sample GU08: Cross-section from silvered scroll with measurements (Side A on the top)



Sample GU09: Cross-section from central painting with measurements (Side A on the top)

<table>
<tr><th colspan="4">Textile</th></tr>
<tr><td>Description</td><td colspan="3">The banner is made of a single layer of fabric. It is constructed from 5 vertical strips of dark-blue dyed rep weave fabric sewn together. The strips were hand sewn along the selvedges with a whip stitch, aligned vertically with the warps perpendicular to the pole (according to the selvedges seen on all four inner seams). There are no seam allowances as they are butted edge to edge and whip stitched. It has no added borders. It has 15 pole loops attached to the top, 11 possibly made of purple-dyed silk grosgrain ribbon with undyed silk wefts, which are considered to be original, and 4 of a different type of ribbon and fabric, indicating later replacement. A thick bullion fringe is attached to the bottom edge, possibly made of red dyed silk and undyed cotton. It has two guide tapes at each bottom corner looped into a chain, possibly made of dark-blue dyed silk and thick, grey-dyed cotton.</td></tr>
<tr><td>Materials

*Not analysed</td><td colspan="3">Fabrics: dark-blue dyed silk

Sewing threads: blue dyed silk and *black dyed cotton

Pole loops: purple dyed silk with undyed silk core (original), *blue dyed cotton and *black dyed silk with undyed cotton (replacements, see section below)

Fringe: red dyed silk and undyed cotton

Guide tapes: *dark-blue dyed silk with *grey dyed cotton core

Corner reinforcements/Eyelets: *dark-blue dyed silk

Ground textile fibres analysed with FTIR-ATR</td></tr>
<tr><td rowspan="4">Dimensions</td><td rowspan="4">Fabric: Each panel measures (H x W):

1. 588 x 2914 mm

2. 597 x 2914 mm

3. 598 x 2914 mm

4. 597 x 2914 mm

5. 588 x 2914 mm

(Numbered left to right from the front)</td><td rowspan="4">Pole loops:

1-3. 50 x 180 mm

4. 51 x 180 mm

5-7. 50 x 180 mm

8. 51 x 180 mm

10-11. 50 x 180 mm

12. 51 x 180 mm

13-14. 50 x 180 mm

15. 49 x 190 mm

(Numbered left to right from the front)</td><td>Fringe:

87 x 2914 mm</td></tr>
<tr><td>Guide tapes:

20 x 755 mm</td></tr>
<tr><td>Thickness (min./max.)</td></tr>
<tr><td>250.13µm/250.82µm (digitally measured)</td></tr>
<tr><td rowspan="5">Weave</td><td colspan="3">Fabric: warp-faced plain weave (also called rib or rep fabric)

Average thread count: 60 warps/cm by 20 wefts/cm (Figure 1)</td></tr>
<tr><td colspan="3">Pole loops (originals): warp-faced plain weave (also called grosgrain ribbon)

Average thread count: 74 warps/cm by 14 wefts/cm (Figure 2)</td></tr>
<tr><td colspan="3">Fringe: 2 ply “Z” twist (also called thick bouillon fringe)

Average braid count: 28 braids/15 cm (Figure 10)</td></tr>
<tr><td colspan="3">Guide tapes: 3 ply cord (1 plain strand, 1 2-ply strand with “S” twist and both of them twisted “Z” to each other)</td></tr>
<tr><td colspan="3">Eyelets: warp-faced plain weave (also called rib or rep fabric)

Average thread count: 60 warps/cm by 20 wefts/cm</td></tr>
</table>

Figure 1. Upholsterers' banner DinoLite detail of the fabric's weave (20x)

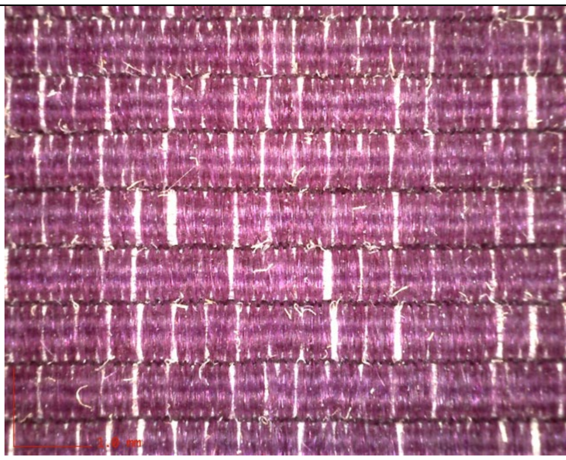
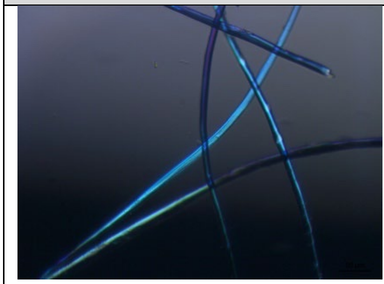
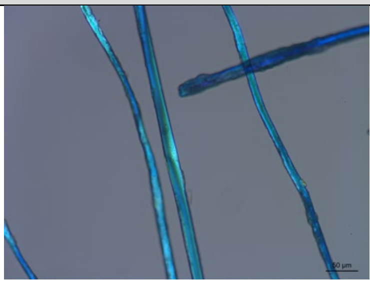


Figure 2. Upholsterers' banner DinoLite detail of the loop's weave (20x)

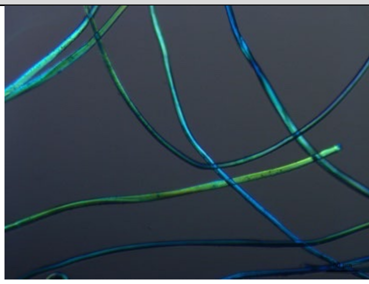
Micrographs of textile fibres (crossed polarisers, 200x)



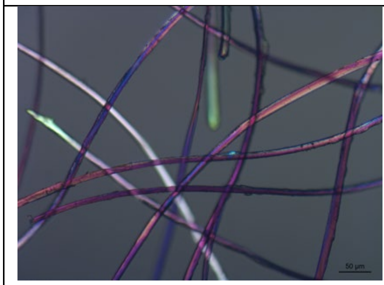
Sample GU01: warp silk fabric



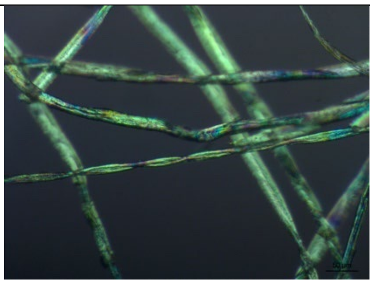
Sample GU02: weft silk fabric



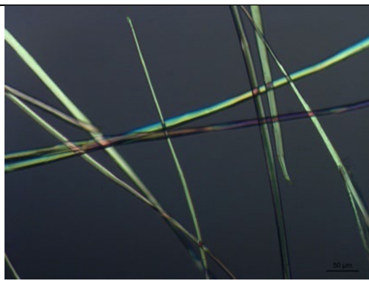
Sample GU03: silk stitching thread



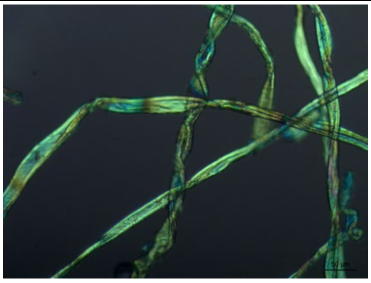
Sample GU04: warp silk loop



Sample GU05: weft cotton loop



Sample GU06: silk coating of fringe



Sample GU07: core cotton fringe

Construction	The five strips of silk are sewn together along the selvedges, with hand-sewn whip stitched seams and blue dyed threads (Figure 5). The seams are very neatly sewn, with an average width of 1mm. The panel is finished with lateral hemmed edges folded towards side A (side of the fringe attachment). Both left and right edges are sewn by hand using a running stitch, with blue dyed thread and a turning with an average width of 13 mm, very regular (Figure 4). The top and bottom edges are machine-stitched with flat felled seams and black dyed thread, with an average width of 11 mm between each pair of stitching lines (Figures 3 and 8). Both hemmed edges are also folded to the

front of the banner. The 11 original pole loops are attached to each side of the top hemmed edge by means of the same stitching lines, with the edges of the loops folded inside to prevent fraying (Figure 7). The fringe is attached very neatly to the front with a machine running stitch and black thread (Figures 6 and 10). Both left and right eyelets are reinforced from the front with a square of the same silk, with their four edges folded in to prevent fraying (Figure 9). The weave is aligned similarly to the banner panels. The stitches are hand-sewn, going through each side with the same running stitch and blue dyed thread, plus a hand-sewn buttonhole stitch surrounding each of the holes. The ties are a 3-ply yarn. It is additionally looped by hand into a chain and tied to the eyelets with a single knot (Figure 9).

Figure 3. Upholsterers' banner top right corner showing the machine-stitches continuing towards the folded hemmed edge

Figure 4. Upholsterers' banner running stitch (hand-made) hemming the edges of the right side of then banner

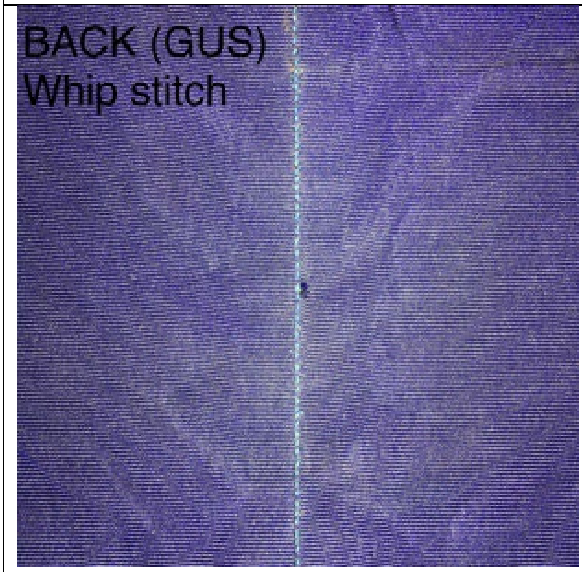


Figure 5. Upholsterers' banner whip stitch (hand-sewn) joining the strips of the ground silk

Figure 6. Upholsterers' banner machine-stitch hemming the bottom edge of the banner and attaching the fringe

Figure 7. Upholsterers' banner folded edges to prevent fraying

Figure 8. Upholsterers' banner machine stitches hemming the top edge and attaching the pole loops.

Figure 9. Upholsterers' banner, reinforce of the left eyelet

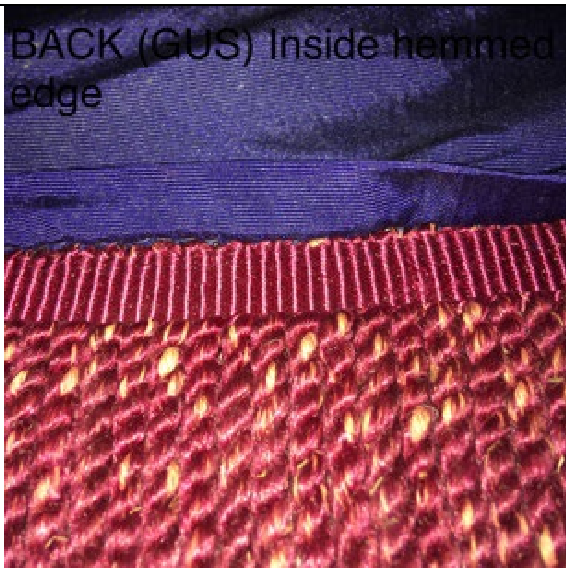
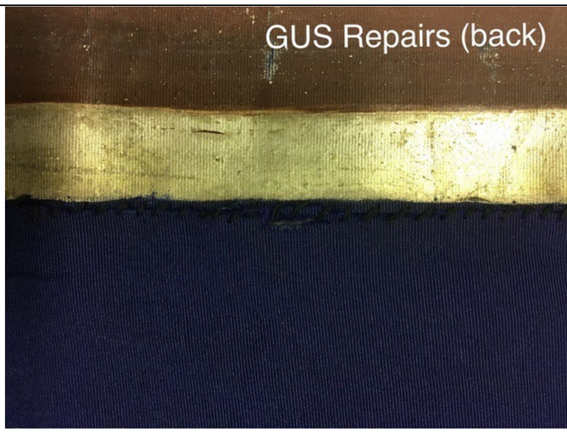
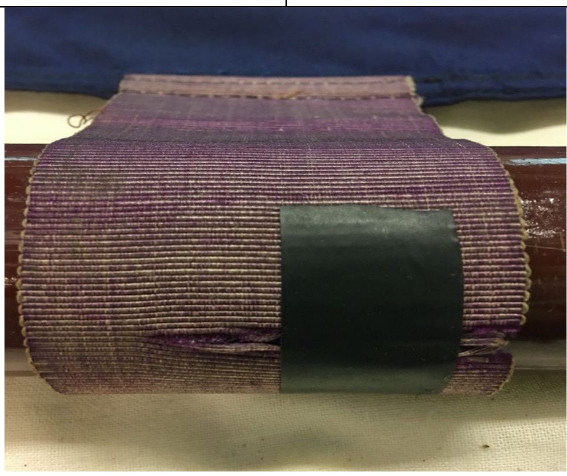


Figure 10. Upholsterers' banner appearance of the hemmed edge with the attached fringe

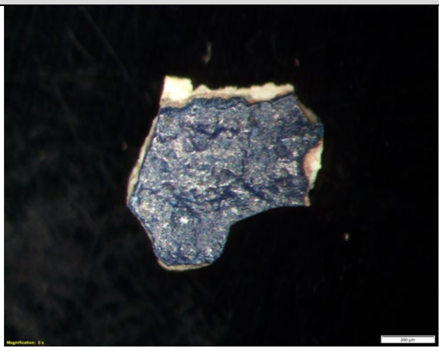
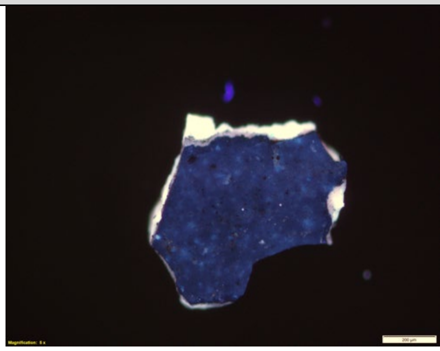
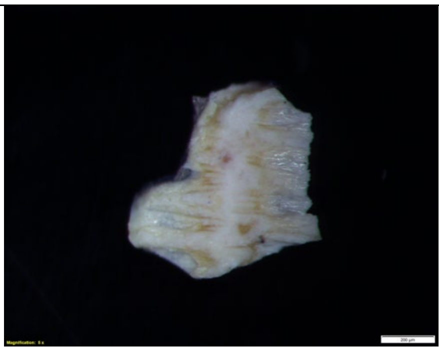
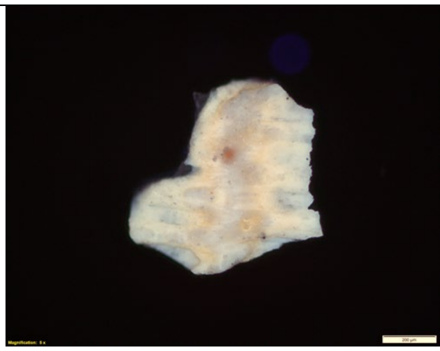
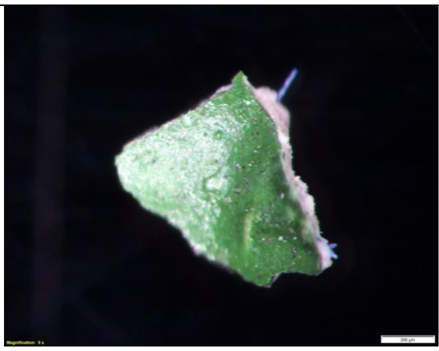
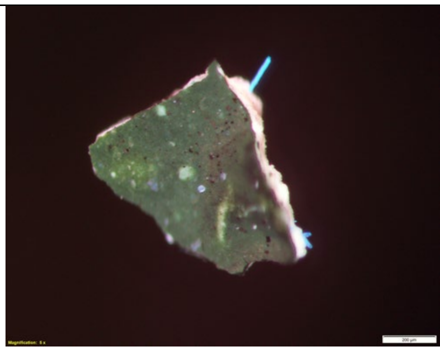
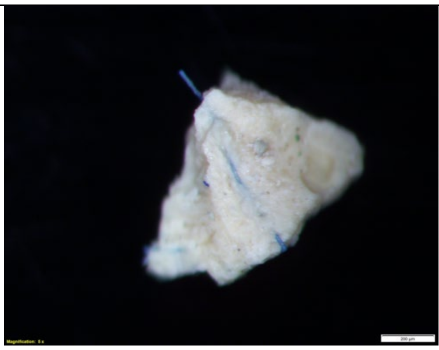
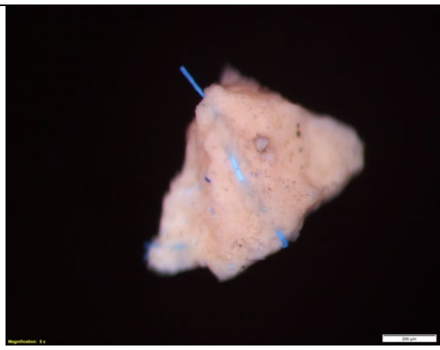
Repairs	Patches There is a line of machine-stitched patches applied from side B of the banner, located on the lower left half of the painted scene, re-attaching the unpainted textile to the silvered frame (Figure 11). The patches are dark blue-dyed but with a different weave, machine-stitched with a black sewing thread. Stitching There are localised re-attachments of the ground textile to the central painting accomplished with a hand- made whip stitch and black thread (Figure 12). Loops replaced Four of the pole loops have been replaced; loops #4, #8 and #12 have been replaced with a black dyed grosgrain ribbon, and loop #15 has been replaced with a piece of blue-dyed tabby weave fabric, much slender than the other ribbons. Loops re-joining

	Loops #5 and #6 have been re-joined at the top of the pole with black electrical tape (Figure 13).
 Figure 11. Upholsterers' banner machine-stitched patch re-joining the ground textile with the central painting	 Figure 12. Upholsterers' banner hand-made whip stitch re-joining the ground textile with the central painting
 Figure 13. Upholsterers' banner black electrical tape used for re-attaching the partly torn 11th loop	
Condition	Soiling There is ingrained soiling on both sides, accumulated on the lower half of the banner. The ingrained soiling occurs correspondingly on the lower third of both sides, also possibly affecting the silvered decoration (see silvering table). Both fringe and the original loops have discoloured in a mottled pattern, exposing their undyed wefts due to the abrasion of their dyed silk covering (Figure 14). Creasing/distortion The banner has an overall, yet minor distortion, with creases both on and around the applied decoration, potentially formed during its making and due to the rolling of the banner. The pattern of distortion, paint loss and spacing between horizontal splits, indicate the tight rolling of the banner on its own pole (Figure 15). Structural condition Some of the silvered scroll of the front transferred to the textile on the back, and there is brown coloured paper (possibly machine made with wooden pulp) adhered over some of the black letters. This could indicate the insertion of a protective paper which was known to have been used by Tutill to prevent the fresh paint from adhering to itself (Clark, 2011). The textile has five horizontal splits on the central painting and around sections of the scrolls. However, the warps and wefts along the splits show no evident fraying. Sections of the seams on the painted sections have split vertically

<table>
<tr><td></td><td>along the stitches, also without evident fraying of the textile. Finally, both eyelets are ripped slightly by the pulling of the guide tapes, and the original pole loops are splitting along the top of the pole due to abrasion.</td></tr>
<tr><td>

Figure 14. Upholsterers' banner mottled appearance of the fringe caused by the exposing of the undyed cotton core with the abrasion of the red-dyed silk covering</td><td>
Figure 15. Upholsterers' banner pattern of distortion related to the tight rolling of the banner in its own pole, causing paint loss</td></tr>
</table>

Painting	
Description	Side A: the official coat of arms of the City of Glasgow is depicted at the centre, with the effigy of Saint Mungo in the crest, patron saint of Glasgow; two salmons as supporters; the tree, crow, fish holding a ring and the bell in the field; but lacking the usual mantling or helmet, similar to the design included in Partick Bridge dating 1878. The escutcheon is flanked on its right side by the figure of Saint Paul, saint patron of the upholsterers, and on its left side by Saint Andrew, saint patron of Scotland. Both figures stand over a long rectangular base and between them and below the escutcheon's motto, there are two clasped hands framed inside an oval frame.
	Side B: three taut white fabric tents, crowned by red onion domes are set on an open field background arranged in a triangle. Each tent is topped with a horizontal red cross flag, similar to the Saint Patrick's saltire included in the Union Jack to represent Ireland after the act of union 1800, and to the International Maritime Flag for assistance, used as such since 1857. Placed at the base of the composition is the Lamb of God holding a red laced cross, symbolising the coming of Christ. The scene is based on the "three tents" verse on Matthew 17:4 related to the Transfiguration and its being framed by a purple curtaining.
Layers on each side* *Numbered by order of application	1. Size layer (seen in the periphery of the scene as a 1 cm impregnated outline, more evident in the back) 2. White ground 3. Thick paint applied as background or base colour 4. Thick paint applied as contrasting colour 5. Thin translucent paint applied as shadows 6. Thin paint applied as finishing lines
Thickness	Ground side A 44.51 μm; ground side B 158.36 μm; paint side A 24.50 μm; paint side B 24.50 μm; central paint both sides 393.30 μm (digitally measured)
Preparatory drawing	Inferred (not seen) in the back by the usage of the white ground as base for the three flags, denoting the shapes were outlined (and reserved) in advance. Clearly seen in the front around the fingers of the clasped hands, on the head of Saint Mungo and the contour of Saint Andrew, as dark lines that do not correspond with the final outlines (pentimenti). Hence, it was potentially drawn over the white ground with a black charcoal or graphite, as seen in the historical video of banner painters (Pathé, 1958).
Palette	Side A: Light brown, dark brown, white, dull green, burnt red, pink, brown (translucent), red (translucent), grey, ochre, light blue, dark blue (translucent)
	Side B: Light brown, dark brown, white, light green, burnt red, red (translucent), pale yellow, light blue, purple, ochre
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size and isolation coating) (FTIR/SYPRO RUBY); lead white, barium sulphate, synthetic ultramarine, red ochre, yellow ochre, calcium carbonate, magnesium carbonate (extenders) (SEM-EDX).

Micrographs of paint samples showing appearance of paint (front) and ground (back) (50x)	
 Sample GU15: front, crossed polarisers	 Sample GU15: front, UV filter
 Sample GU15: back, crossed polarisers	 Sample GU15: back, UV filter
 Sample GU23: front, crossed polarisers	 Sample GU23: front, UV filter
 Sample GU23: front, crossed polarisers	 Sample GU23: front, UV filter

Appearance under UV light	Each paint colour shows a different response to the UV radiation, either presence or lack of fluorescence, highlighting the absence of a coating. The light colours have a strong pale-yellow fluorescence, regularly associated with the presence of lead white, which could indicate the presence of this white pigment in the mixture.
Structure	The paintings on both sides are constructed in a simple way, with an efficient use of paint and an overlaying of scumbles or thin layers of paint over a thicker base, producing the volumes, shadows and other details (Figure 16). The brushstrokes of the base layers are very evident, highlighting the thickness of the paint when applied. The brushstrokes of

	the scumbles on the top are also evident, but not by its thickness, but by the pattern left by the bristles, indicating its further dilution (Figure 17). There is also plenty of colour smudging, particularly in the faces and all throughout the scene on the back, to create a more realistic effect. On the side A, the lighter shade of brown is applied over the white ground reserving the figures, highlighting the use of a preparatory drawing. The figures are constructed from a plain colour base to which thinner layers of paint were added to create the volumes, mixing the colour in the canvas in addition to the palette (wet-on-wet application) (Figure 18). The scene of side B is constructed in a similar manner, with the colour applied only in the areas marked by the preparatory drawing (inferred, not seen). The lighter tones were applied thickly as a base and the darker tones (and translucent shadows) have been added thinly on top. There is much evidence of wet-on-wet application of paint in side B, which indicates that the paint was applied over a still fresh layer, possibly forming a better bond than side A, where there is less evidence of that. Some of the brushstrokes and scumbles on side A appear to have been applied after the drying of the subjacent layer, as there is no evidence of blending as it happens on side B (Figure 19). An interesting feature is that the white background of the flags on the back is actually the white ground layer left exposed intentionally.
Condition	The condition of the paint layer is different on both sides of the banner. The thick paint on side A seems to have a frail attachment to the white ground, presenting dry powdery delamination in multiple areas. There is evidence of abrasion along the folds and creases of the textile, partially exposing the textile in areas. However, the exposed textile maintains some of the white ground embedded into its fibres, possibly indicating the absence of a size layer on side A (Figure 25). The thick paint of side A seems very firmly attached to the white ground and hence to the textile, with only minor loses directly associated with the abrasion caused by the surrounding folds and creases. All areas of paint loss in side B expose the textile without any residue of the white ground, suggesting the presence of a size layer (Figure 24). Both sides of the banner show a similar craquelure pattern, formed by a horizontal breakage of the film along the spaces between the ribs of the weave, mostly noticeable under magnification (Figures 20 and 21). Likewise, both sides of the banner show a series of white protrusions coming from the white ground layer, some of them seen only under magnification and some noticeable with the naked eye (Figures 22 and 23). Bloom is evident over the different colours on both sides, particularly over the darker tones of side A (Figure 16). All paint loses are associated with the formation of creases and folds and they delaminate from the raised parts of the weave (ribs), exposing the white ground-embedded textile on the front and a “clean” textile on the back. There is a particular craquelure pattern seen in the dark scumbles of the red, blue and brown shadows. It resembles a drying-crack pattern with very fine parallel lines that do not correspond with wefts of the weave. In some cases, the cracks follow the direction of the brushstrokes (Figures 22 and 23). They show interrupting “craters” forming along the cracks, similarly to the phenomenon of ‘micro cissing’ reported as characteristic of British paintings (Jones, 1990; Kneller, et al., 2005; Jones, et al., 2013; Albertson, et al., 2012). There is distortion on the paint layer on both sides, much more evident from side A. The horizontal pattern suggests it was caused by the tight rolling of the banner onto its own pole, and the curving of the layer indicates it was rolled with the front facing in, possibly adding to its damage.

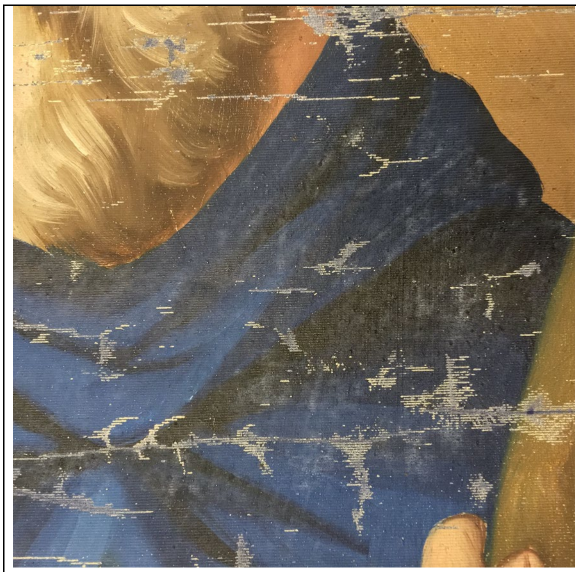


Figure 16. Upholsterers' banner overlaying of scumbles or thin layers of paint over a thicker base of paint


Figure 17. Upholsterers' banner evident brushstrokes of diluted paint applied over a thicker base of paint

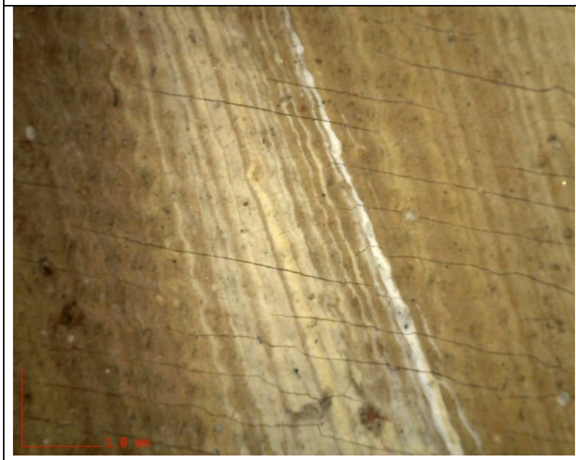


Figure 18. Upholsterers' banner DinoLite detail of wet-on-wet application of paint (20x)


Figure 19. Upholsterers' banner DinoLite detail of paint application over previously dry base (20x)


Figure 20. Upholsterers' banner breakage of the paint layer in St Andrew's cape along the weave, DinoLite detail (20x)

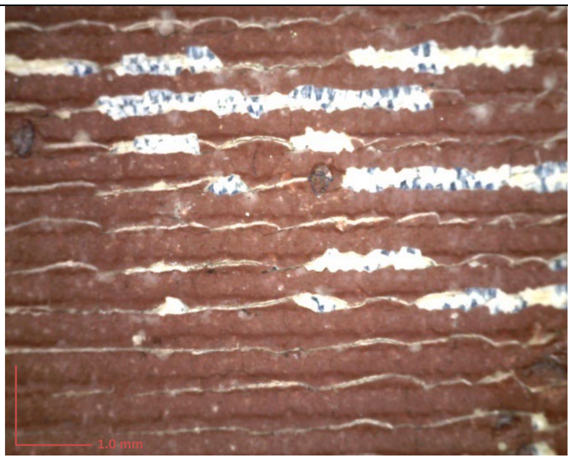


Figure 21. Upholsterers' banner detail of the paint breakage in the dark red of the tents in side B, DinoLite detail (20x)

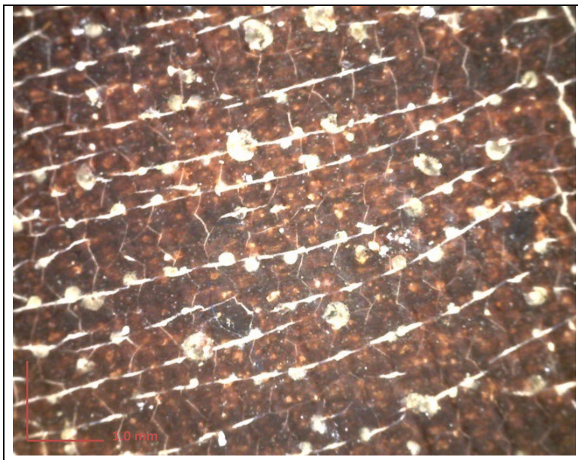


Figure 22. Upholsterers' banner white protrusions and micro-cissing in brown of side A, DinoLite detail (20x)

Figure 23. Upholsterers' banner white protrusions and micro-cissing in brown of side B DinoLite detail (20x)

Figure 24. Upholsterers' banner DinoLite detail of paint loss in side B showing a clean textile possibly sized (20x)

Figure 25. Upholsterers' banner DinoLite detail of paint loss in thicker layers of paint showing ground residues embedded into the textile (20x)

Silvering	
Description*	Upper scroll (also called ribbon): Golden coloured coated composite scrolls with black block capitals lettering, distributed along three arched bands. Each band is separated by a small returning band and finished on both ends with another alternated band and a roll. All sections without lettering are decorated with alternated vertical bands of red and gold. It is further decorated on the left and right sides with a descending scrollwork, finished with a hanging tasselled rope, coloured in alternated bands of bright yellow, sepia and gold.
	Frame: thin line rectangular frame with a golden coloured coating on top.
*Besides the wording, silvering is identical on sides A and B	Lower scroll (also called ribbon): Golden coloured coated simple scroll with black block capitals lettering, formed by a regular band with two long returns and one roll at each end. All sections without lettering are decorated with alternated vertical bands of red and gold.
Layers on each side** **Numbered by order of application	1. Size layer (seen as an external outline impregnating about 1 cm of the textile, more evident in the back) 2. White ground 3. Metal leaf 4. Coloured coating 1 (golden) 5. Coloured coating 2 (red) and coloured coating 4 (yellow) 6. Coloured coating 3 (sepia) 7. Black paint (lettering and finishing lines) **** Only for the frame: 1. Size layer (seen as an external outline impregnating about 1 cm of the textile, more evident in the back) 2. White ground 3. Metal leaf 4. Coloured coating 1 (golden)
Thickness	Metal leaf approximately 1-2 μm; ground side A 23.12 μm; ground side B 80.95 μm; silvered scroll both sides 284.63 μm (digitally measured)
Preparatory drawing	Inferred (not seen) by the restricted application of the metal leaf on the shapes and their almost perfect matching on both sides. Potentially made with the method of pouncing suggested by Kelly (Kelly, 1911).
Palette	Golden (translucent), black, red (translucent), yellow, sepia (translucent)
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size and silver isolation layers) (FTIR/SYPRO RUBY); lead white, barium sulphate, calcium carbonate (ground), silver (metal leaf) (SEM-EDX); linseed oil and mastic natural resin (red and yellow coatings) (FTIR-ATR); black paint and sepia coating not analysed.
Appearance under UV light	The golden coloured coating applied fully over the metal leaf, shows a weak fluorescence of a pale green colour. In areas where it seems to be thicker (more concentrated) the fluorescence is stronger (Figure 27). The fluorescence colour may highlight the presence of drying oil and/or terpenic resin as binders. Some areas with no fluorescence (dark purple) may indicate the presence of oxidation products (silver sulphates). The black paint of the lettering and fine lines shows a green fluorescence, highlighting the possible the presence of drying oil and/or

terpenic resin as binders. The red bands have a strong orange fluorescence colour, regularly associated with the presence of shellac (Figures 26-29). The exposed ground has a very strong pale-yellow fluorescence, regularly associated with the presence of lead white (Figures 30 and 31). The yellow-coloured coating has a very strong fluorescence of a pale green colour, possibly associated with the presence of drying oil and terpenic resin as binders.

Figure 26. Upholsterers' banner, area selected for UV light image under normal light

Figure 27. Upholsterers' banner UV light image, showing orange fluorescence colour on red banding and green fluorescence colour in golden coating

Figure 28. Upholsterers' banner, area selected for UV light image under normal light

Figure 29. Upholsterers' banner UV light image, showing orange fluorescence colour on red banding and green fluorescence colour on black paint

Figure 30. Upholsterers' banner, area selected for UV light image under normal light

Figure 31. Upholsterers' banner UV light image, showing green fluorescence colour on golden coating and bright fluorescence of exposed ground

Structure	There is a darker outline suggesting impregnation of the textile of about 1 cm exceeding both scrolls (Figures 32 and 33), indicating the probable application of size for impeding the spread of the oily ground, as recommended by Gibson and Kelly (Gibson, 1870; Kelly, 1911). A thin layer of white ground is applied on top, potentially used as gold-size to adhere the metal leaf, as recommended by Kelly for oil gilding of silk banners (Kelly, 1911). On top of the metal leaf, there is a thin golden coloured coating to make it appear as gold leaf. The golden coloured coating is diluted depending on the areas of the scroll, to produce a volumetric effect. Over that overall golden coloured coating there are bands of a red coloured coating in the scrolls and of a yellow-coloured coating in the elaborated scrollwork, these latter with an added sepia coloured coating for added contrast. All is finished with fine lines of black paint and the black lettering on top.

Figure 32. Upholsterers' banner, outline of surpassing size surrounding the scroll

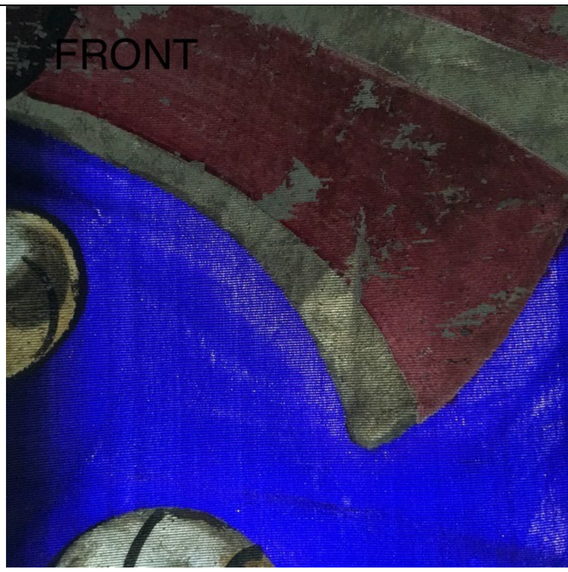


Figure 33. Upholsterers' banner, transmitted light image of outline of surpassing size surrounding the scroll

Condition	The silvering is in a fair condition, with localised tarnishing, particularly on the lower scrolls of both sides, possibly caused by the dampness or (dirty) water absorption over its use (Figure 34). The silvering has a very firm attachment to the white ground and the textile, with only minor losses associated to the formation of creases. It has a very fine and homogeneous craquelure pattern, only noticeable under magnification, forming parallel lines along the spaces between the ribs of the weave (Figure 35). The few paint loses are associated with direct abrasion and loss of adherence, particularly on the black paint of the letters that delaminates along with the silver leaf, exposing the white ground (Figures 35 and 36). The losses also coincide with the raised part of the weave (ribs) and are concentrated in the lower scroll of side A (Figure 36). Additionally, there is an untarnished outline around each of the letters and adjacent to the red bands, which seemed to have shrunk pulling the golden coloured coating towards them (Figures 37-39). Finally, there is evidence of silver leaf transferring to the top of the banner, most likely caused during its rolling. The transfer coincides with the losses of the other side, indicating it happened whilst being rolled up tightly onto its pole.

Figure 34. Upholsterers' banner, bottom scroll side A

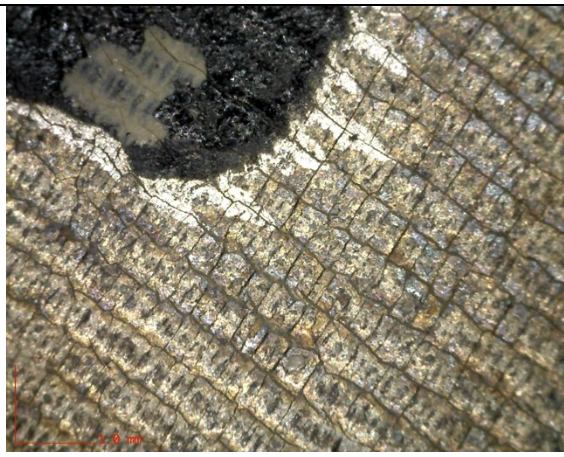


Figure 35. Upholsterers' banner, DinoLite detail (20x) of micro-craquelure of silver leaf

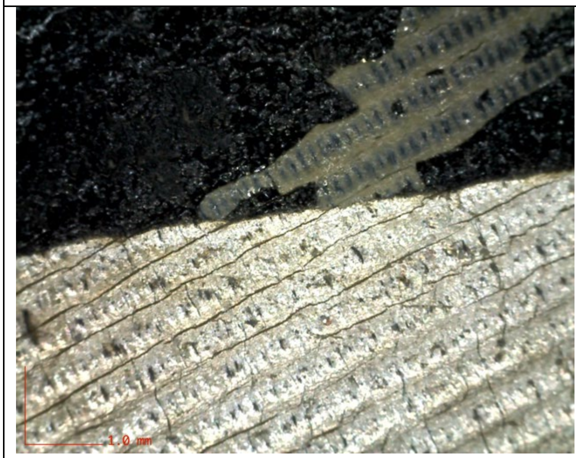


Figure 36. Upholsterers' banner DinoLite detail (20x) of micro-craquelure of silver leaf and black paint detachment exposing ground

Figure 37. Upholsterers' banner, detail of untarnished outline surrounding letters

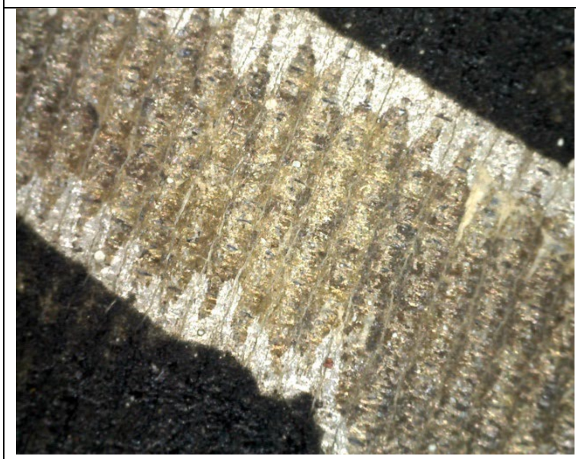


Figure 38. Upholsterers' banner DinoLite detail of untarnished outline next to black paint (20x)

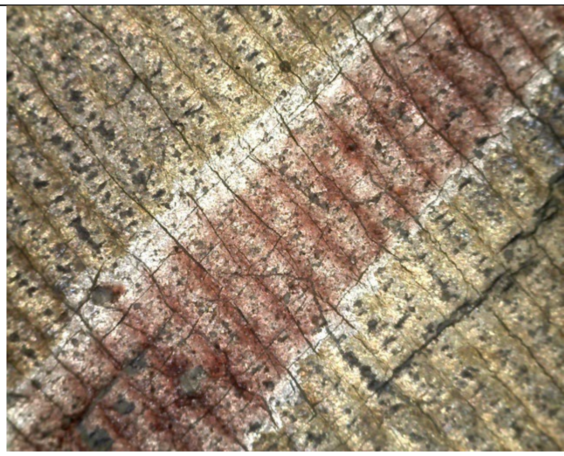


Figure 39. Upholsterers' banner DinoLite detail of untarnished outline next to red glaze (20x)

Gilding	
Description	Side A central painting, centre (Glasgow coat of arms): a thin line frame surrounding the shape of the two-engrailed-top shield or escutcheon, as well as alternated segments on the torse under Saint Mungo’s effigy and the leafed-shaped scrollwork above the motto. Side A central painting, bottom (clasped hands): a thin line oval frame surrounding the two clasped hands over a light blue background.
Layers on side A* *Numbered by order of application	**** Only for the Glasgow coat of arms: 1. Size layer (not seen, but same of the painting) 2. White ground 3. Possible gold-size 4. Possible gold leaf 5. Brown coloured coating (outlines and shadows) **** Only for the oval frame: 1. Size layer (not seen, but same of the painting) 2. White ground 3. Possible gold-size 4. Possible gold leaf
Thickness	Not measured.
Preparatory drawing	Inferred (not seen) by the restricted application of the metal leaf on the shapes and the invasion of the brown and blue backgrounds over the gilded areas (indicating the metal leaf was applied before the backgrounds). The design was potentially drawn over the white ground with a black charcoal of graphite, as seen in the historical video of banner painters (Pathé, 1958).
Palette	Brown (translucent)
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size) (FTIR/SYPRO RUBY); lead white, barium sulphate and calcium carbonate (ground) (SEM-EDX); rest not analysed.
Appearance under UV light	The metal leaf shows no fluorescence (dark purple colour), highlighting the absence of any type of coating. The added brown lines appear darker and not translucent under the UV radiation, reportedly related to the lack of fluorescence of brown pigments (Cosentino, 2015). Areas of the exposed ground have a very strong pale-yellow fluorescence, regularly associated with the presence of lead white.
Structure	The white ground appears to be the same as the rest of the painted scene, applied evenly and thinly inside the area reserved for the painting (frame included). A thin, translucent and glossy coating is seen under the metal leaf and over the white ground, potentially indicating the additional application of gold-size to adhere the gold leaf. Brushstrokes of a brown coloured coating are applied free-handed over the gold leaf on the coat of arms’ scrollwork in two thicknesses, thick and thin, to create contrast and suggest volume (Figure 41). The oval frame of the bottom has a similar layout, minus the coloured coating,

	with both brown and blue backgrounds invading the frame, indicating the layering sequence (Figure 40).
Condition	The gilding has a firm attachment to the white ground and the textile, with only minor losses and without signs of tarnishing, suggesting it is made of gold. It shows a very fine and homogeneous craquelure pattern, mostly noticeable under magnification, following the spaces of the ribs of the textile (Figure 42). The losses occur in the raised parts of the weave (ribs), exposing the white ground when the losses are caused by delamination, or the textile when they are a consequence of further abrasion. All losses are associated with the formation of creases and folds in the textile.

Figure 40. Upholsterers' banner, evidence of the layout of all the layers from textile to gold leaf

Figure 41. Upholsterers' banner, brown coloured coating over gold leaf

Figure 42. Upholsterers' banner, craquelure of gold leaf along the ribs and associated losses

Pole	
Description	Wooden pole, maroon stained and varnished, with one brass end cap at each end, one longer than the other. Only the left end cap has screwed-in fittings. It has a central brass piece which could be added as an extension or reinforcement. As only one of its sides is perforated and the opposite end cap is twice as long, it could have been one of the two original side poles, not the top hanging pole, which is now missing.
Dimensions	3200 x 40 mm
Inventory number	PP.1973.4.2
Materials* *Not analysed but inferred by their appearance	Pole: conifer wood (due to the pattern associated with the formation of tree rings) with possible shellac varnish End caps, centre piece and fitting: brass
Appearance under UV light	The varnish has a strong orange fluorescence colour, regularly associated with shellac.
Condition	The coating (varnish and maroon stain) has areas of abrasion exposing the wood (Figure 43). The left side end cap is slightly loose, and all the metal parts show some tarnishing, more acutely in the centre piece.

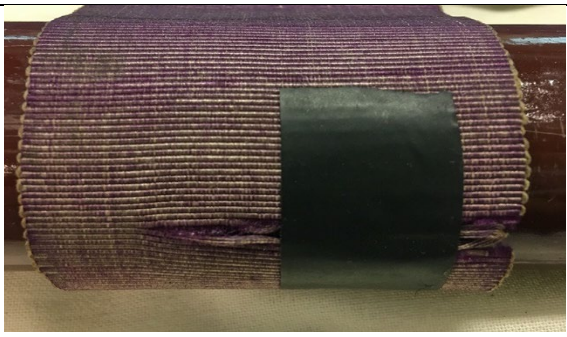


Figure 43. Upholsterers' banner, detail of pole showing the varnish and maroon stain

9.1.3 I.3 The Grain Millers of Glasgow banner

<table>
<tr><td colspan="2">

Side A (side of fringe attachment)</td><td colspan="3">

Side B (side opposite to fringe attachment)</td></tr>
<tr><td>Title</td><td colspan="4">Banner of The Grain Millers of Glasgow</td></tr>
<tr><td>Maker</td><td colspan="4">George Kenning (signed on side A central painting lower right as G Kenning London)</td></tr>
<tr><td>Date of making</td><td colspan="4">1884. The society was constituted in 1860. Although there is no record of their banner, the society was reported by the Glasgow Herald as one of the participants on the Franchise Bill Demonstration held on 4th September 1884. The Millers previously reported their participation on the laying of the foundation stone of Glasgow City Chambers on 6th October 1883, highlighting the absence of a banner. Hence, the year on the banner indicates that of its making, most likely requested for the Franchise Bill Demonstration.</td></tr>
<tr><td>Technique</td><td colspan="4">Oil paint, coloured glazes and silver leaf on silk</td></tr>
<tr><td>Description</td><td colspan="4">Dark blue banner with a red fringe on the bottom edge, painted on both sides on a single layer of fabric with the following layout: an upper scroll indicating the name of the society on both sides. A central scene depicting a Gray's patent noiseless roller mill on side A and three types of mills (windmill, steam mill and watermill) on side B. A small square containing the year 1884 on the lower part of the front side, and the year 1884 placed isolated on the corresponding back side. Includes its original hanging top pole with brass ends and two yellow guide tapes.</td></tr>
<tr><td rowspan="2">Exact wording</td><td>Side A</td><td colspan="3">Upper scroll: "THE GRAIN MILLERS OF GLASGOW"

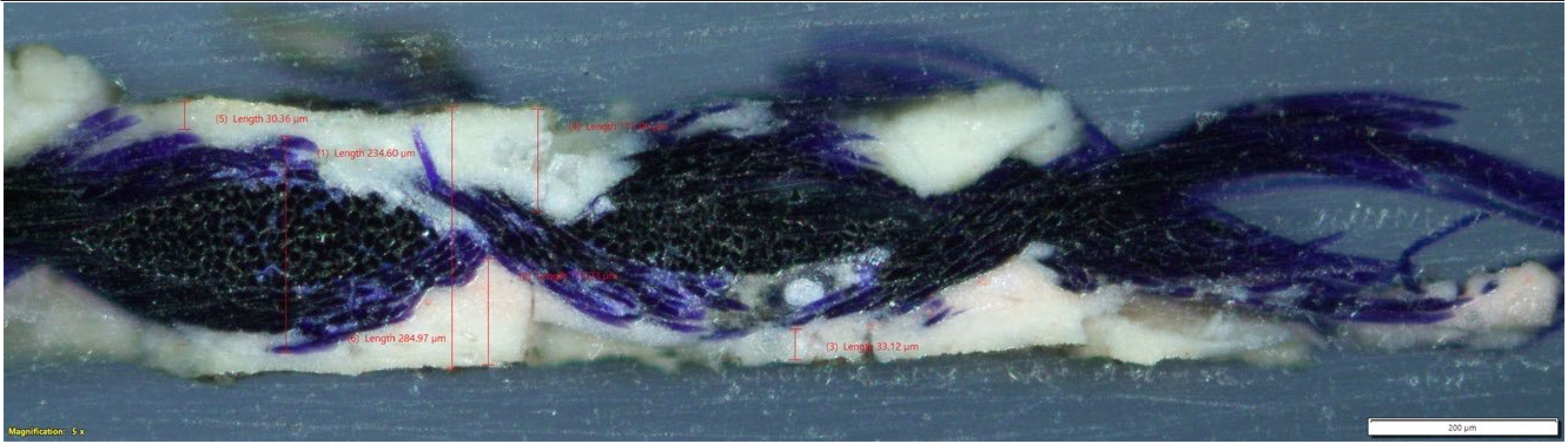
Central scene: "THE GOLDEN GRAIN, GOD'S GIFT, WE GRIND."

Lower part of the frame: "1884"</td></tr>
<tr><td>Side B</td><td colspan="3">Upper scroll: "THE GRAIN MILLERS OF GLASGOW"

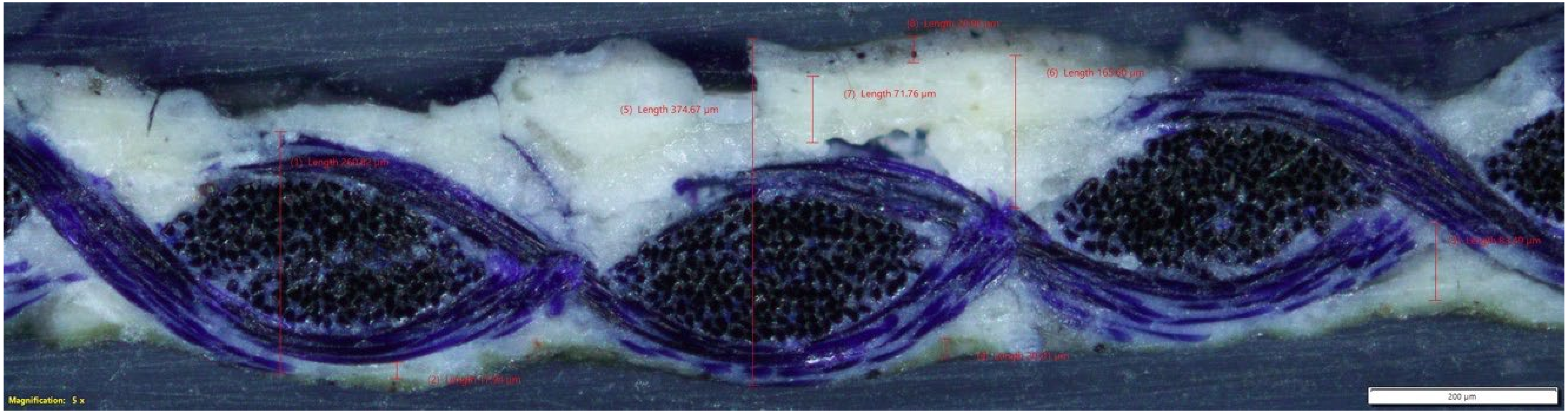
Lower part of the frame: "1884"</td></tr>
<tr><td>Dimensions</td><td colspan="2">Height 2,650 mm (including loops/pole and fringe)</td><td colspan="2">Width 2,870 mm (not including pole)</td></tr>
<tr><td>Owner</td><td>Glasgow Museums</td><td>Date of acquisition</td><td colspan="2">1988</td></tr>
</table>

Inventory number	PP.1988.43.1	Location	Glasgow Museums Resource Centre, Pod 12
General assessment of condition	The banner is in poor condition, mostly due to the fragile condition of the textile and a previous conservation treatment not carried out by Glasgow Museums' staff. Side B appears more deteriorated than side A. It has ingrained dirt all over, more evident on the back, as well as chalk guiding lines for the stitching of a nylon net repair. Bloom is evident on both sides, concentrated along the lower half of the central painted sections. The metal leaf decorations show tarnishing on both sides, concentrated on the floral garlands of the frames. The fringe shows a mottled discolouration, more acute on the bottom, due to surface abrasion. The banner has four long horizontal splits in the central scene with associated paint losses, running along each of the seams of the five pieces of fabric. Further paint losses are associated with horizontal splits and cracks within the painted sections, considerably more damaged on side B than side A.		
Photography	Digital photography – Side A, normal light/ Side B, normal light/ Macro images of the textile construction, painting technique and scrolls layering sequence (including transmitted light, raking light and UV images). Dino-Lite images (20x) – textile weave, preparation, painting technique, layer sequence and tarnishing on the scrolls.		
Examiner/Date	Daniel Sanchez Villavicencio/September 2018		
Place and conditions of examination	Glasgow Museums Resource Centre, Research Room. Banner examined flat over an examination table using both natural illumination and fluorescent tubes light (daylight).		

Cross-sections micrographs (crossed polarisers, 100x)



Sample MG26: Cross-section from silvered scroll with measurements (Side A on the top)



Sample MG10: Cross-section from central painting with measurements (Side A on the top)

<table>
<tr><th colspan="4">Textile</th></tr>
<tr><td>Description</td><td colspan="3">The banner is made of a single layer of fabric. It is constructed from 5 vertical strips of dark-blue dyed rep weave fabric sewn together. The strips were machine stitched along the selvedges with a flat felled seam, joined vertically with the warps perpendicular to the pole (according to one selvedge seen inside the hemmed left edge). It has no added borders. It has 19 pole loops attached to the top, 7 possibly made of red-dyed silk grosgrain ribbon, which are thought to be original, and 12 of a wider, red-dyed grosgrain ribbon attached with different stitches, indicating later addition (some of the newest loops are stitched over the original pole loops). A thick bullion fringe is attached to the bottom edge, possibly made of undyed cotton covered with red dyed silk. It has two guide tapes sewn at each bottom corner, possibly made of yellow-dyed cotton with a herringbone weave.</td></tr>
<tr><td>Materials

*Not analysed</td><td colspan="3">Fabrics: dark-blue dyed silk
Sewing threads: blue dyed silk and black dyed cotton* (originals); green*, blue* and red* dyed cotton (additions/replacements)
Pole loops: red dyed silk warps* with undyed cotton wefts* (originals), red dyed acetate warps* with undyed cotton wefts* (replacements)
Fringe: red dyed silk and undyed cotton
Guide tapes: yellow dyed cotton
Seam tape: undyed cotton
Ground textile fibres analysed with FTIR-ATR</td></tr>
<tr><td rowspan="4">Dimensions</td><td rowspan="4">Fabric: Each panel measures (H x W):
1. 588 x 2870 mm
2. 593 x 2870 mm
3. 591 x 2870 mm
4. 590 x 2870 mm
5. 585 x 2870 mm
(Numbered left to right from the front)</td><td rowspan="4">Pole loops:
1. 51 x 215 mm
2. 38 x 215 mm
3-13. 51 x 215 mm
14-19. 38 x 215 mm (numbered left to right from the front)</td><td>Fringe:
93 x 2870 mm</td></tr>
<tr><td>Guide tapes:
34 x 1730 mm</td></tr>
<tr><td>Thickness</td></tr>
<tr><td>234.60μm/260.82μm (digitally measured)</td></tr>
<tr><td rowspan="5">Weave</td><td colspan="3">Fabric: warp-faced plain weave (also called rib or rep fabric)
Average thread count: 60 warps/cm by 22 wefts/cm (Figure 1)</td></tr>
<tr><td colspan="3">Pole loops (originals): warp-faced plain weave (also called grosgrain ribbon)
Average thread count: 40 warps/cm by 12 wefts/cm (Figure 2)</td></tr>
<tr><td colspan="3">Fringe: 2 ply “Z” twist (also called thick bouillon fringe)
Average braid count: 28 braids/15 cm (Figure 10)</td></tr>
<tr><td colspan="3">Guide tapes: herringbone weave ribbon (Figure 10)</td></tr>
<tr><td colspan="3">Corner reinforcements/Eyelets: not present</td></tr>
</table>

Figure 1. Millers' banner DinoLite detail of the fabric's weave (20x)

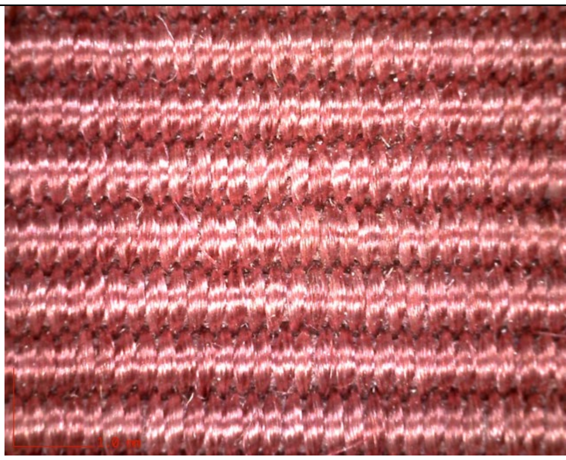
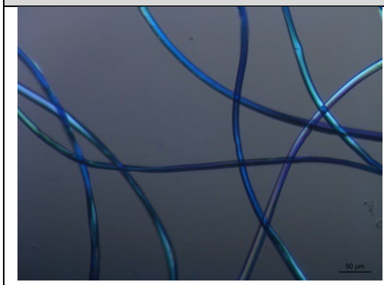
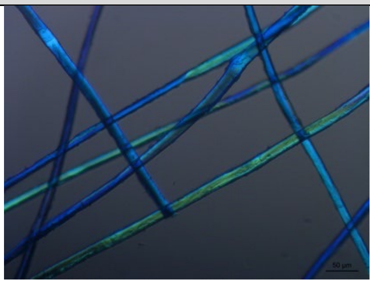


Figure 2. Millers' banner DinoLite detail of the loop's weave (20x)

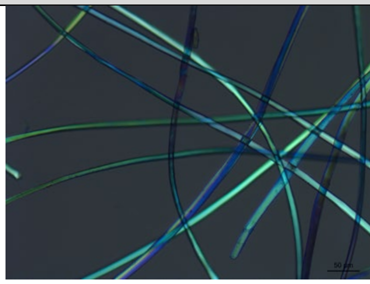
Micrographs of textile fibres (crossed-polars, 200x)



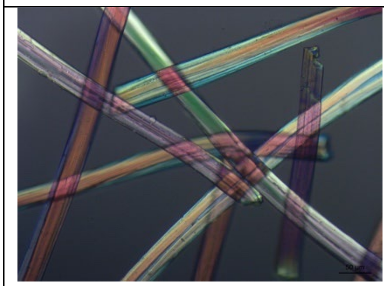
Sample MG22: warp silk fabric



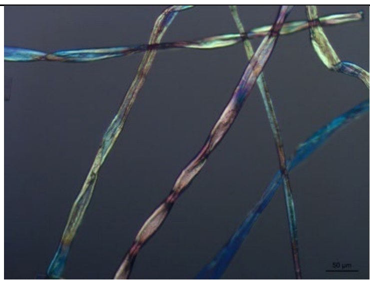
Sample MG22: weft silk fabric



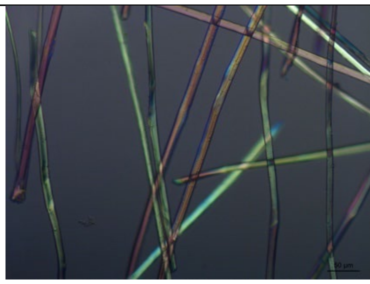
Sample MG03: silk stitching thread



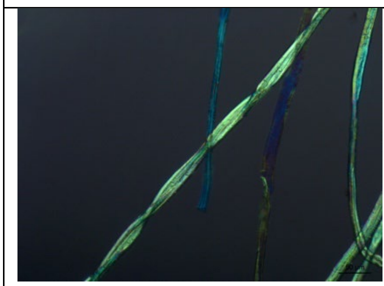
Sample MG04: Loop warp (man-made fibre)



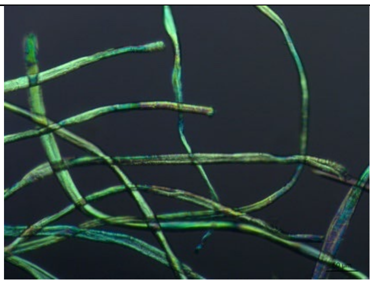
Sample MG05: Loop weft cotton



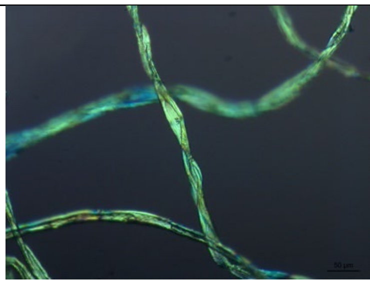
Sample MG06: silk coating of fringe



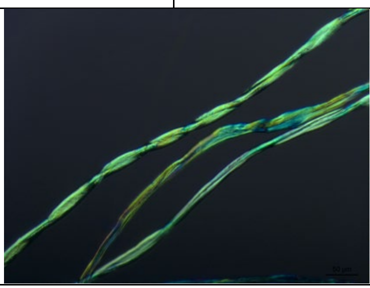
Sample MG07: core cotton of fringe



Sample MG08: cotton of guide tape



Sample MG23: warp of cotton strip



Sample MG23: weft of cotton strip

Construction	The five strips of fabric are sewn together along the selvedges, with machine-stitched flat felled seams and blue dyed threads (Figure 5). The average width of the seams is 4 mm and is possible that the selvedges were concealed inside them for added strength as one was found in the right-side edge (Figure 9). The seams have crimping on both sides of the stitching lines (more evident in the painted sections), a possible indication of either over-stretching while being stitched or differential tension due to the presence of the selvedge in the seam. Both left and right edges are turned and hemmed with a manual running stitch, with blue dyed thread and a turning of an average width of 15 mm (Figure 4). The top and bottom edges are also finished with a hemmed edge, sewn with a machine stitch. The top edge is folded towards side B and the bottom is folded towards side A (Figures 3 and 6). The thread used for sewing the top is blue dyed and the threads of the bottom are green and red. The top hemmed edge has an average width of 14 mm and the bottom is most irregular, ranging from 10 to 16 mm. Seven of the pole loops are tucked inside the hemmed edge and sewn individually from the back with a running stitch and black thread (Figure 7). The fringe is attached very irregularly to the front with similar stitches to the bottom edge, with some crimping of the fabric along the line. The guide tapes are sewn by hand to the frontal corners with a running stitch and red thread (Figure 10). A cotton strip, possibly used for adding strength whilst stretching to the frame, was found inside the right-side hemmed edge (Figure 8).

Figure 3. Miller's banner top hemmed edge machine-stitched

Figure 4. Millers' banner right-side hemmed edge with manual running stitch

Figure 5. Millers' banner machine-stitched flat felled seams

Figure 6. Miller's banner bottom hemmed edge machine-stitched

Figure 7. Original loop stitched inside the top hemmed edge and additional loop stitched on top of both

Figure 8. Miller's banner cotton strip concealed and sewn inside the right side hemmed edge (possibly used for stretching to the frame)

Figure 9. Miller's banner detail of selvedge of ground fabric hemmed inside the right edge

Figure 10. Miller's banner detail of fringe and guide tape attachments

Repairs

Full support

The banner is sandwiched between two pieces of blue-dyed nylon net, one on each side (Figures 11 and 12), sewn along the original seams of the five strips of fabric, using a running stitch by hand and blue thread (Figures 13 and 14). The treatment has the distinctive style of the Royal Society of Needlework (Lennard, 2018, personal communication) and was likely done between 1986 and 1988, as it was photographed without it at the former National Museum of Labour in Limehouse Town Hall, London (People's History Museum, Gorman Archive) and referred to as being in the museum by John Gorman in a correspondence dated 20/10/1986 (GMRC, Banner Archive), entering Glasgow Museums Collection in 1988 with such treatment.

Ingrained chalked from preparatory grid and net attaching stitches

In addition to those lines, a previously chalked grid of 60 x 60 mm is stitched from the back of the banner over the unpainted areas (Figure 15). The silvered decoration is also stitched around its perimeter, securing both nets in place whilst puncturing all the contours of the decoration (Figures 16-18).

Replacement loops

The 12 replacement pole loops are stitched to the back over the top hemmed edge, without being tucked in as the originals, using both green and red threads for sewing their reinforcement stitches. Loop #2 is sewn with a tacking stitch and red thread to the original loop.

Possible re-attachment of fringe and guide tapes

The fringe has the same green and red threads used for the replacement loops, which might indicate a later re-attachment to the bottom edge coinciding with the work on the loops. The guide tapes are attached with running stitches by hand and a different red thread; their stitches are not as neat as the originals, which could also indicate a later addition, although different from the work done on the fringe and the loops.

Figure 11. Miller's banner nylon net sandwiching the banner

Figure 12. Miller's banner nylon net covering the guide tape and mottled fringe

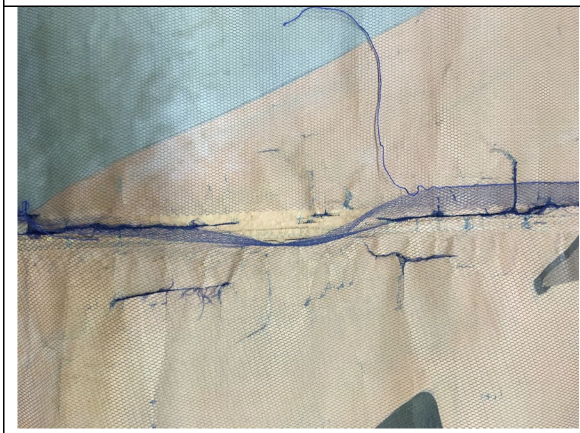


Figure 13. Miller's banner overlapping of nylon nets on side A and running stitches coming undone

Figure 14. Miller's banner hand-made running stitch adjoining the nylon nets

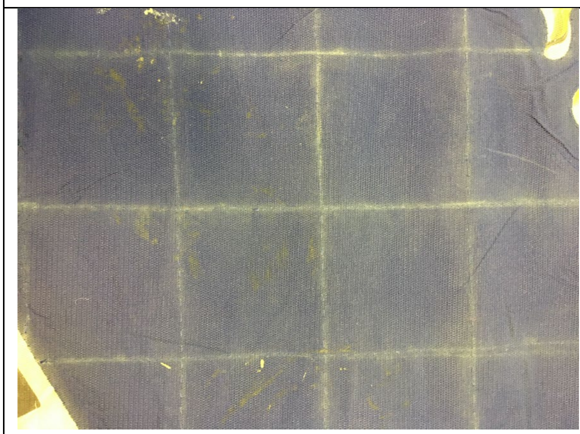


Figure 15. Miller's banner chalked and stitched grid on ground fabric

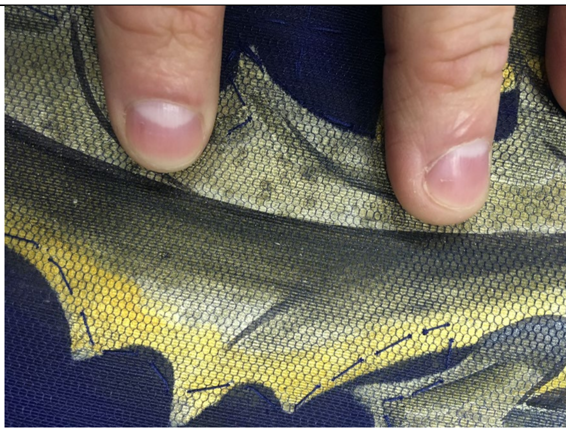


Figure 16. Miller's banner stitches surrounding metal decorations on leaves

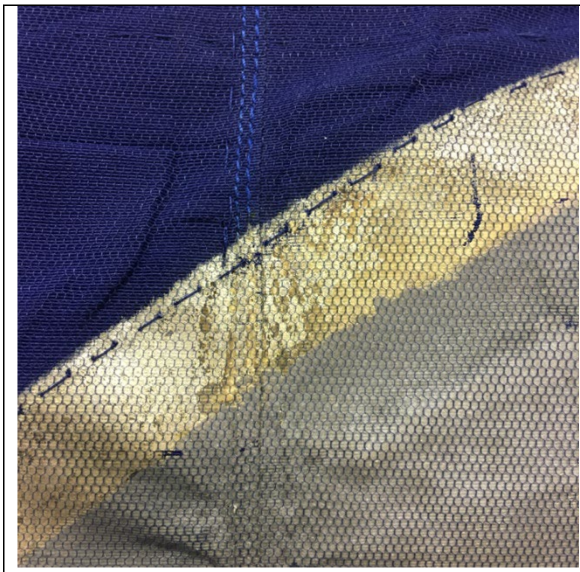


Figure 17. Miller’s banner stitches surrounding metal decorations on frame

Figure 18. Miller’s banner stitches surrounding metal decorations on wheat

Condition

Soiling

Side B of the banner has the chalk grid ingrained within the fibres in addition to the overall dirt of both sides (Figure 15). The fringe has discoloured in a mottled pattern, mostly restricted to the bottom, caused by the abrasion of the red dyed silk, possibly caused by the dragging of the banner (Figure 12).

Creasing/distortion

The banner shows distortion overall, with creases surrounding the painted and silvered decoration (Figure 20), potentially formed during its original preparation or changes in environmental conditions over time. There is also a distortion caused by the tight rolling of the banner onto its own pole, recognised by the undulating pattern, convex towards side A and concave towards side B. However, there is a considerable distortion in the lower section of the painted scenes, which was possibly increased by the restrain caused by the perimeter stitches applied to attach the net. Further distortion is observed in the bottom edge, apparently caused by the sewing of the fringe, as it pulls the fabric irregularly along the stitches (indicating possible later re-attachment) (Figure 19).

Structural Condition

The textile has several vertical splits of variable lengths, localised along the seams over the painted scenes, with some extending horizontally to the sides (Figure 21). Neither of them shows evident fraying of the weave. There are also small, localised splits between the unpainted silk and the upper scroll, as well as inside painted areas which show some fraying of the wefts (Figure 22). In addition to this damage, all the metallic decorations and the stitching lines attaching the nylon nets to the ground textile, have regular punctures caused by stitching (Figures 23 and 24). Since the stitches were made from side B and some of the designs do not coincide exactly with one another, the punctures in some sections go through paint and silvering layers in addition to the textile. This is more evident on the lower frontal section, where the punctures trace the inverse of the number on the back (Figure 24).

Figure 19. Distortion observed in the bottom edge, apparently caused by the sewing of the fringe.

Figure 20. Miller's banner distortion potentially caused by the stretching of the silk for painting.

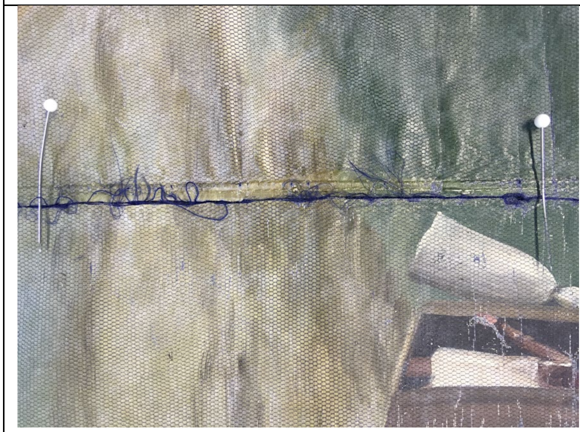


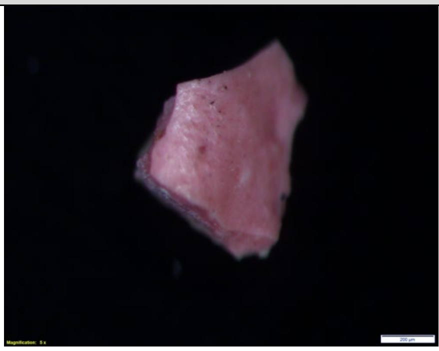
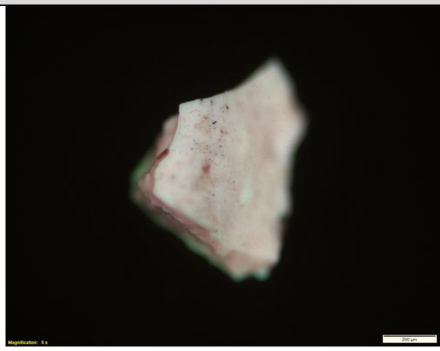
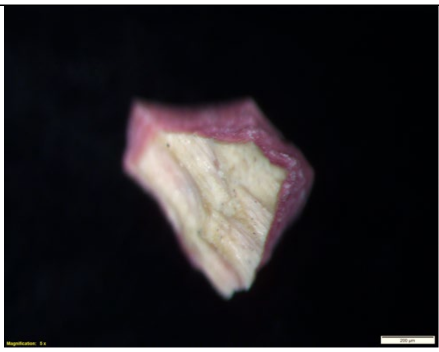
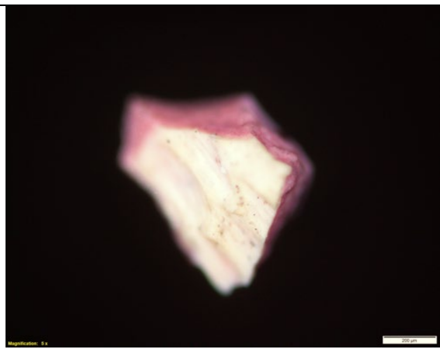
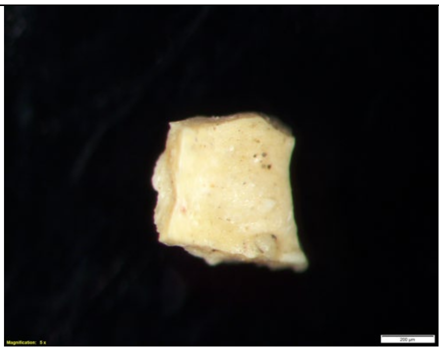
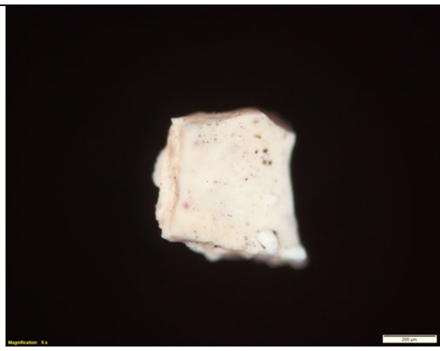
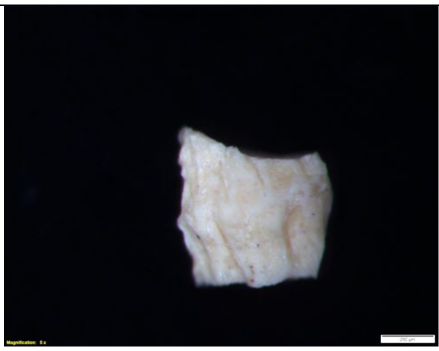
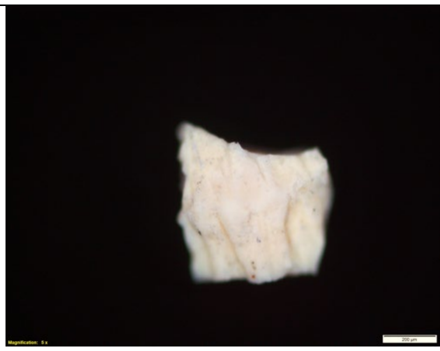
Figure 21. Miller's banner long splits without evident fraying, side B.

Figure 22. Miller's banner smaller splits showing fraying of the wefts.

Figure 23. Miller's banner punctures caused by the net attachment stitches

Figure 24. Miller's banner inverse puncture of the stitches of side B towards side A

Painting	
Description	Side A: a very detailed depiction of a Gray's patent noiseless roller mill is placed on the centre of a light blue background, on top of a dull orange rectangle. The drawing was based on the manufacturer's brochure (E.P. Allis, Milwaukee), whose name is even inscribed around the 'feeder' at the top centre of the machine. The mill is flanked on both sides by milling stones, emulating the design of the Partick coat of arms, topped with a mixed-line pink scroll with undulating returns at each end and black lettering.
	Side B: the mixed-line frame is divided vertically in three separate scenes by two burnt red lines. On the left there is a depiction of an octagonal base windmill in an open field, reportedly used for threshing and very common in Scotland (Cookson, 2018). On the right there is a typical brick watermill, set in a rural landscape by the river. And on the centre, there is a steam power mill set in an urban area, alongside two sets of train tracks and a navigable river with a red and black merchant ship. Due to the similarity in appearance, it is possible that the mill on the centre represents one of the two biggest mills of Partick: either the Scotstoun or the Bunhouse mill (Mitchell Library, GC 679 WHI; Glasgow Collection), neither of them surviving.
Layers on each side* *Numbered by order of application	1. Size layer (seen in the periphery of the scene as a 1 cm impregnated outline, evident on both sides) 2. White ground 3. Thick paint applied as background or base colour 4. Thick paint applied as contrasting colour 5. Thin translucent paint applied as shadows 6. Thin paint applied as finishing lines
Thickness	Ground side A 165.60µm; ground side B 17.94µm; paint side A 29.98µm; paint side B 20.01µm; central paint both sides 374.67µm (digitally measured)
Preparatory drawing	Clearly seen on side A in the outlines of Gray's patent noiseless roller mill, as thin grey lines possibly made with graphite over the white ground, similarly to the historical video of banner painters (Pathé, 1958). Also clearly seen on side B as dark lines underneath the paint, particularly around the small figures (horse and people); as well as by the restricted application of the colour surrounding the shapes (reserved by the previous drawing on the white ground).
Palette	Side A: Light brown, dark brown, white, dull green, pale yellow, burnt red, pink, grey, light blue, black
	Side B: Light brown, dark brown, white, light green, bright green, dull green, burnt red, light blue, grey, ochre, black, pink
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size) (FTIR/SYPRO RUBY); lead white, barium sulphate, calcium carbonate, synthetic ultramarine, bone black, red ochre, clay, yellow ochre, magnesium carbonate (SEM-EDX).

Micrographs of paint samples showing appearance of paint (front) and ground (back) (50x)	
 Sample MG21: front, crossed polarisers	 Sample MG21: front, UV filter
 Sample MG21: back, crossed polarisers	 Sample MG21: back, UV filter
 Sample MG25: front, crossed polarisers	 Sample MG25: front, UV filter
 Sample MG25: back, crossed polarisers	 Sample MG25: back, UV filter
Appearance under UV light	Each paint colour shows a different response to the UV radiation, either presence or lack of fluorescence, highlighting the absence of a coating. The light colours have a strong pale-yellow fluorescence, regularly associated with the presence of lead white, which could indicate the presence of this white pigment in the mixture. The UV image allows to see underneath the bloom, indicating it is not related to a varnish layer but a paint transformation, most likely metal soaps migration (Figures 25 and 26).

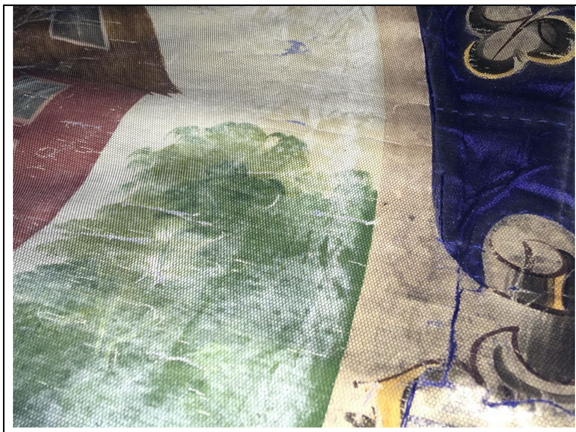


Figure 25. Miller’s banner showing area of intense bloom under normal light, side B

Figure 26. Miller’s banner showing area of intense bloom under UV light, side B

Structure	The paintings on both sides are constructed in a simple way, with an efficient use of paint. The brushstrokes of the thick paint are very evident, whereas the brushstrokes of the thin paint are smudged and blended with the base layer to create a more realistic effect of volume (Figure 27). The forms are constructed from a plain colour base, to which thin scumbles were smudged in and subsequent *impasto* added to create the different planes (lights and shadows), textures and details (Figure 28). The colours were applied in the areas marked by the preparatory drawing, as some white lines can be seen between the changes of tone (e.g., white ground partly left exposed in the locomotive of the back scene) (Figure 29). Most lighter tones were applied thick, and the darker tones were added thinly on top. There is much evidence of wet-on-wet application of paint on both sides of the banner, which could either indicate a speed-up process or the technique of the painter(s) (Figure 31). There is a very precise and effective application of paint for creating the shapes; few brushstrokes produce the small human figures and alternated *impasto* of light and dark colours give the volume to the roller mill (Figures 30 and 32).
Condition	The condition of the paint layer is different on both sides of the banner. The paint on side B seems to have a lesser attachment to the white ground, mostly on the lower half. It is delaminated in some areas exposing the subjacent layer (Figure 34). The thick paint on the front seems very firmly attached to the white ground and hence to the textile, with only minor loses directly associated with the abrasion caused by the surrounding folds and creases. In both sides of the banner the areas of loss exposing a white ground-embedded in the textile. There is an overall craquelure pattern formed by a horizontal breakage of the film along the spaces between the ribs of the weave, mostly noticeable under magnification (Figures 31-34). Both sides of the banner show a series of white protrusions coming from the white ground layer, some of them seen only under magnification and some noticeable with the naked eye (Figure 33). There is a localised yet intense white bloom over all the colours of the lower half of both scenes, following the shape of the frame. All paint loses are associated with the formation of creases and folds and they delaminate from the raised parts of the weave (ribs), exposing the white ground-embedded in the textile. There is no evidence of coatings in any part of the painted areas, but there is surface dirt ingrained in the paint, more acutely on side A.

Figure 27. Miller's banner, evident brushstrokes of light tones and smudge of shadows for volume

Figure 28. Miller's banner, application of colour in basic blocks and impasto for lights

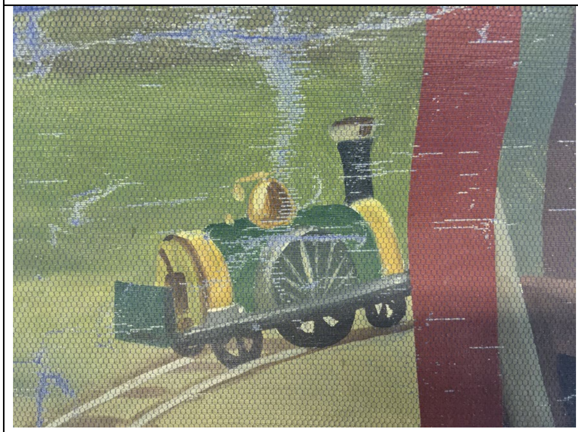


Figure 29. Miller's banner, side B, locomotive with areas of white ground left exposed

Figure 30. Miller's banner detail of lights and text applied as white *impasti* at the end

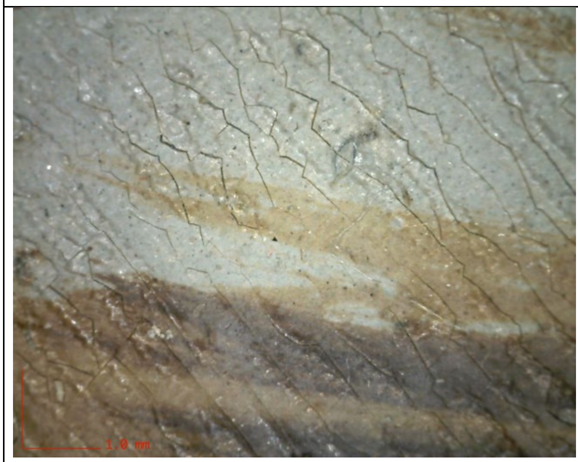


Figure 31. Wet-on-wet application of paint in the straw rooftop of side B, DinoLite detail (20x)

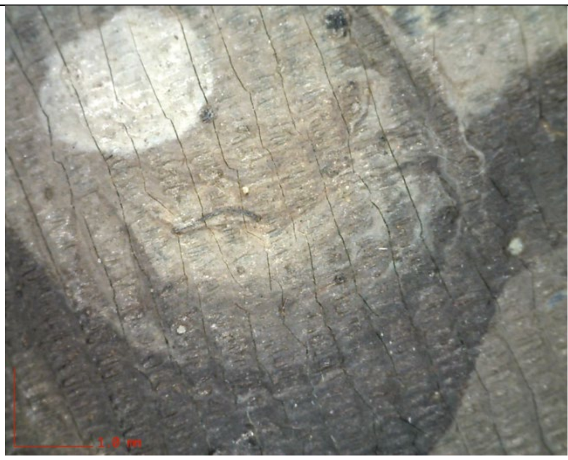
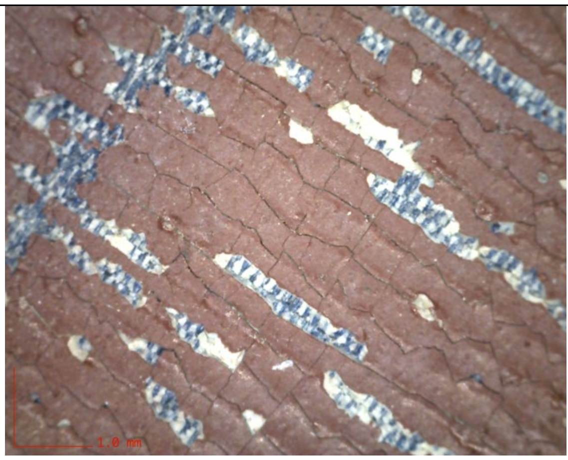


Figure 32. Wet-on-wet application of paint in the mill bolt and white impasto for the light, side A, DinoLite detail (20x)

	
Figure 33. Miller's banner, white protrusions in the background of side A	Figure 34. Miller's banner paint delamination in side B

Silvering	
Description * *Identical on sides A and B	Upper scroll (also called ribbon): Curved golden coloured scroll with two and a half returns on each end, both finished with a roll. It has black block capital letters distributed along the central curve, decorated on both ends with alternated thick and thin red bands and a black asterisk on each of the returns. Frame: Mixed shaped frame formed by a thin line perimeter surrounded by a composite flower garland comprising a succession of wheat sheaf, thistles, roses, shamrocks, and thistles, topped at the top with an ornate curlicue and decorated at the bottom with a roll. The year of its making is placed under the roll, within a golden rectangle on side A and by itself on side B.
Layers on each side* *Numbered by order of application	1. Size layer (seen as an external outline impregnating about 1 cm of the textile, evident in both sides) 2. White ground 3. Metal leaf 4. Coloured coating 1 (golden) 5. Coloured coating 2 (red) and coloured coating 4 (yellow) 6. Coloured coating 3 (sepia) 7. Black paint (lettering and finishing lines) **** Only for the garland and the top curlicue: 1. Size layer (seen as an external outline impregnating about 1 cm of the textile, evident in both sides) 2. White ground 3. Metal leaf 4. Coloured coating 1 (golden) 5. Coloured coating 2 (yellow) 6. Coloured coating 3 (sepia) 7. Black paint (finishing lines)
Thickness	Metal leaf approximately 1-2μm; ground side A 30.36μm; ground side B 115.23μm; silvered scroll both sides 284.97μm (digitally measured).
Preparatory drawing	Inferred (not seen) by the restricted application of the silver leaf on the shapes and their almost perfect matching on both sides. Potentially made with the method of pouncing (Kelly, 1911).
Palette	Golden (translucent), black, red (translucent), yellow, sepia (translucent)
Materials *Mixed within the ground not over the silver leaf	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size) (FTIR/SYPRO RUBY); silver leaf, lead white, barium sulphate, calcium carbonate, *vermillion, *red ochre, *red lead (SEM-EDX)

Appearance under UV light	The golden coloured coating applied fully over the metal leaf shows a weak fluorescence, of mottled appearance and a pale green colour. In areas where it seems to be thicker (more concentrated) the fluorescence is stronger (Figures 35 and 36). The fluorescence colour may highlight the presence of drying oil and/or terpenic resin as binders. The spots without fluorescence (dark purple) could indicate the presence of oxidation products (silver sulphates in case the main metal is silver). The black paint of the lettering and fine lines appears translucent and show a slightly greenish fluorescence, suggesting the probable presence of drying oil and/or terpenic resin as binders (Figure 36). The red bands and the yellow-coloured coatings have a strong orange fluorescence colour, regularly associated with the presence of shellac (Figure 36). The exposed ground has a very strong pale-yellow fluorescence, regularly associated with the presence of lead white (Figures 36 and 38). No coating is seen over the painted sections. The sepia-coloured coating has a very strong fluorescence of a pale green colour, regularly associated with the presence of drying oil and/or terpenic resin as binders (Figures 39 and 40).

Figure 35. Miller's banner scroll, side B, normal light

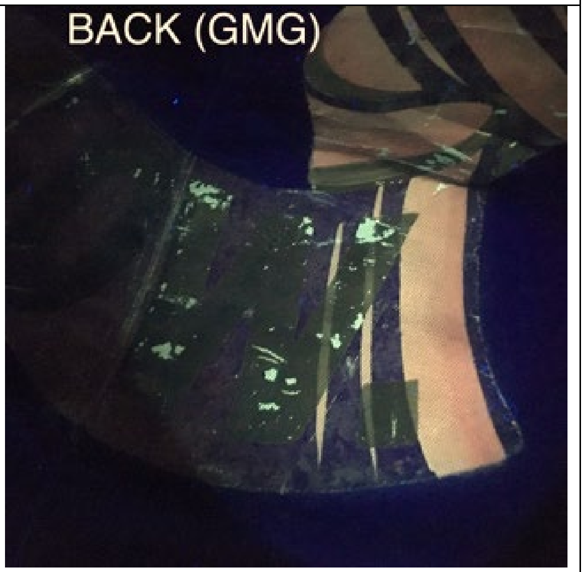


Figure 36. Miller's banner scroll, side B, UV light


Figure 37. Miller's banner floral decorations, side B, normal light

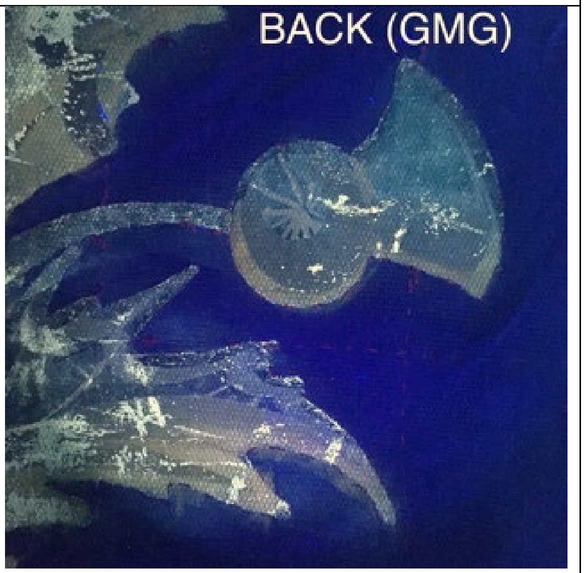


Figure 38. Miller's banner floral decorations, side B, UV light

Figure 39. Miller's banner floral decorations, side A, normal light

Figure 40. Miller's banner floral decorations, side A, UV light

Structure	There is a darker outline suggesting impregnation of the textile of about 1 cm exceeding both scrolls (Figures 41 and 42), indicating the probable application of size for impeding the spread of the oily ground, as recommended by Gibson and Kelly (Gibson, 1870; Kelly, 1911). A thin layer of white ground is applied on top of the sized textile, potentially used as gold-size to adhere the metal leaf, as recommended by Kelly for the making of silk banners (Kelly, 1911). On top of the metal leaf, there is a golden coloured coating to make it appear as gold leaf. The golden coloured coating appears thicker and with a more intense tone in the arches of the scroll, producing a voluminous effect. On top of this golden coloured coating there are bands of a red coloured coating in the scrolls and a yellow-coloured coating in the elaborated scrollwork. The scrollwork has an additional sepia coloured coating, and all is finished with fine lines of black paint and the black lettering overall.

Figure 41. Miller's banner darker outline suggesting impregnation of the textile under normal light

Figure 42. Miller's banner size outline suggesting impregnation of the textile under transmitted light. Punctures of previous intervention are also evident.

Condition	The silvering is in a fair condition, with localised tarnishing but significant abrasion in the floral garland of the frame, being more acute on side B (Figure 43). The silvering on the scroll has a very firm attachment to the textile and only minor losses associated with the formation of creases in the textile (Figure45). All layers have a very fine and homogeneous craquelure pattern only noticeable under magnification, forming parallel lines along the spaces between the wefts of the textile (Figure 44). There is evidence of wrinkling of the metal leaf produced while transferring it from the transfer booklet (Figure 46), as experienced during the silvering of reconstruction 2 (see Appendix IV). The loses of black paint and yellow/sepia-coloured coatings are associated with direct abrasion and loss of

adherence, particularly on the floral garland and the scrolls, where they detach exposing the white ground (Figures 45 and 46). There are also loses produced by the puncturing of the repair stitches, particularly in the year “1884” on the front. Additionally, there is an untarnished outline around some of the black decorative lines in the garlands and adjacent to the red bands, potentially formed after the drying of the black paint and red coloured coating, which seemed to have shrunk pulling the golden coloured coating towards them. Finally, there is evidence of metal leaf transferring to the top of the banner (Figure 47), most likely caused during its rolling. The transfer coincides with the losses of the other side (Figure 48), indicating it happened with the back of the banner facing out, whilst being rolled up tightly onto its pole.

Figure 43. Miller’s banner side B showing mottled tarnishing in silver leaf and black oultines painted on top

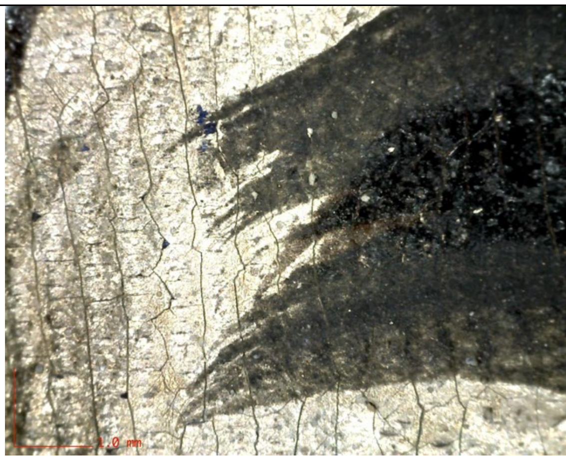


Figure 44. Miller’s banner showing typical craquelure of silver leaf along the ribs of the textile, DinoLite (20x)

Figure 45. Miller’s banner silver leaf detaching leaving ground and possible added gold-size exposed, DinoLite (20x)

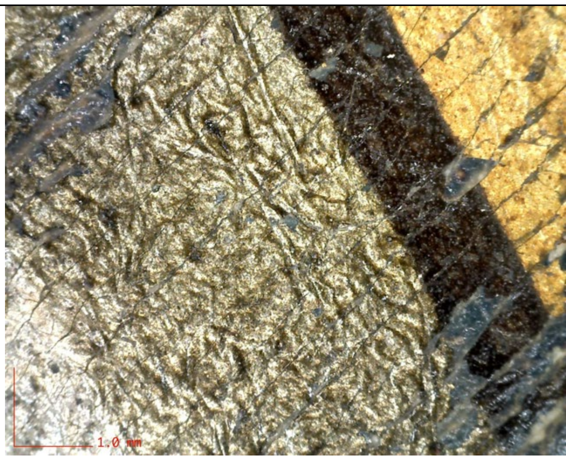
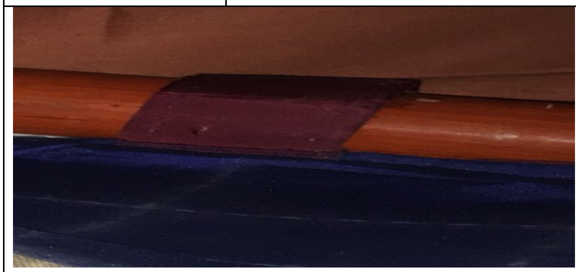


Figure 46. Miller’s banner, detail of wrinkles on silver leaf produced while transferring, DinoLite (20x)

Figure 47. Miller's banner evidence of adhesion of side A scroll onto side B as a consequence of tight rolling whilst still fresh.

Figure 48. Miller's banner, side A top scroll showing the area adhered to side B.

Pole	
Description	Top hanging wooden pole, orange stained and varnished, with one brass end cap at each end. The brass ends have iron pins screwed at each side, both with cast-iron screw fittings (Figure 51). These indicate the use of side poles, now missing.
Dimensions	3098 x 40 mm
Inventory number	PP.1988.43.2
Materials* *Not analysed but inferred by their appearance	Pole: conifer wood (due to the pattern associated with the formation of tree rings) with possible shellac varnish End caps: brass Pins and fittings: cast-iron
Appearance under UV light	The varnish has a strong orange fluorescence colour, regularly associated with shellac (Figures 49 and 50).
Condition	The coatings (varnish and orange stain) have areas of abrasion exposing the wood. The end caps are slightly loose, and all the metal parts show some localised tarnishing. There is splitting of the wood around the centre of the pole in the direction of the grain.
 Figure 49. Miller’s pole under normal light	 Figure 50. Miller’s pole under UV light
 Figure 51. Miller’s pole brass cap end and cast-iron fittings	

9.1.4 The National Union of Vehicle Builders, Glasgow Branch banner

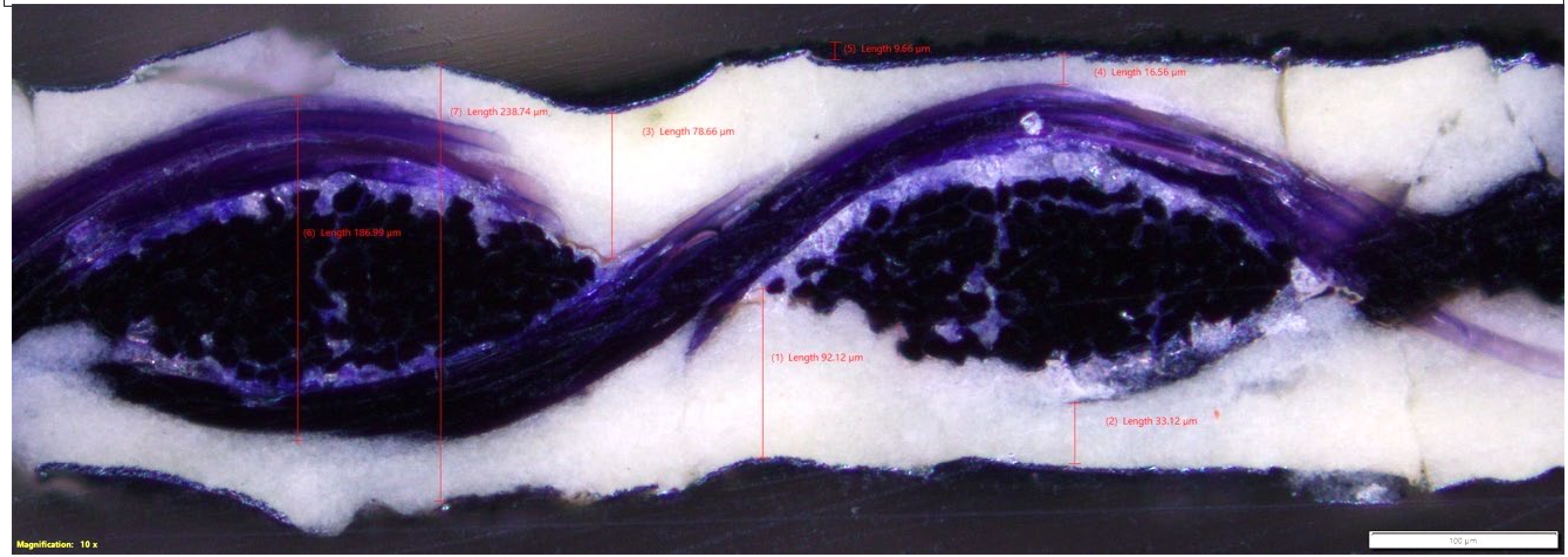
Side A (side of fringe attachment)

Side B (side opposite to fringe attachment)

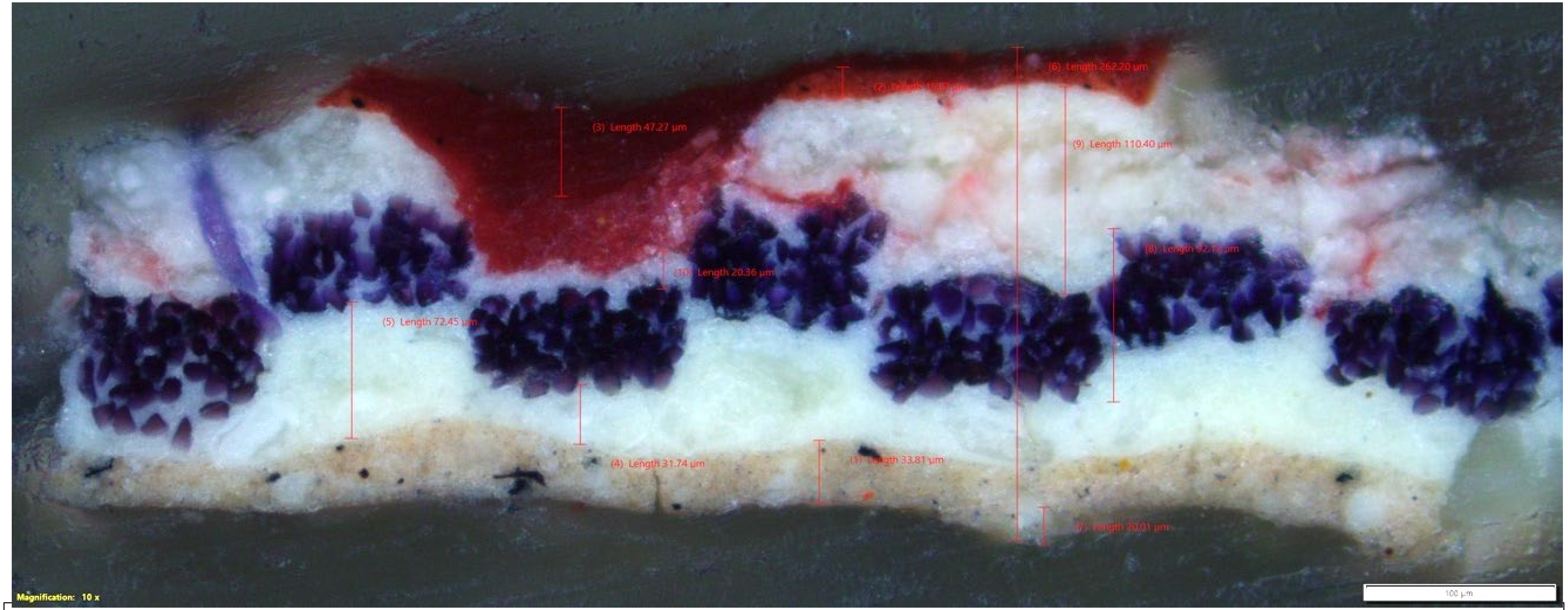
Title	Banner of the National Union of Vehicle Builders Glasgow Branch		
Maker	George Kenning & Son (signed on the lower scroll left on both sides as G. Kenning & Son London)		
Date of making	1914. Stated in the society's minutes: The Committee purchased a new banner from George Kenning & Son on March 27th, 1914. It was delivered by September 2nd of the same year (Mitchell Library, T.U. F331.881847 NAT).		
Technique	Oil paint, coloured glazes, aluminium, and gold leaves on silk.		
Description	Dark blue banner with a yellow and dark blue fringe on the bottom edge, painted on both sides on a single layer of fabric with the following layout: an upper scroll indicating the name of the society on both sides, a main central scene with the society's coat of arms and a central scroll indicating the branch on both sides, as well as two main scenes depicting on side A, a red and black Ford Model T, and on side B a blue landau carriage. It has four surrounding scenes depicting types of vehicles on side A and trade union related imagery on side B. A lower scroll indicates the society's motto on side A and date of institution on side B. It includes its original hanging top pole with brass ends and two guide tapes.		
Exact wording	Side A	Upper scroll: "NATIONAL UNION OF VEHICLE BUILDERS" Central scroll: "GLASGOW BRANCH" Lower scroll: "TRIUMPHANT WE BRAVELY DEFEND"	
	Side B	Upper scroll: "NATIONAL UNION OF VEHICLE BUILDERS" Central scroll: "GLASGOW BRANCH" Lower scroll: "ESTABLISHED 1834"	
Dimensions	Height 2,710 mm (including loops/pole and fringe)	Width 2,610 mm (not including pole)	
Owner	Glasgow Museums	Date of acquisition	1973

Inventory number	PP. 1973. 16	Location	Glasgow Museums Resource Centre, Pod 12
General assessment of condition	The banner is in poor condition, mostly due to the fragile condition of the textile. Side A appears more deteriorated than side B. It has ingrained soiling all over, more evident on the lower half of the back. Side B is more soiled than the back, possibly indicating this side facing outwards for longer. There is no evident bloom on neither side of the painted sections, but there is a significant gloss due to the (later) application of varnish overall. The fringe seems discoloured, but it appears to be due to the ingrained soiling. The banner has multiple horizontal splits in the central scene, with the fraying of both warps and wefts, as well as associated paint losses. Further paint losses are associated to the formation of creases, the application of adhesive tape and stitched repairs through the painted areas. There are several stains from the adhesive tape over the paint, scrolls and impregnating the textile.		
Photography	Digital photography – Side A, normal light/ Side B, normal light/ Macro images of the textile construction, painting technique and scrolls layering sequence (including raking light and UV images). Dino-Lite images (55x) – textile weave, preparation, painting technique, layering sequence and details of the scrolls.		
Examiner/Date	Daniel Sanchez Villavicencio/October 2018		
Place and conditions of examination	Glasgow Museums Resource Centre, Research Room. Banner examined flat over an examination table using both natural illumination and fluorescent tubes light (daylight).		

Cross-sections micrographs (crossed polarisers, 100x)



Sample VB11: Cross-section from silvered scroll with measurements (Side A on the top)



Sample VB12: Cross-section from central painting with measurements (Side A on the top)

<table>
<tr><th colspan="4">Textile</th></tr>
<tr><td>Description</td><td colspan="3">The banner is made of a single layer of fabric. It is constructed from 4 horizontal strips of dark-blue dyed rep weave fabric sewn together. The strips were hand-sewn along the selvedges with a whip stitch, joined horizontally with the warps parallel to the pole (according to the selvedges seen in the three inner seams). There are no seam allowances as they are butted edge to edge and whip stitched. It has no added borders. It has 13 pole loops, which are thought to be original, possibly made of blue-dyed silk grosgrain ribbon with light-blue dyed cotton wefts, attached to the top between two light blue-dyed ribbons with an. A thick bi-colour bullion fringe is attached to the bottom edge, possibly made of dark blue and yellow dyed wool. It has two guide tapes at each bottom corner, made of a similar alternated herringbone weave ribbon as the top.</td></tr>
<tr><td>Materials

*Not analysed</td><td colspan="3">Fabrics: dark-blue dyed silk
Sewing threads: blue dyed silk (originals) and blue dyed cotton* (repairs)
Pole loops: dark-blue dyed silk with light-blue dyed cotton wefts
Fringe: dark blue and yellow dyed wool
Guide tapes and top reinforcements: light-blue dyed cotton*
Corner reinforcements: dark-blue dyed silk* with light-blue dyed cotton wefts*
Ground textile fibres analysed with FTIR-ATR.</td></tr>
<tr><td rowspan="4">Dimensions</td><td rowspan="4">Fabric: Each panel measures (H x W):
1. 608 x 2610 mm
2. 616 x 2610 mm
3. 616 x 2610 mm
4. 603 x 2610 mm (Numbered top to bottom)</td><td>Pole loops:
1-13. 50 x 190 mm
(Numbered left to right from side A)</td><td>Fringe:
150 x 2610 mm</td></tr>
<tr><td>Top reinforcement:
30 x 2610 mm</td><td>Guide tapes:
30 x 2170 mm</td></tr>
<tr><td rowspan="2">Corner reinforcements:
120 x 130 mm</td><td>Thickness</td></tr>
<tr><td>186.99µm/92.12µm (digitally measured)</td></tr>
<tr><td rowspan="6">Weave</td><td colspan="3">Fabric: warp-faced plain weave (also called rib or rep fabric)
Average thread count: 60 warps/cm by 26 wefts/cm (Figure 1)</td></tr>
<tr><td colspan="3">Pole loops: warp-faced plain weave (also called grosgrain ribbon)
Average thread count: 60 warps/cm by 14 wefts/cm (Figure 2)</td></tr>
<tr><td colspan="3">Top reinforcement: alternated herringbone weave</td></tr>
<tr><td colspan="3">Fringe: 2 ply “Z” twist (also called thick bouillon fringe)
Average braid count: 24 braids/15 cm (Figure 10)</td></tr>
<tr><td colspan="3">Guide tapes: alternated herringbone weave</td></tr>
<tr><td colspan="3">Corner reinforcements: warp-faced plain weave (also called grosgrain ribbon)
Average thread count: 60 warps/cm by 14 wefts/cm (Figure 10)</td></tr>
</table>

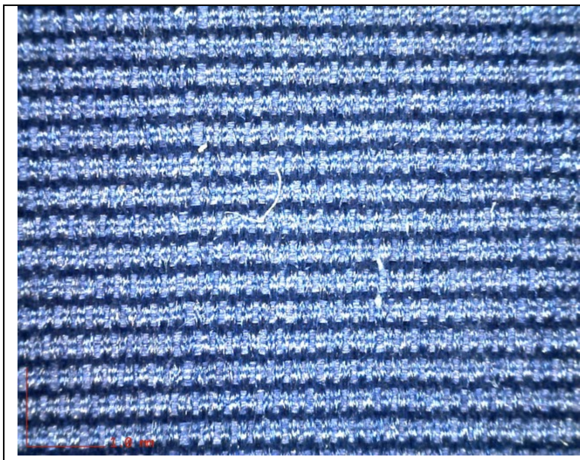


Figure 1. Vehicle Builders' banner DinoLite detail of the fabric's weave (20x)

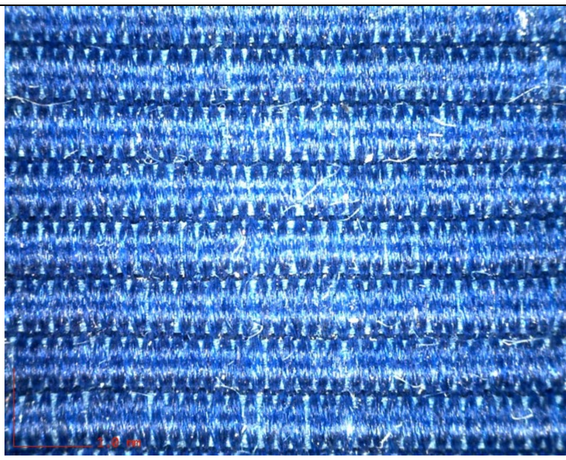
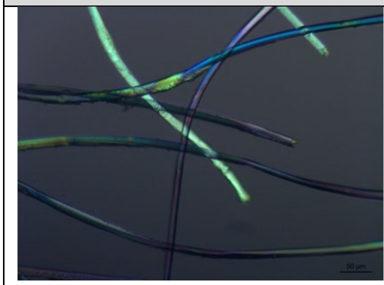
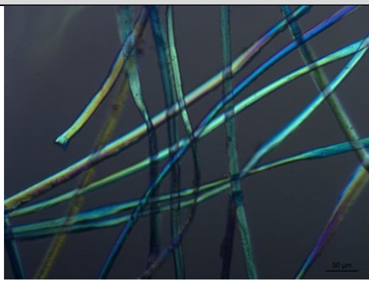


Figure 2. Vehicle Builders' banner DinoLite detail of the loop's weave (20x)

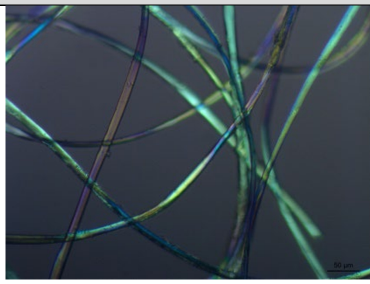
Micrographs of textile fibres (crossed-polars, 200x)



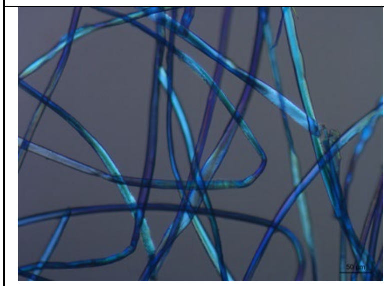
Sample VB01: warp silk fabric



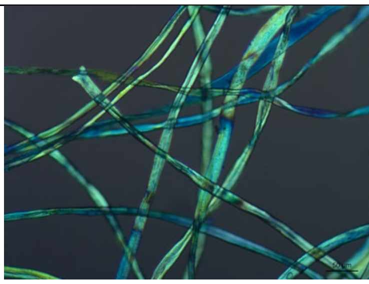
Sample VB02: weft silk fabric



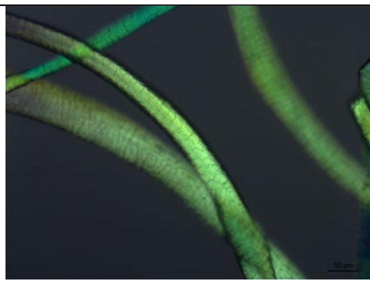
Sample VB03: silk stitching thread



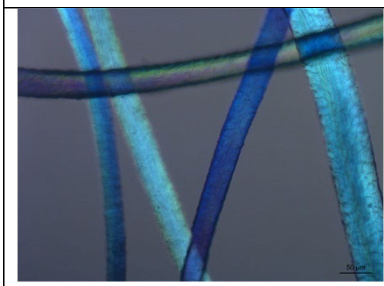
Sample VB04: loop silk warp



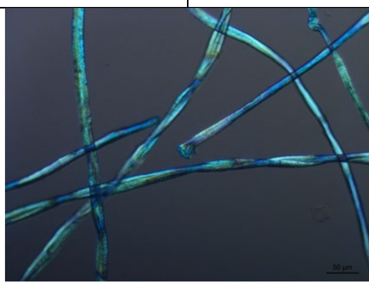
Sample VB05: loop silk weft



Sample VB06: yellow wool fringe



Sample VB07: blue wool fringe



Sample VB31: cotton guide tape

Construction	The four strips of silk are sewn together along the selvedges, with hand-sewn whip stitched seams and blue dyed threads (Figure 5). The panel is finished with lateral hemmed edges folded towards side B (opposite to the fringe attachment) (Figure 4). Both left and right edges are machine-stitched with a straight stitch and blue dyed thread, of irregular seam width and irregular line. Their turnings have and average width of 7 mm. The bottom edge is also hemmed and folded towards side B, machine-stitched with a blue dyed thread and an average turning width of 7 mm (Figure 6). The top edge is concealed between two blue alternated-herringbone weave ribbons,

	and the 13 original pole loops are machine stitched between them by means of four lines of straight stitches (Figure 7), evenly spaced, and finished on both sides with two reinforcement stitching straight lines (Figure 3). Both top and bottom edges have a different width of the seams The fringe is attached to side A with a hand stitched running stitch and blue thread (Figure 10). Both left and right corners are reinforced on both sides with a wider dark blue grosgrain ribbon, manually sewn with blue thread and aligned perpendicularly to the banner's weave (Figures 8 and 9). The guide tapes have similar alternated-herringbone ribbons, manually sewn from side B with a whip stitch and a thicker blue dyed thread (Figure 9).

Figure 3. Vehicle Builders' top hemmed edge finishing with reinforcement stitch lines

Figure 4. Vehicle Builders' machine-stitched right side hemmed edge

Figure 5. Vehicle Builders' hand-made whip stitch for joining the ground textile strips

Figure 6. Vehicle Builders' bottom hemmed edge, machine-stitched

Figure 7. Vehicle Builders' pole loop sandwiched between the herringbone ribbons

Figure 8. Vehicle Builders' reinforcement of right corner with ribbon at perpendicular direction to the ground textile

Figure 9. Vehicle Builders' reinforcement of left corner with ribbon at perpendicular direction to the ground textile

Figure 10. Vehicle Builders' fringe attached to side A

Repairs	Repair stitches There are 4 repair stitches of variable length, reattaching the split textile to the adjacent scroll or frame (Figures 11, 15 and 16). They are all sewn by hand with a 2 ply "Z" twist blue cotton thread (sometimes by means of double threads), using two different stitches: herringbone and whip stitch. Both stitches go through the paint layer of both sides. There are also 3 additional repair stitches reattaching the split seams of the textile pieces on each side (left and right) (Figures 12 and 13). Reweave of puncture There is an attempt of reweaving a large puncture using a cross- stitch and two sets of a similar blue dyed thread (Figure 14). Adhesive tape residues Additionally, it has multiple adhesive tapes over 29 other textile splits, applied both over textile and painted features (Figures 15 and 16).

Figure 11. Vehicle Builders' repair whip stitch puncturing paint

Figure 12. Vehicle Builders' repair whip stitch re-joining the split ground textile

Figure 13. Vehicle Builders' repair herringbone stitch re-joining the split original joining

Figure 14. Vehicle Builders' attempt of re-weaving of a puncture

Figure 15. Vehicle Builders' repair herringbone stitch puncturing the paint on top scroll and black stain of adhesive tape reside on textile

Figure 16. Vehicle Builders' repair herringbone stitch puncturing the paint on bottom scroll and black stain of adhesive tape reside on textile

Condition	Soiling The textile has some ingrained soiling on both sides of the banner and ingrained adhesive stains from the adhesive tape repairs. The fringe shows

some discolouration, but it could be due to the ingrained soiling. There is also an even discolouration in the blue ribbons on the top and used as guide tapes, possibly caused by light fading.

Creasing/distortion

The banner has a minor overall distortion, with creases both on and around the painted and silvered decoration, potentially formed during its original preparation (Figure 17). The pattern of distortion seems also associated with the original tight rolling of the banner on its own pole for storage, done with side A facing out (currently the banner is properly rolled around a thick insulated cardboard tube to extend the diameter of the rolling surface and reduce at the maximum possible the inward compression of paint layers).

Structural Condition

The textile has thirty-two horizontal splits distributed along the four strips of the banner, as well as four other splits following the contour of the scrolls and one of the frames. The splits are broken at the wefts along the warps and have fraying of both warps and wefts (Figure 19). One split is actually the unstitching of the original joining of the ground textile, showing how the selvedges are butted edge to edge (Figure 18). There are also about 20 vertical splits, located mostly inside the central paintings and the upper and lower scrolls. These splits are less marked but underline the weakening of the textile. Most splits are in the central paintings. The reinforced corners of the banner have slightly ripped along the ribbons (Figure 8). Finally, the pole loops have punctures caused by the tacks used to fixed them to the pole (Figure 20).

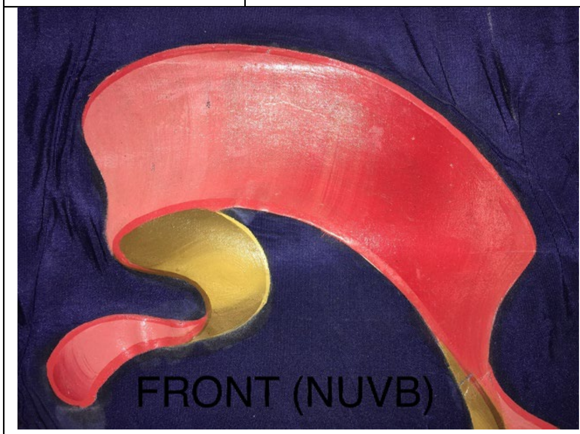
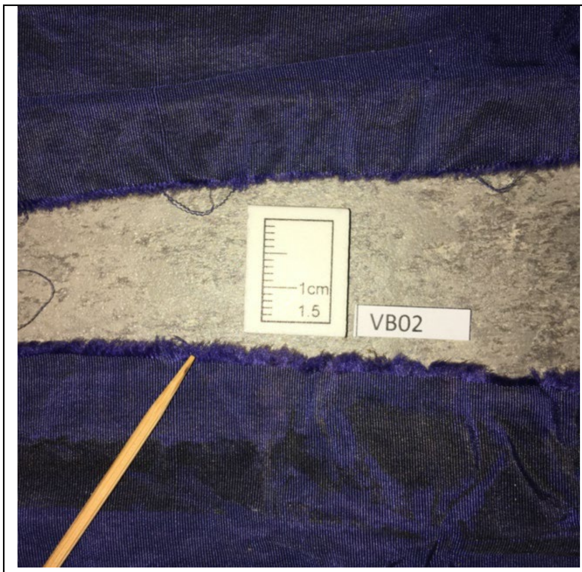
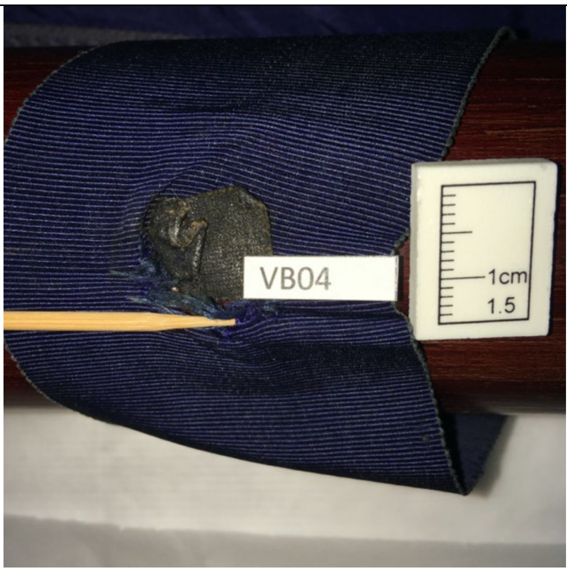
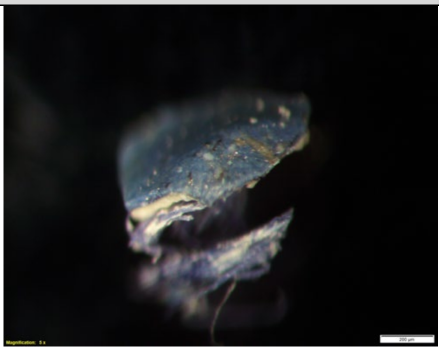
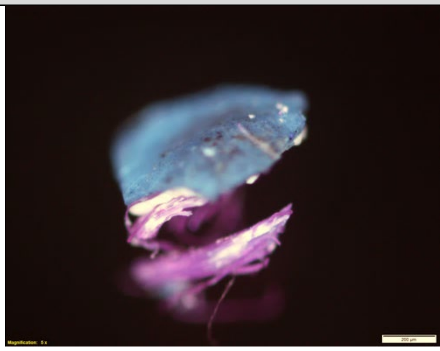
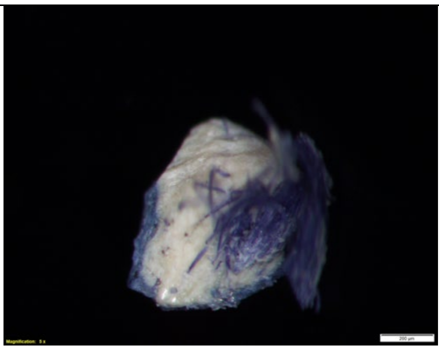
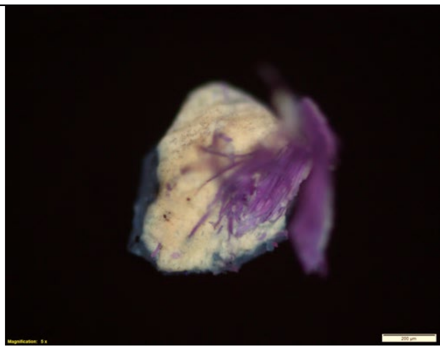
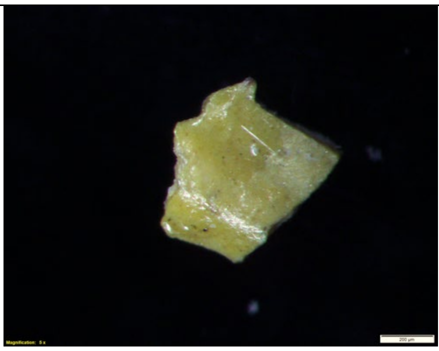
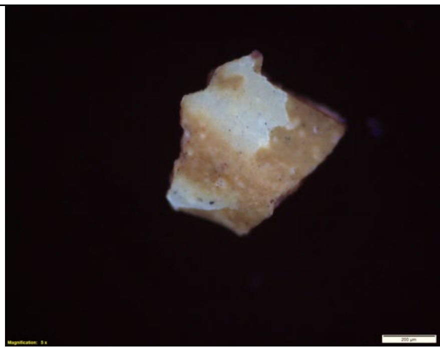


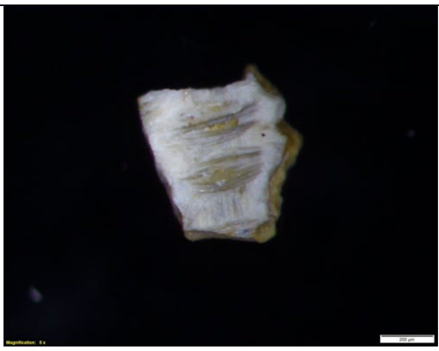
Figure 17. Vehicle Builders’ creasing surrounding scrolls


Figure 18. Vehicle Builders’ unstitching of ground silk showing the selvedge of each strip

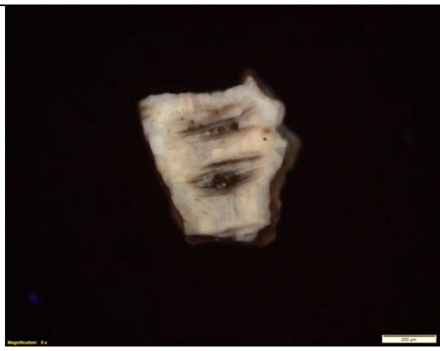
 Figure 19. Vehicle Builders' split across the wefts producing fraying	 Figure 20. Vehicle Builders' puncture of loop ribbon with metal tack

Painting	
Description	Side A: The upper scene depicts the official coat of arms of the association (see silvering table for details). The centre scene portrays a lateral right view of a Ford Model T over a forested background, with the main body coloured in dark red, the top and bottom in black and white tires. The peripheral scenes depict (clockwise from the right): a dark blue landau carriage/coach with dark red wheels, a double-decker yellow and red tramcar, a single-decker brown and white tramcar and an ochre Roman style chariot.
	Side B: The upper scene depicts the official coat of arms of the association (see silvering table for details). The centre scene portrays a sumptuous blue landau carriage/coach with an unidentified coat of arms on the door and the drivers' seat. The coat of arms has the motto '*Dum Spiro Spero*' meaning 'while I breathe, I hope'. The peripheral scenes depict (clockwise from the right): a beehive as a symbol of industry; a scene taken from their 1886 official emblem representing the 'succour to the afflicted and bereaved'; a scene taken from the same emblem representing the 'support in old age'; a pair of clasped hands as a symbol of friendship, surrounded by a laurel wreath. Incidentally, the official 1886 emblem is included framed in the background of both lowermost scenes.
Layers on each side** **Numbered by order of application	1. Size layer (seen in the periphery of the scene as a 6 mm impregnated outline, more evident in the back side) 2. White ground 3. Thick paint applied as background or base colour 4. Thick paint applied as medium tones 5. Thick paint applied as light tones 6. Thin paint applied as darker tones and finishing lines 7. Thick glossy varnish **** Only for side A centre scene 1. Size layer (seen in the periphery of the scene as a 6 mm impregnated outline, more evident in the back side) 2. White ground 3. Initial paint layers covered with the 1942 repair (probably similar to layers 3 to 6 of the previous sequence) 4. Thick paint applied to cover the previous painting (with similar colour as the subjacent painting) 5. Thick paint applied as lights and shadows 6. Thick paint applied as finishing lines 7. Thick glossy varnish
Thickness	Added paint side A 47.27μm; paint side A 15.87μm; ground side A 110.40μm; ground side B 74.45μm; paint side B 33.81μm; added paint side B 20.01μm; central paint both sides 267.20μm.
Preparatory drawing	Seen through the contours of some of the figures in the lower back scenes, as well as in the borders of the table and architectural features. It is also seen around the clasped hands of the upper peripheral scene of the back. The

	drawing was potentially drawn over the white ground with a black charcoal or graphite, as seen in the historical video of banner painters (Pathé, 1958).
Palette	Side A: Light brown, dark brown, white, dull green, burnt red, bright red, pink, grey, ochre, yellow, light blue, dark blue, black
	Side B: Light brown, dark brown, white, light green, burnt red, bright red, red (translucent), pale yellow, light blue, blue, dark blue, pink, purple, ochre, yellow, black.
Materials *Overpaint materials, not GK&S	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size) (FTIR/SYPRO RUBY); lead white, red ochre, clay, umber, vegetable black, yellow ochre, *red lake pigment (alum based), *barium sulphate, *calcium sulphate (SEM-EDX).
Micrographs of paint samples showing appearance of paint (front) and ground (back) (50x)	
 Sample VB29: front, crossed polarisers	 Sample VB29: front, UV filter
 Sample VB29: back, crossed polarisers	 Sample VB29: back, UV filter
 Sample VB32: front, crossed polarisers	 Sample VB32: front, UV filter



Sample VB32: front, crossed polarisersz



Sample VB32: back, UV filter

Appearance under UV light	The fluorescence of each pigment is hindered by the presence of a thick varnish, which appears cloudy and shows a bright-green fluorescence colour under the UV light (Figures 21 and 22). Additionally, the residues of adhesive tape show a bright whitish fluorescence (Figures 23 and 24).

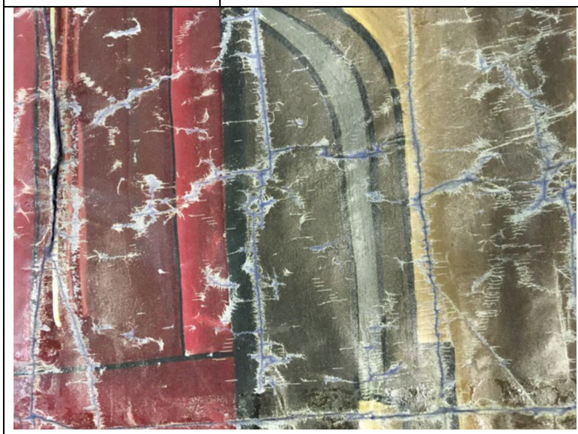


Figure 21. Vehicle Builders' overpainted area of side A under normal light

Figure 22. Vehicle Builders' overpainted area of side A under UV light

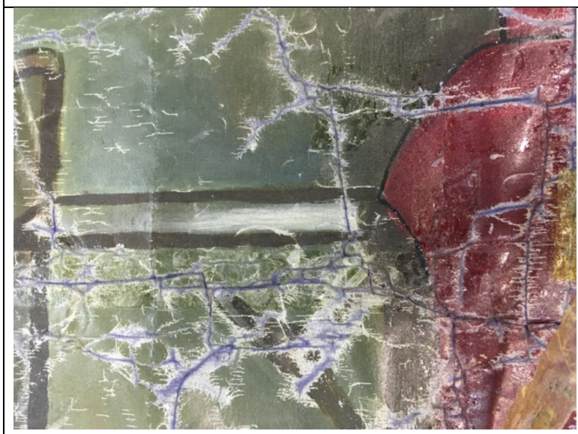


Figure 23. Vehicle Builders' adhesive tape residue on side A under normal light

Figure 24. Vehicle Builders' adhesive tape residue on side A under UV light

Structure	The base colours of the backgrounds are applied over the white ground, which appears to have been applied thoroughly (Figure 32). This means that the preparatory drawing could have been partly covered with these layers and had to be retraced in some sections, like in the bottom scenes where the lines appear to be over the coloured background. There is much evidence of wet-on-wet application of paint, which could indicate the style of the painter(s) to blend the tones (Figures 28 and 30). The figures seem to be constructed in the following order: application of a thick paint layer of a medium tone, followed by the light tones also applied thickly. The darker tones and details are applied diluted as scumbles over the whole, and there is no evidence of smudging with the previous tones, suggesting that they were applied over a dried (to touch) base (Figure 27). The brushstrokes are very evident in all the cases, indicating that the paint was applied thick or possibly highlighting the

	addition of some bulking additive (i.e., calcium carbonate) (Figure 29). In the case of the frontal central scene, the second paint layer shows a much coarser finishing, with irregular brushstrokes and a very plain application of colour. The tones are supposedly replicating the subjacent colours, but the extension of the overpaint impedes to verify it.
Condition	The condition of the paint layer is much better on side B than side A. Regardless, both sides show a similar craquelure pattern formed by evenly spaced cracks that follow the spaces between the ribs of the weave, mostly seen under magnification over the thinner paint layers (Figure 28). The thicker paint layers show instead a series of diagonal or perpendicular cracks (Figure 33). The paint losses seem to be associated to the first craquelure pattern, as it delaminates from the raised parts of the weave (ribs), exposing the white ground-embedded textile on the front, and on the back a “clean” textile, suggesting the possible application of a size layer. The persistent use and rolling of the banner, increased the areas with paint loss due to direct abrasion, mostly seen on side A. There is also evidence of dry powdery delamination of paint associated to splits and creases of the textile (Figures 25, 26 and 34). Both sides of the banner show a series of white protrusions coming from the white ground layer, some of them seen only under magnification and some noticeable with the naked eye (Figure 31).

Figure 25. Vehicle Builders’ bottom left scene of side B showing paint loss associated to splits and creases

Figure 26. Vehicle Builders’ upper right scene of side B showing paint loss associated to splits and creases

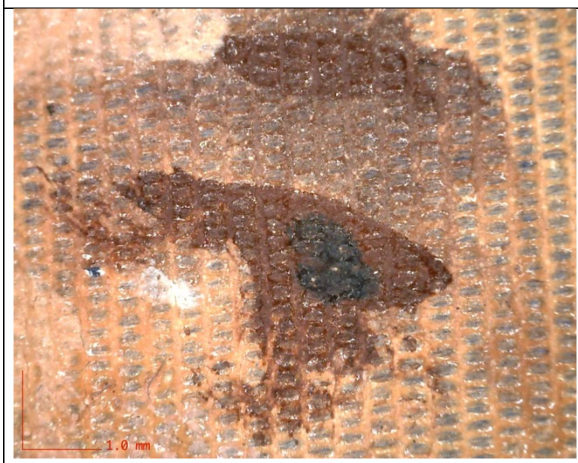


Figure 27. Vehicle Builders’ DinoLite detail of old woman’s eye showing wet-on-dry paint application (20x)

Figure 28. Vehicle Builders’ DinoLite detail of bee on hive showing wet-on-wet paint application (20x)

Figure 29. Vehicle Builders' detail of the coach crest with thick paint and evident brushstrokes

Figure 30. Vehicle Builders' DinoLite detail of the small crest showing wet-on-wet paint application (20x)

Figure 31. Vehicle Builders' DinoLite detail of white protrusions (20x)

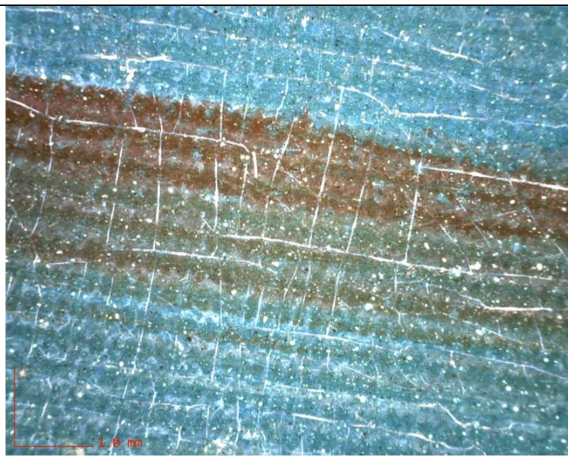


Figure 32. Vehicle Builders' DinoLite detail showing the blue base colour applied over the white ground with brown scumble on top (20x)

Figure 33. Vehicle Builders' DinoLite detail showing diagonal craquelure in thicker paint layers (20x)

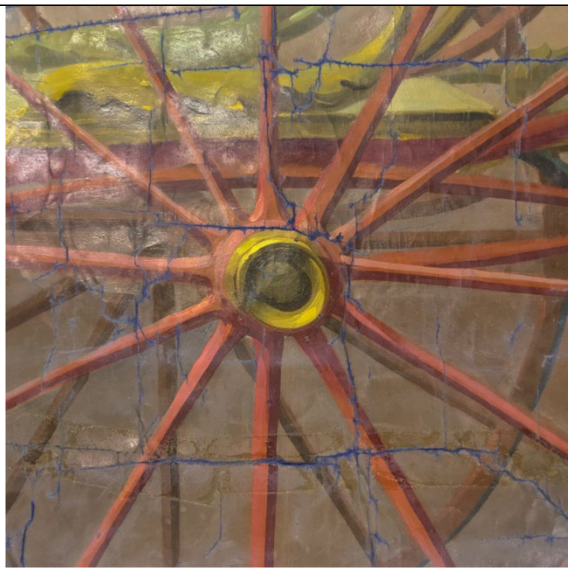


Figure 34. Vehicle Builders' central painting of side B showing paint loss associated to splits and creases

Silvering	
Description*	Central scroll (also called ribbon): Undulating composite scroll, graded in white and green with the returns ochre; with black Roman capitals lettering, distributed along the central band. Finished on each side with three alternating returns and a slender volute.
	Frames and peripheral decorations: Central frame formed by overlapped ostrich feathers in opposite directions from the centre-bottom. Peripheral and coat of arms frames have thin lines decorated with volutes in the upper half, and four arrows pointing outside in the lower half. The space between the frames is filled with decorative ropes with hanging tassels and a branch of laurel with berries, arranged symmetrically on both sides (left and right).
*Besides the wording, silvering is identical on sides A and B.	Lower scroll (also called ribbon): Undulating composite scroll, graded in white and green with black Roman capitals lettering, distributed along the centre. Finished on each side with a simple roll.
Layers on each side ** **Numbered by order of application	**** Only for the central and lower scrolls: 1. Size layer (seen as an external outline impregnating about 6 mm of the textile, more evident in the back side) 2. White ground 3. Metal leaf 4. Green/white paint (grading) and ochre/black paint (grading) 5. Black paint (lettering and finishing lines) 6. Thick glossy varnish **** Only for the frames and peripheral decorations: 1. Size layer (seen as an external outline impregnating about 6 mm of the textile, more evident in the back side) 2. White ground 3. Metal leaf 4. Coloured coating (golden) and coloured coating 2 (purple) 5. Black paint (finishing lines)
Thickness	Metal leaf approximately 1-2μm; black lettering side A 9.66μm; ground side A 78.66μm; ground side B 92.12μm; silvered scroll both sides 238.74μm (digitally measured).
Preparatory drawing	Inferred (not seen) by the restricted application of the silver leaf on the shapes and their almost perfect matching on both sides. Potentially made with the method of pouncing recommended by Kelly (Kelly, 1911).
Palette	Gold (translucent), black, purple (translucent), ochre, yellow, Emerald green, white
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size and coatings) (FTIR/SYPRO RUBY); lead white, aluminium leaf, bone black (SEM-EDX)
Appearance under UV light	The metal leaf shows no fluorescence in the undecorated areas, highlighting the absence of an overall coating. The two-coloured coatings and black paint show in an intense and distinctive fluorescence: the black paint has a greenish fluorescence colour, usually associated with

drying oil and terpenic resins (Figures 35 and 36). The golden coloured coating has a bright orange fluorescence colour, usually associated with shellac (Figures 37 and 38). The purple glaze has a different fluorescence colour of a bright red hue, which could highlight the presence of a fluorescent lake or dye. There is evidence of a thick varnish applied over both silvered scrolls, showing a cloudy greenish fluorescence associated with terpenic resins (Figures 39 and 40). The added legend of RENOVATED 1942 has a different fluorescence than the original signature (Figures 41 and 42).

Figure 35. Vehicle Builders' metallic decoration side A under normal light

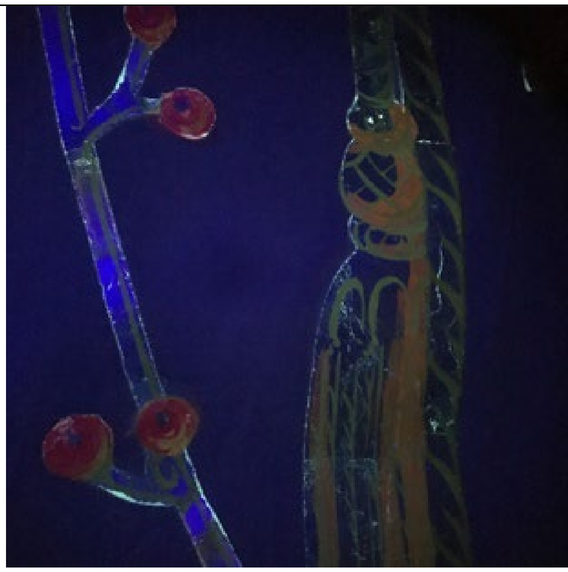


Figure 36. Vehicle Builders' metallic decoration side A under UV light

Figure 37. Vehicle Builders' metallic decoration side B under normal light

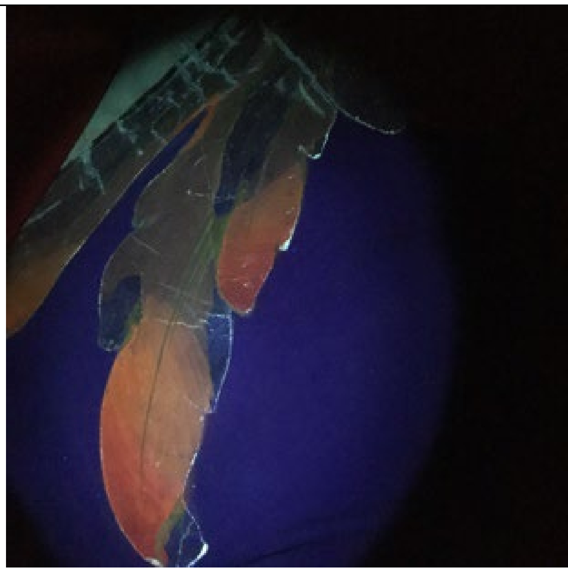


Figure 38. Vehicle Builders' metallic decoration side B under UV light

Figure 39. Vehicle Builders' central scroll side A under normal light

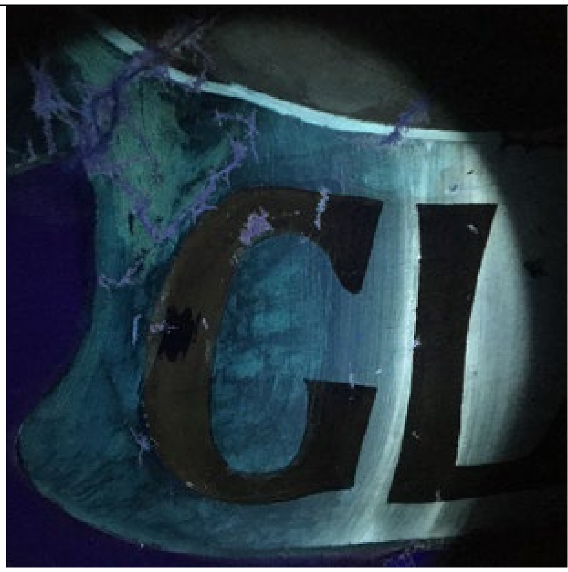


Figure 40. Vehicle Builders' central scroll side A under UV light

Figure 41. Vehicle Builders' signature and added legend on side A under normal light

Figure 42. Vehicle Builders' signature and added legend on side A under UV light

Structure	There is a darker outline suggesting impregnation of the textile of about 1 cm exceeding both scrolls (Figure 39), indicating the probable application of size for impeding the spread of the oily ground, as recommended by Gibson and Kelly (Gibson, 1870; Kelly, 1911). A thin layer of white ground is applied on top, used as gold-size to adhere the silver leaf, as recommended by Kelly for oil gilding of silk banners (Kelly, 1911). The golden coloured coating is applied selectively in the feathers, leaves, tassels, and ropes of the decorations. The purple-coloured coating is applied locally over the golden glazed feathers and on the berries of the laurel branches (Figure 50). Both scrolls have a very economic application of metal leaf, only applied over the areas to be left unpainted, blended onto the remaining band with a grading of white/green paint (Figures 45-47), and an ochre/black, accordingly. All the silvered areas are finished with fine lines of black paint and the black lettering. There is evidence of a thick glossy varnish applied on top of the scrolls as part of a later repair (possibly the 1942 renovation indicated in the lower scrolls and documented in the society's minutes).

Condition	The silvering is in a very good condition, with only minor losses associated with splits and creases in the textile and no evidence of tarnishing (Figures 43 and 45), identified as aluminium with SEM-EDX. Their craquelure pattern does not follow the weave of the textile as in the three George Kenning banners, breaking either tangentially or perpendicularly to the ribs (Figure 49). This relates to the thicker metal leaf that is aluminium, as it was experienced during the making of reconstruction 2 (see Appendix IV). There are also many wrinkles caused by the application of the metal leaf, also experienced during the making of reconstruction 2. The paint and coloured coatings are very firmly attached to the leaf, exposing the white ground when abraded (Figure 48). Both glazes have colour fading in some areas, being almost unnoticeable under normal light but still recognisable under UV light. Their presence is also noticeable under raking light, where the volume of the glaze stands out from the flat metal leaf. Fading seems more acute on side B, suggesting it could have been exposed on that side for longer. Yellow stains of adhesive tape residues are seen in the affected areas (Figures 43 and 44). The colour of the original signature is different from that of the added renovation in 1942 (Figures 51 and 52)

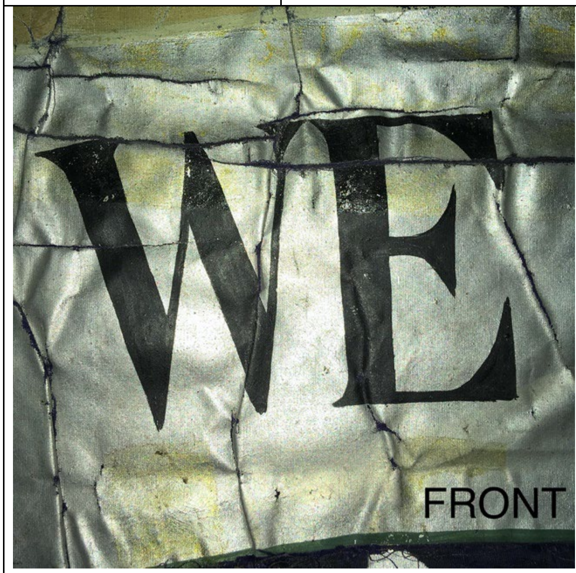


Figure 43. Vehicle Builders' paint losses associated with splits and creases and adhesive stains

Figure 44. Vehicle Builders' oxidised adhesive tape joining the split sections of the banner

Figure 45. Vehicle Builders' economic use of metal leaf blended with a painted ombre

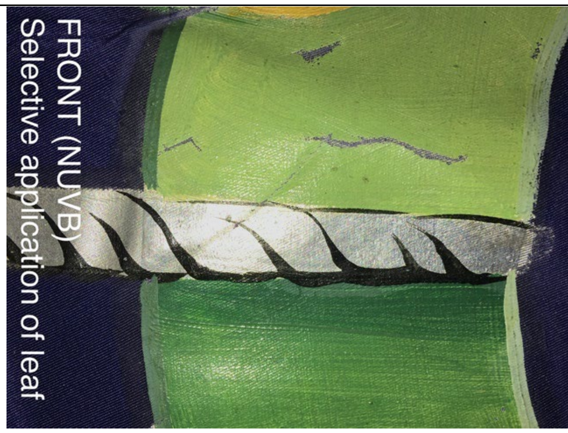


Figure 46. Vehicle Builders' economic application of silver leaf only where intended to be seen

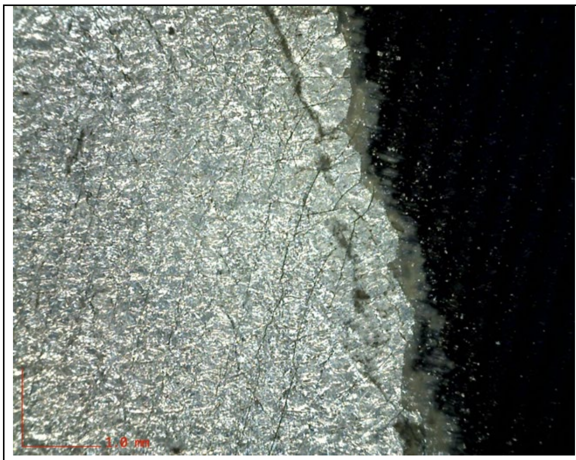


Figure 47. Vehicle Builders' DinoLite detail of metal leaf application precisely over the white ground (20x)

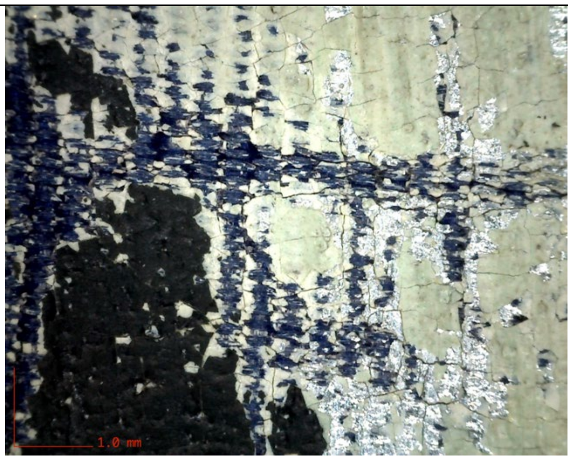


Figure 48. Vehicle Builders' DinoLite detail of abraded area exposing the white ground (20x)

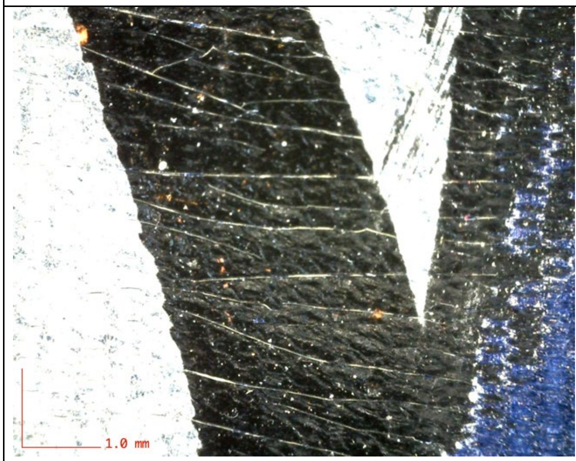


Figure 49. Vehicle Builders' DinoLite detail of perpendicular craquelures (20x)

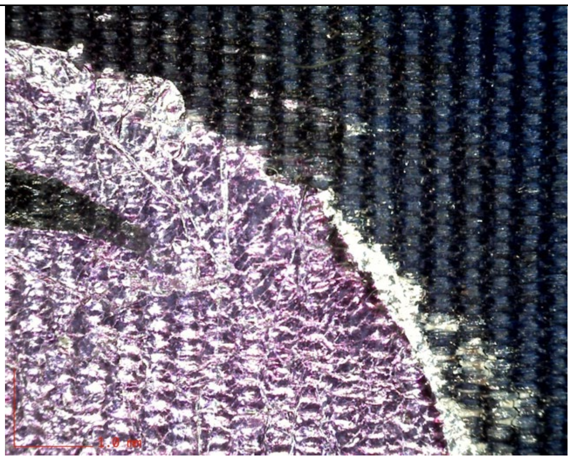


Figure 50. Vehicle Builders' DinoLite detail of the application of purple glaze (20x)

Figure 51. Vehicle Builders' DinoLite detail of R in RENOVATED (20x)

Figure 52. Vehicle Builders' DinoLite detail of E in KENNING (20x)

<table>
<tr><th colspan="2">Gilding</th></tr>
<tr><td rowspan="2">Description*

*Gilding is identical on sides A and B</td><td>Upper scroll: Red and ochre composite scroll, with gilded Roman capitals lettering distributed along two sections, left and right, divided by a central return. The overall scroll has multiple returns to the back and two forked undulating ends at each side.</td></tr>
<tr><td>Coat of arms: Two oval escutcheons face diagonally to each other; the left one with blue background and three black coaches (coat of arms of the Livery Company of Coachmakers); the right one with the Royal Standard quartered in red, blue and yellow. The escutcheons are supported by two brown horses, topped at the crest with the figure of the god Phoebus driving the chariot of the sun through the clouds. A torse in alternated gold and blue separates the escutcheons from the crest.</td></tr>
<tr><td>Layers on each side**

Numbered by order of application</td><td>** Only for the upper scrolls:
1. Size layer (seen as an external outline impregnating about 6 mm of the textile, more evident in the back side)
2. White ground
3. Red paint (base for the gilding), ochre paint (not used for the gilding but on the same level of the red)
4. Possible yellow gold-size
5. Possible gold leaf
6. White and black grading of the red and ochre grounds of the scroll
7. Burnt red shadowing (lettering)
8. The layers are repeated from #3 onwards as there is a second lettering of the scroll
9. Thick glossy varnish (only over the paint, not over the gold leaf)

**** Only for the coat of arms:
1. Size layer (seen as an external outline impregnating about 6 mm of the textile, more evident in the back side)
2. White ground
3. Adhesive (also called gold size)
4. Possible gold leaf
5. Paint (see painting table for details)
6. Thick glossy varnish (only over the paint, not over the gold leaf)</td></tr>
<tr><td>Thickness</td><td>Not measured.</td></tr>
<tr><td>Preparatory drawing</td><td>Inferred (not seen) by the restricted application of the gold leaf on the shapes and the invasion of the surrounding colours (indicating the gold leaf was applied before the painting). Potentially drawn over the white ground with a black charcoal of graphite, as seen in the historical video of banner painters (Pathé, 1958). The lettering could have been previously traced with chalk lines, as recommended by several sources on sign painting (Callingham, 1863; Gibson, 1870; Gardiner, 1871; Scranton, 1899; Kelly, 1911).</td></tr>
<tr><td>Palette</td><td>Bright red, dark red, ochre, light pink, black</td></tr>
</table>

Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size) (FTIR/SYPRO RUBY); lead white, calcium carbonate (ground) (SEM-EDX); rest not analysed.
Appearance under UV light	The metal leaf shows a dark purple colour where its left exposed (Figures 54, 56 and 58), highlighting the absence of any type of coating (glaze or varnish). Parts of the scroll paint show a strong cloudy greenish fluorescence, denoting the addition of a thick natural resin varnish (Figures 54 and 56). Exposed areas of the initial red paint (in damaged sections of the lettering) show a strong orange fluorescence colour, which could be attributed to the pigment alone or of its mixture with the binding media (Figure 58)). Areas of the exposed white ground have a very strong pale-yellow fluorescence, regularly associated with the presence of lead white (Figures 54 and 58). Images of the said areas under normal light are included for comparison (Figures 53, 55 and 57).

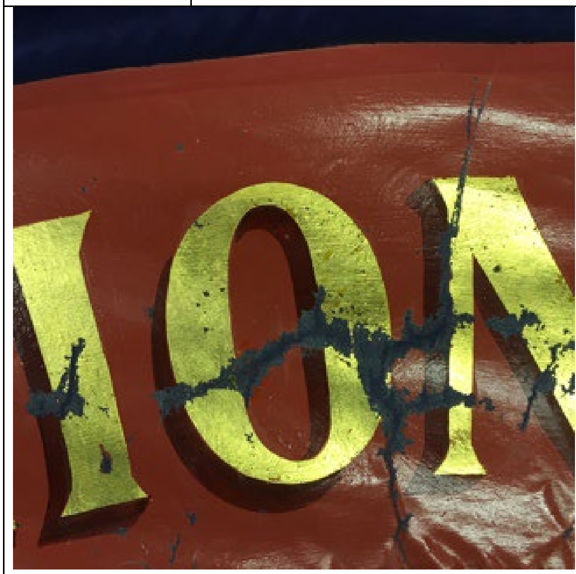


Figure 53. Vehicle Builders' top scroll detail under normal light, side A

Figure 54. Vehicle Builders' top scroll detail under UV light, side A

Figure 55. Vehicle Builders' coat of arms detail under normal light

Figure 56. Vehicle Builders' coat of arms detail under UV light

Figure 57. Vehicle Builders' top scroll detail under normal light, side B

Figure 58. Vehicle Builders' top scroll detail under UV light, side B

Structure	According to the society's minutes, the red scrolls were over painted in 1933, changing the initial lettering of 'United Kingdom Society of Coachmakers', seen in two photographs dating 1926. There is evidence of the previous text protruding through the added one (Figures 59 and 60). The scrolls are applied over a possible layer of size, seen as an exceeding line of impregnated silk surrounding their perimeter. The first layer is a thin white ground or primer onto which a layer of red paint was applied. There are few exposed areas of the first gilding (Figure 61), so it can be inferred that it used a similar yellow coloured gold-size as detected in the unaltered coat of arms (Figures 62 and 64). A thick layer of red paint was subsequently applied to cover the previous scroll. The areas to be gilded had to be traced and a thin layer of yellow coloured gold-size was applied for the lettering. The supposed gold leaf was adhered to the gold-size and the decoration of the scroll continued, with added light-pink grading towards the edges to simulate volume. The shading of the letters was applied on top, as it covers the gold in some areas (Figure 63). The ochre returns of the scrolls were consequently painted (yellow on top of the red), mixing the colour with black for creating a volumetric grading. The coat of arms is applied over an initial layer of size followed by a white ground or primer. The design was drawn, and yellow gold-size was applied only to the areas to be gilt. The gold leaf was subsequently adhered, followed by the layers of painting (see painting table for details). Both scrolls and coat of arms have a thick glossy varnish, applied thoroughly except for the gilt motifs.
Condition	The gilding has a firm attachment to the base layers and only has losses associated with folds and direct abrasions of the banner (Figures 65 and 66). It shows no evidence of tarnishing, suggesting it is likely gold. It shows a very fine and homogeneous craquelure pattern, only noticeable under magnification, following the spaces between the ribs of the textile. There is some soiling on the surface. The top layer of paint (red and burnt red shadings) shows some delamination associated with creases and direct abrasions (Figure 61). In certain areas it exposes the initial red layer, only distinguishable under UV light due to its different fluorescence colour. The overlapped scroll is much thicker than the original, which produces more unstable craquelures and losses (Figure 66).

Figure 59. Vehicle Builders' side A top scroll

Figure 60. Vehicle Builders' side A top scroll with digital tracing of underlying T of UNITED KINGDOM

Figure 61. Vehicle Builders' detail of overlapping gildings in top scroll, side B


Figure 62. Vehicle Builders' creases and splits producing pain loss

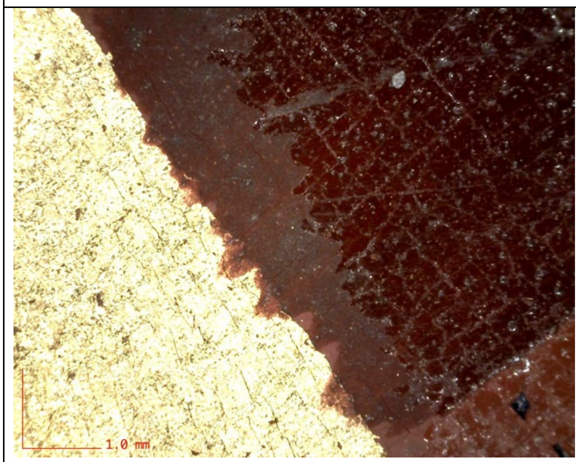


Figure 63. Vehicle Builders' DinoLite detail of second gilding sequence with added varnish (20x)

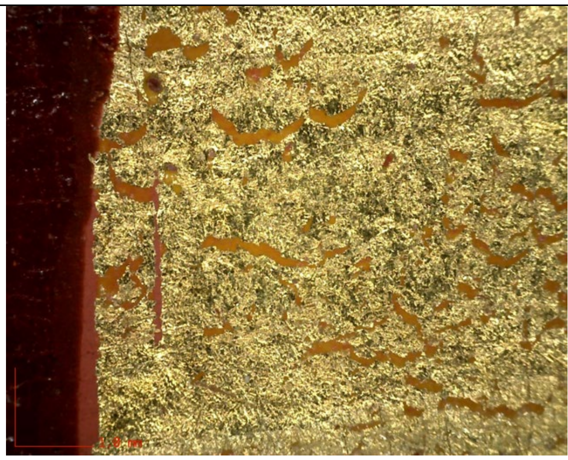


Figure 64. Vehicle Builders' DinoLite detail of original gilding with added varnish (20x)

Figure 65.

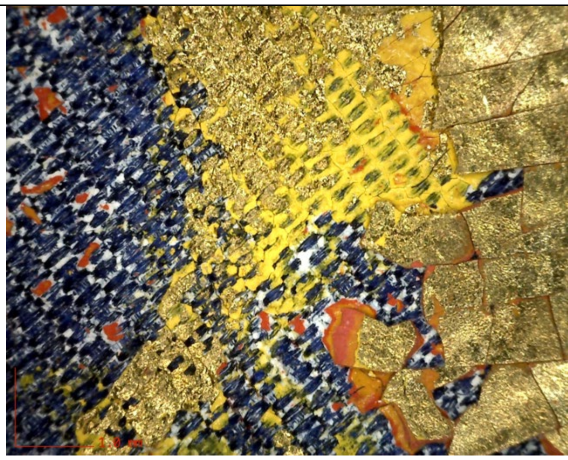


Figure 66.

Pole	
Description	Top hanging wooden pole, maroon stained and varnished, with one decorative brass end cap at each end. The brass ends have iron pins screwed at each side, both with screw fittings. These indicate the use of side poles, now missing.
Dimensions	2870 x 60 mm
Inventory number	Same as banner
Materials* *Not analysed but inferred by their appearance	Pole: conifer wood (due to the pattern associated with the formation of tree rings) with possible shellac varnish End caps: brass Pins and fittings: cast-iron
Appearance under UV light	The varnish has a strong orange fluorescence colour, regularly associated with shellac.
Condition	The coatings (varnish and maroon stain) have areas of abrasion exposing the wood. The pole is slightly bent towards the middle and is perforated by 13 tacks to fix the pole loops into position (Figure 67). Both end caps and fittings show evidence of corrosion (Figures 68 and 69).

Figure 67. Vehicle Builders' banner pole with measurement

Figure 68. Vehicle Builders' top pole end cap with measurement

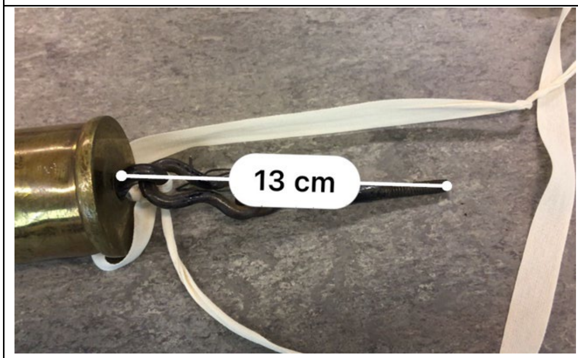


Figure 69. Vehicle Builders' top pole end cap and fittings with measurement

9.1.5 The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner

<table>
<tr><td colspan="2">

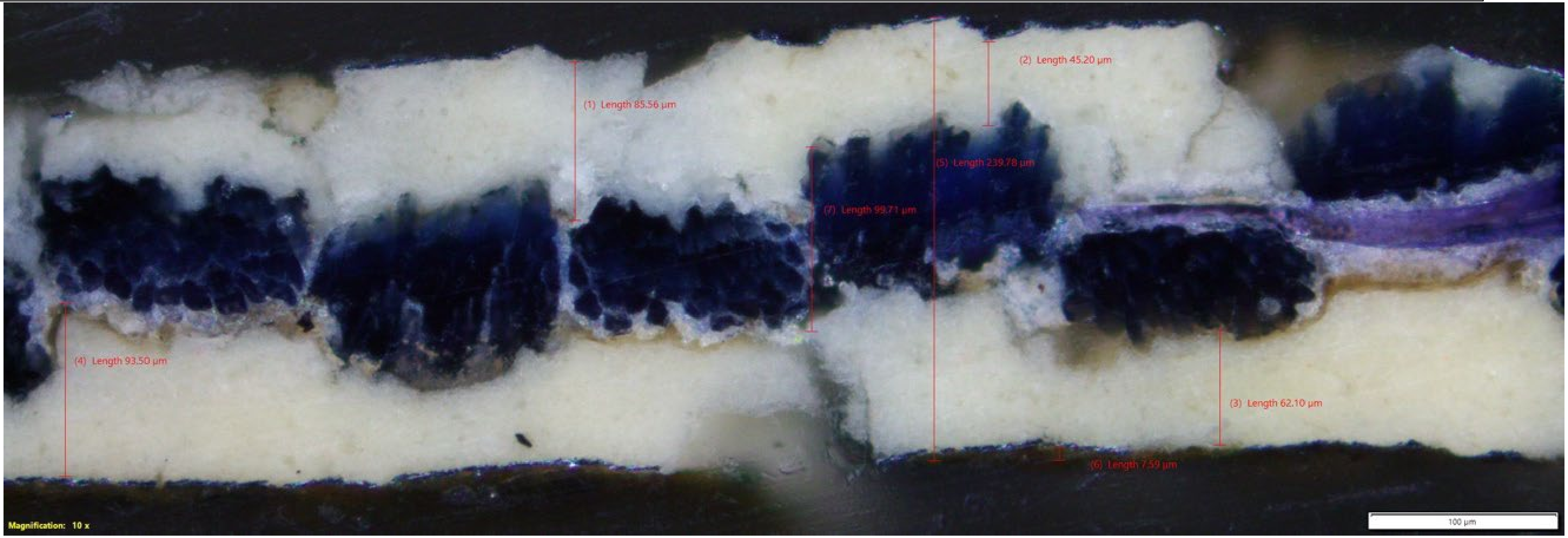
Side A (side opposite to folded edges)</td><td>

Side B (side of folded edges)</td></tr>
<tr><td>Title</td><td colspan="2">Banner of the Scottish Tin Plate Braziers and Sheet Metal Workers' Society</td></tr>
<tr><td>Maker</td><td colspan="2">George Kenning & Son (Signed on the lower scroll on both sides as G. Kenning & Son London)</td></tr>
<tr><td>Date of making</td><td colspan="2">c.1916. The banner has a George Kenning & Son brass tag, which could only have been added from 1907 onwards after the opening of their Coventry factory branch. The Society changed its name to that on the banner by April 1911, and by April 1914 they adopted a new emblem, suggesting the possibility of requesting a new banner too. However, the NUVB banner dated 1914 lack such brass tag, suggesting they were added at least a year later. By April 1917 the Society changed their name again, so the banner could have only been made between 1915 and 1917. The only other dated example found with a brass tag is from 1916 (Peoples' History Museum), thus suggesting c.1916 as the most likely date of making for the Society's banner.</td></tr>
<tr><td>Technique</td><td colspan="2">Oil paint, coloured glazes, aluminium, and gold leaves on silk</td></tr>
<tr><td>Description</td><td colspan="2">Dark blue banner with absent fringe on the bottom edge, painted on both sides on a single layer of fabric with the following layout: an elaborated upper scroll indicating the name of the society on both sides. A main central scene with four smaller surrounding scenes depicting on the front, a possible syncretism of the god Athena with the allegory of Glasgow in Victorian fashion; and on the back, a Tin Plate workers' workshop. The lower scroll on the front has the Society's motto and, on the back, indicates the date of institution of the society. It includes its original hanging top pole with brass ends, two pairs of yellow guide tapes, one side carrying pole with decorative tip and leather harness, a pair of side carrying poles with braided cords, a brass banner tag, a two-colour braided rope and its original wooden box.</td></tr>
<tr><td>Exact wording</td><td>Side A</td><td>Upper scroll: "SCOTTISH TIN PLATE BRAZIERS AND SHEET METAL WORKERS' SOCIETY"

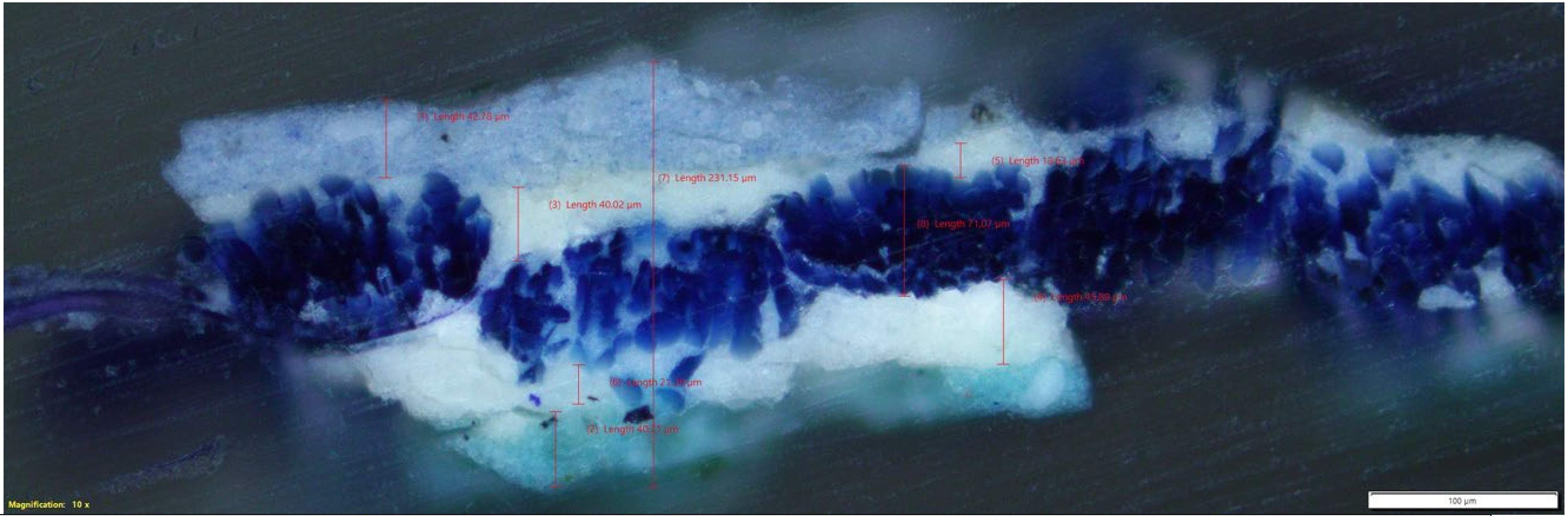
Lower scroll: "LABOUR IS THE SOURCE OF ALL WEALTH"</td></tr>
</table>

	Side B	Upper scroll: “SCOTTISH TIN PLATE BRAZIERS AND SHEET METAL WORKERS’ SOCIETY” Lower scroll: “INSTITUTED 1833”	
Dimensions	Height 2,400 mm (including loops/pole)	Width 2,660 mm (not including pole)	
Owner	Glasgow Museums	Date of acquisition	1981
Inventory number	PP. 1981. 11 [1]	Location	Glasgow Museums Resource Centre, Pod 12
General assessment of condition	The banner is in poor condition, mostly due to the fragile condition of its metal leaf decoration. Side B appears more deteriorated than side A. It has ingrained soiling all over, mostly accumulated on the lower half of side B. Side B is more soiled than side A, possibly indicating the side facing outwards for longer. A significant bloom is seen over the paint of both central scenes, more acutely on the lower right of side A, possibly associated with direct moisture. There is a significant detachment of painted metal leaf in large areas of both central frames and lower scrolls on both sides. It has a large tear on the lower part, associated to the guide tapes. There are splits, both horizontally and around the scrolls and frames, with localised paint losses. There are two long patches stitched along the banner, one vertical next to the central scene on both sides and one horizontal on the bottom edge. Further paint losses are associated with hand sewn repairs and the application of adhesive tape.		
Photography	Digital photography – Side A, normal light/ Side B, normal light/ Macro images of the textile construction, painting technique and scrolls layering sequence (including raking light and UV images). Dino-Lite images (55x) – textile weave, preparation, painting technique, layer sequence and flaking on the scrolls.		
Examiner/Date	Daniel Sanchez Villavicencio/October 2018		
Place and conditions of examination	Glasgow Museums Resource Centre, Research Room. Banner examined flat over an examination table using both natural illumination and fluorescent tubes light (daylight).		

Cross-sections micrographs (crossed polarisers, 100x)



Sample SM26: Cross-section from silvered scroll with measurements (Side A on the top)



Sample SM16: Cross-section from central painting with measurements (Side A on the top)

<table>
<tr><th colspan="4">Textile</th></tr>
<tr><td>Description</td><td colspan="3">The banner is made of a single layer of fabric. It is constructed from a single square of dark-blue dyed rep weave fabric. The fabric is aligned with the wefts parallel to the pole (identified after its comparison with the other banners, as there were no selvedges to be found). It has no added borders. It has 11 pole loops attached to the top hemmed edge, possibly made of blue-dyed silk grosgrain ribbon, which are thought to be original. It has two pairs of guide tapes at each bottom corner, possibly made of yellow dyed cotton with a herringbone weave.</td></tr>
<tr><td>Materials

*Not analysed</td><td colspan="3">Fabric: dark-blue dyed silk
Sewing threads: blue dyed silk (originals), dark-blue dyed silk/viscose-rayon* (repairs)
Pole loops: dark-blue dyed silk
Guide tapes: yellow dyed cotton
Corner reinforcements: dark-blue dyed silk/viscose-rayon*
Ground textile fibres analysed with FTIR-ATR</td></tr>
<tr><td rowspan="2">Dimensions</td><td>Fabric:
2300 x 2660 mm</td><td>Guide tapes:
30 x 1200 mm</td><td rowspan="2">Thickness:
99.71µm/71.07µm</td></tr>
<tr><td>Pole loops:
1-11. 76 x 190 mm
(Numbered left to right from the front)</td><td>Corner reinforcements:
120 x 130 mm</td></tr>
<tr><td rowspan="4">Weave</td><td colspan="3">Fabric: warp-faced plain weave (also called rib or rep fabric)
Average thread count: 40 warps/cm by 30 wefts/cm (Figure 1)</td></tr>
<tr><td colspan="3">Pole loops: warp-faced plain weave (also called grosgrain ribbon)
Average thread count: 60 warps/cm by 14 wefts/cm (Figure 2)</td></tr>
<tr><td colspan="3">Guide tapes: herringbone weave</td></tr>
<tr><td colspan="3">Corner reinforcements: warp-faced plain weave (also called grosgrain ribbon)
Average thread count: 60 warps/cm by 14 wefts/cm (Figure 10)</td></tr>
</table>

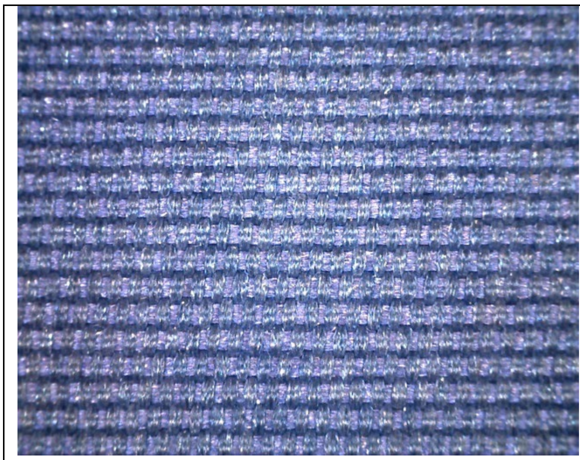


Figure 1. Metal Workers' banner DinoLite detail of the ground textile weave (20x)

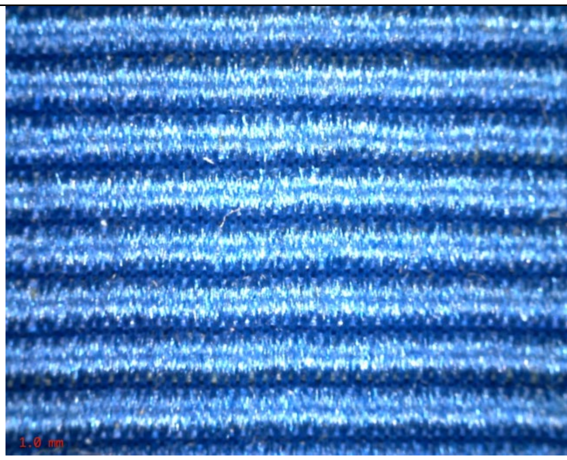
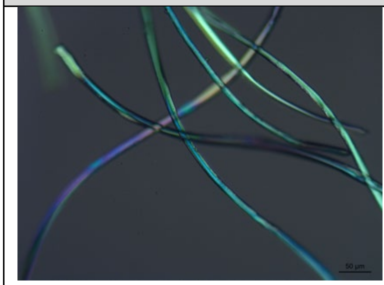
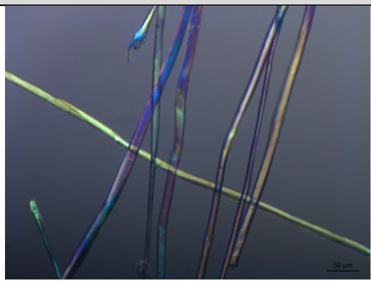


Figure 2. Metal Workers' banner DinoLite detail of the pole loop weave (20x)

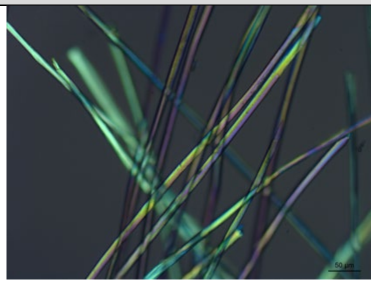
Micrographs of textile fibres (crossed-polars, 200x)



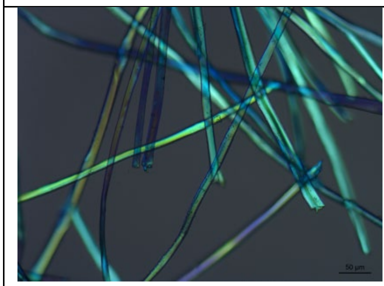
Sample SM01: warp silk fabric



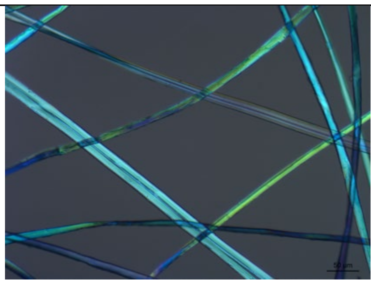
Sample SM02: weft silk fabric



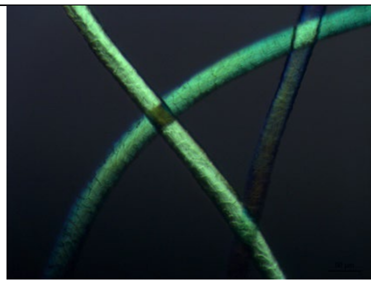
Sample SM03: silk stitching thread



Sample SM04: warp silk loop



Sample SM05: weft silk loop



Sample SM06: wool guide tape

Construction	The single piece of fabric, the thinnest of all five banners due to its fine yarns, is finished to the right, left and top sides with machine-stitched hemmed edges, all of them folded towards side B with a turning of 7 mm width (Figures 3-5). No selvedges were found but evidence of them being cut (Figure 6), so the identification of the warps and the wefts was done by comparison with the other examples, it is likely that the ribs of the weave correspond to the thicker wefts. The 11 original pole loops are hand sewn from side B to the top of the hemmed edge using a hand made whip stitch (Figure 8). The edges of each loop are folded in to prevent fraying and sewn like that to the textile (Figure 7). The left corner is reinforced from both sides with an irregular shaped piece of rep fabric, hand sewn with a dark-blue dyed thread and aligned tangentially to the banner's wefts (Figure 9). The pair of guide tapes on the left corner are hand sewn irregularly over the reinforcements towards side A, using dark-blue dyed thread (Figure 10). The right corner is not reinforced, and the other pair of guide tapes are both hand-sewn and tied to the bottom repair in a very coarse way.

Figure 3. Metal Workers' top right corner finishing, side B

Figure 4. Metal Workers' right side hemmed edge, side B

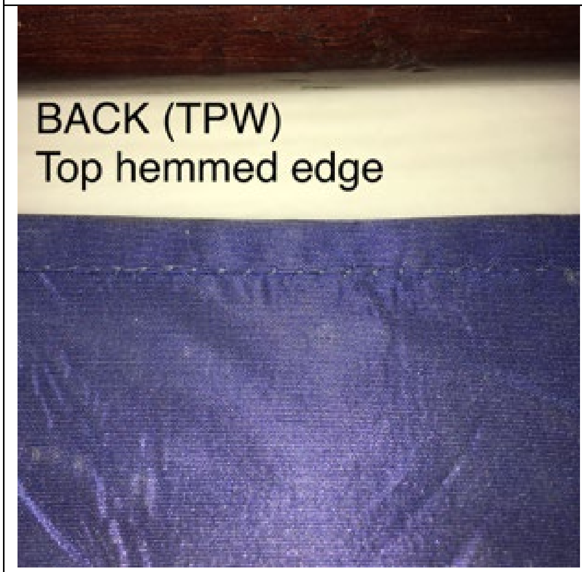


Figure 5. Metal Workers' top hemmed edge, side B

Figure 6. Metal Workers' cut edge of fabric folded inside top hemmed edge, side B

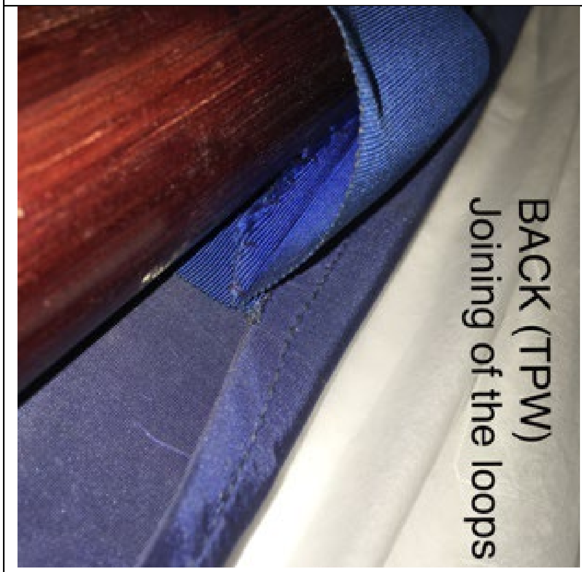


Figure 7. Metal Workers' folded loop to prevent fraying, side B

Figure 8. Metal Workers' hand-sewn whip stitch attaching the loop, side B

<table>
<tr>
<td colspan="2">


Figure 9. Metal Workers’ folded edge of ground textile and fabric reinforce, side A
</td>
<td>


Figure 10. Metal Workers’ attaching of corner reinforcements and guide tape, side A
</td>
</tr>
<tr>
<td>Repairs</td>
<td colspan="2">
The banner has three types of repairs made with different materials: a fragment of the same banner (same thread count and with some remains of the scrollwork decoration); a blue-dyed tabby weave fabric and adhesive tape.
Patch of same banner fragment
The first type of repair consists of one long rectangular patch, most likely made of a fragment from the now missing bottom section of the banner (Figures 11, 13 and 15). It is sewn vertically to both sides, apparently to reinforce a tear or split concealed by it. The patch is sewn through the decorated bottom scroll and the weave is aligned perpendicularly to the direction of the banner’s wefts.
Patch of tabby weave fabric
The second type of repair is a thin strip of a tabby weave fabric, hand sewn to both sides of the remains of the bottom edge, encapsulating the original fabric (Figure 16). The repair also incorporates the long rectangular patch, indicating it was done afterwards.
Adhesive tape
The third type of repair are strips of adhesive tape directly adhered to the central painting on both sides, although there is no evidence of splits underneath, thus they might have been applied as a “preventive” measure (Figure 12). There is also adhesive tape applied directly to the pole loops to fixed them onto the pole (Figure 14).
</td>
</tr>
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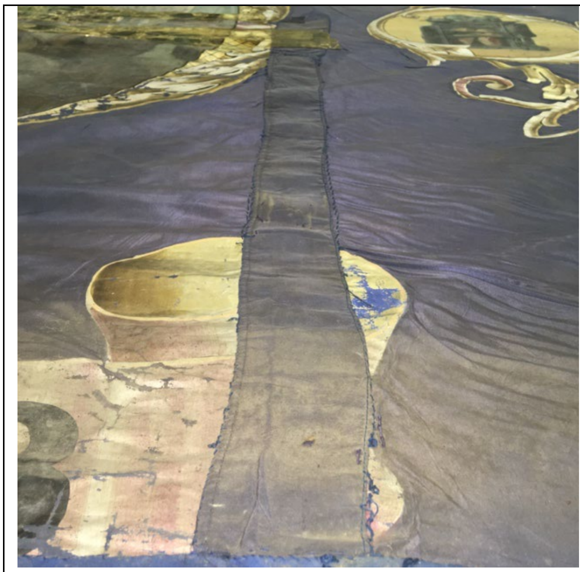


Figure 11. Metal Workers' self-banner long patch and textile distortion

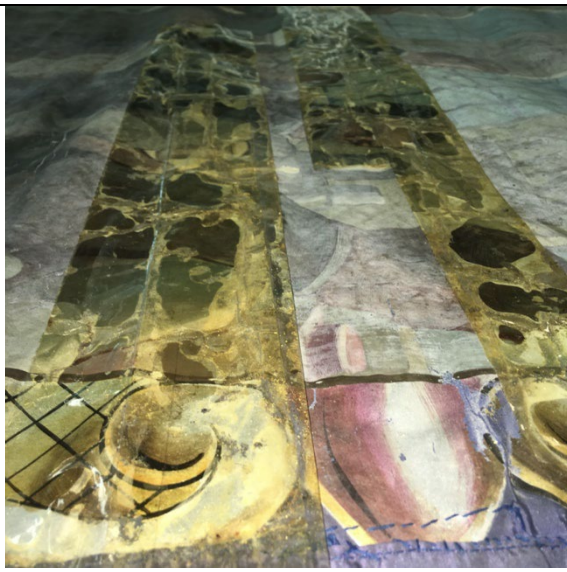


Figure 12. Metal Workers' adhesive tape over central paint and adjacent textile

Figure 13. Metal Workers' close-up of self-banner long patch

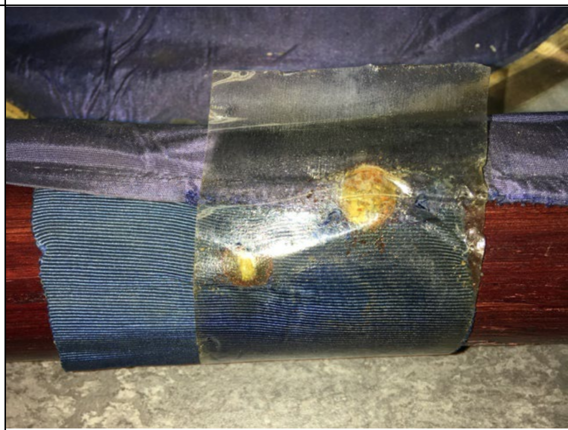
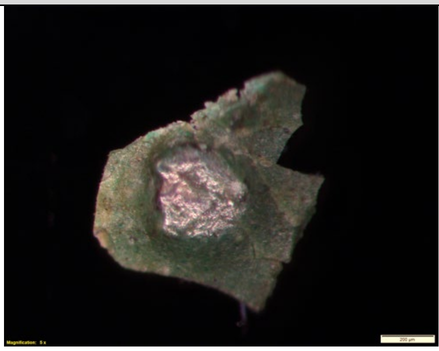
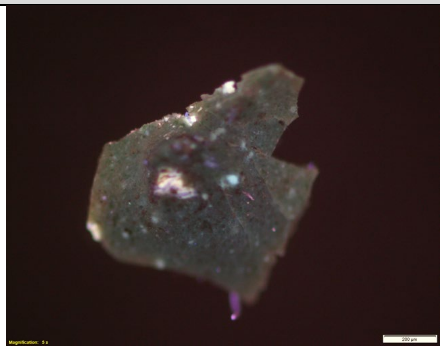
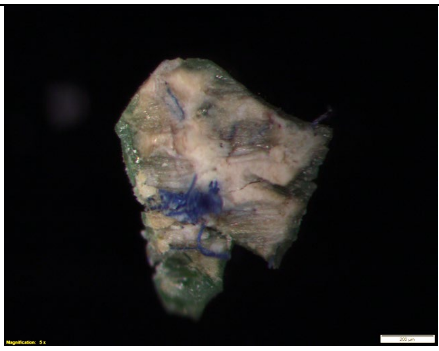
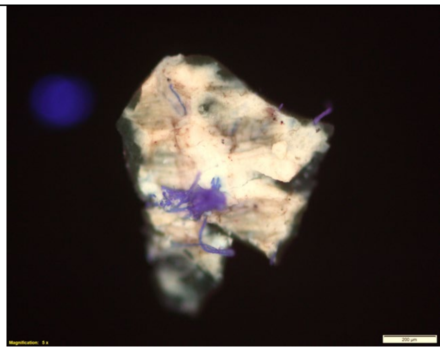
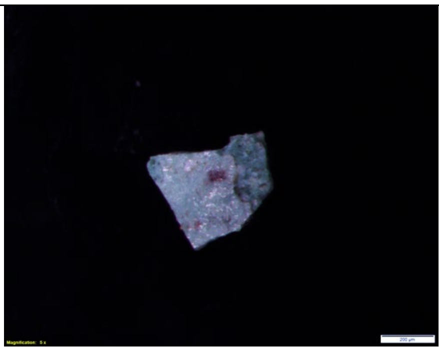
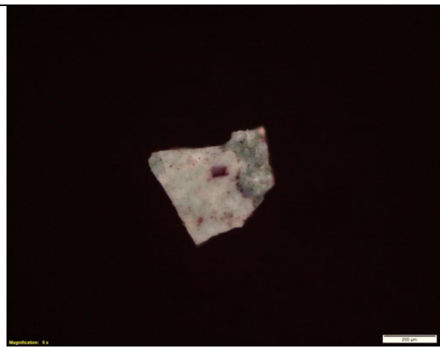
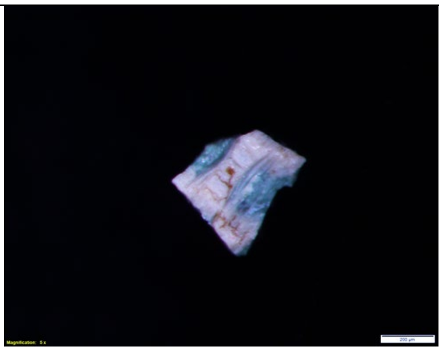
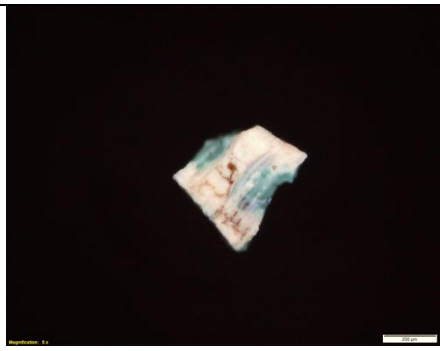


Figure 14. Metal Workers' adhesive tape over tacked loop

Condition	Soiling There is soiling overall on both sides of the banner, but is further accumulated in the lower third section, significantly more in the back where even cobwebs are seen (Figure 16). Creasing/distortion There is an acute distortion of the fabric in all the unpainted areas, showing creases and probably even signs of shrinkage, which could be related both to their manufacture and to the free movement of the unrestrained textile under humid conditions (Figures 11 and 15). There are creases located in the top and bottom sections, related to the tight rolling of the banner onto its own pole for storage. Structural Condition There is a large tear in the lower right side of the banner, which seemed to have been formed after the excessive tension of the lateral ties. The fabric around that damage also looks much dirtier and abraded. The banner lacks its complete bottom edge and fringe, indicating that they probably got damaged with use. The irregular outline of the current border, the fact that the fabric in the lower section of the banner is impregnated with dirt and that the textile seems more damaged than the rest, might indicate a direct humidity absorption damage. The pole loops have adhesive tape adhered to the top of the pole, with impregnated stains of the adhesive (Figure 14).

 Figure 15. Metal Workers' self-banner long patch with fragment of original silvering and textile distortion	 Figure 16. Metal Workers' bottom repaired edge with ingrained soil and cobwebs

Painting	
Description	Side A: A blonde haired woman in Victorian fashion is seated in front of two torched pillars by a maritime port. It is identified as a syncretism between the Greek god Athena (Ravenhill-Johnson, 2014), holding a distaff as her attribute. An industrial urban landscape is seen on the left side background, while a ship with the Rampant Lion of Scotland is placed on the right-hand side. Next to the woman there is a representation of a globe depicting Europe, Africa, Asia and Australia; a tied jute sack with the acronym STP (Scottish Tin Plate workers); an anchor and a wreath of pink roses. The peripheral scenes portray (clockwise from the right): a brass kerosene lamp; a Victorian Jappaned coal scuttle with decorated lid, brass handle and white (ivory) handle shovel; an outdoor gas lamp; and a red maritime or port gas lamp.
	Side B: A group of 7 workers are depicted doing different tasks related to sheet metal work, inside a double-height ceiling workshop. Part of a foundry with its extraction bell is seen on the left side, as well as an anvil and a long working table. The peripheral scenes portray (clockwise from the right): a three-piece set of enamelled metal products (kettle, container with lid and basin); a stove with pots and pans, with meat and pastry products inside the oven; a dry gas meter (similar to the design of Thomas Glover & Co., Ltd.); and an enamelled metal bathtub with brass taps and legs. Both sides of the banner are based on the official emblem of the National Amalgamated Tin and Iron Plate Sheet Metal Workers and Braziers by Alexander Gow, dating c.1894 (original request found in the minutes of the National Amalgamated Tin Plate Workers of Great Britain).
Layers on each side** **Numbered by order of application	1. Size layer (seen in the periphery of the scene as a 6 mm impregnated outline, more evident in the back) 2. White ground 3. Thick paint applied as background or base colour 4. Thick paint applied as lights and shadows 5. Thick paint applied as finishing lines
Thickness	Paint side A 42.78μm; ground side A 40.02 μm; ground side B 45.89 μm; paint side B 40.11 μm; central paint both sides 231.15 μm (digitally measured).
Preparatory drawing	Only inferred, not seen. The drawing was potentially drawn over the white ground with a black charcoal or graphite, as seen in the historical video of banner painters (Pathé, 1958).
Palette	Side A: Light brown, dark brown, white, green, dark red, bright red, pink, grey, ochre, pale yellow, light blue, dark blue, black

	Side B: Light brown, dark brown, white, Emerald green, pale yellow, light blue, pink, orangey brown, black, ochre
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size) (FTIR/SYPRO RUBY); lead white, synthetic ultramarine, calcium carbonate, barium sulphate, magnesium carbonate (SEM-EDX).
Micrographs of paint samples showing appearance of paint (front) and ground (back) (50x)	
 Sample SM11: front, crossed polarisers	 Sample SM11: front, UV filter
 Sample SM11: back, crossed polarisers	 Sample SM11: back, UV filter
 Sample SM15: front, crossed polarisers	 Sample SM15: front, UV filter
 Sample SM15: back, crossed polarisers	 Sample SM15: back, UV filter

Appearance under UV light	Each paint colour shows a different response to the UV radiation, either presence or lack of fluorescence, highlighting the absence of a coating. The light colours have a strong pale-yellow fluorescence, regularly associated with the presence of lead white, which could indicate the presence of this white pigment in the mixture. The white efflorescence is not seen under UV light, allowing to see the paint layer underneath (Figures 17 and 18). This suggests the potential lack of lead in their composition (fluorescent), and the possible presence of calcium carbonate (non-fluorescent).
 Figure 17. Metal Workers' detail of white efflorescence under normal light	 Figure 18. Metal Workers' detail of white efflorescence under UV light
Structure	The base colours of the backgrounds are applied thickly over the white ground. Particularly on side B, the application must have followed the preparatory drawing, as the colours are applied restrictively to each shape (Figures 20 and 29). Nevertheless, there are no traces seen of the preparatory drawing, possibly covered by the thick layers of paint. There is evidence of wet-on-wet application of paint with much attention to detail, which could indicate the style of the painter(s) (Figure 22). The figures are constructed in a similar way: starting with the application of thick paint of a medium tone, followed by the light tones also applied as *impasto* (Figure 19). The darker tones and details are applied slightly more diluted over the whole, with few evidence of blending or smudging with the previous tones, indicating the upper layers were applied while the base was dry (Figures 23 and 24). The brushstrokes are very evident in all the cases, indicating that the paint was applied thick and even suggesting the addition of a bulking additive or filler (i.e., calcium carbonate) (Figure 21).
Condition	The paint has a very firm attachment to the white ground and textile. Similarly to the other Kenning & Son banner (Vehicle Builders' banner), there is not an overall craquelure pattern along the ribs of the weave). Instead, there are localised cracks formed diagonally to the ribs (Figures 23 and 24), denoting a thicker width of the paint layer and in this case, a thinner thickness of the textile, with less prominent ribs than any of the other inspected banners. The paint losses are minimum and directly related to the folds of the textile and their consequent abrasion during handling (Figure 27). The paint detaches according to the direction of the fold or textile distortion. Similarly to all the other examples, there are a significant amount of white protrusions scattered throughout the colours (Figures 24, 25 and 27), as well as an intense white bloom that even conceals the underlying tone in some localised areas (Figures 28 and 30). Both effects could be related to the migration of metal

soaps as it has been previously reported in painted banners (Rode, 2008; Smith, Thompson & Hermens, 2014). The white bloom could also be related to a direct humidity damage, as they are located next to the areas with missing silvering. Associated with those areas, there are white efflorescence protruding from parts of the sea, the roses, and the coal scuttle on the front. These efflorescences are not seen under UV light, indicating that they could be formed by calcium carbonate, which does not have a fluorescent response to UV radiation (Figures 17 and 18). There are random splatters of an alien liquid in the main scene of the back, possibly caused during its usage (Figure 29). Side B seems more damaged than side A. However, side A has more localised damages produced by a direct source of humidity. A section of the sky above the female character was adhered to the other side of the banner, as a consequence of its tight rolling while the painting materials were still fresh (Figure 26).

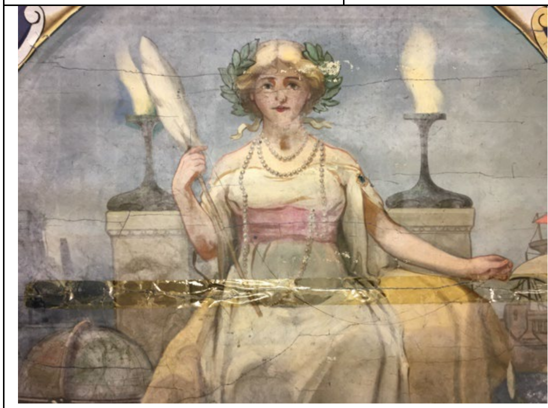


Figure 19. Metal Workers' central paint side A

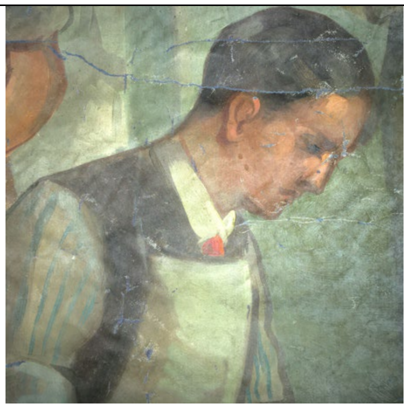


Figure 20. Metal Workers' central paint side B showing restrictive application of colours

Figure 21. Metal Workers' detail of lateral scene with evident brushtrokes

Figure 22. Metal Workers' DinoLite detail of wet-on-wet paint application (20x)

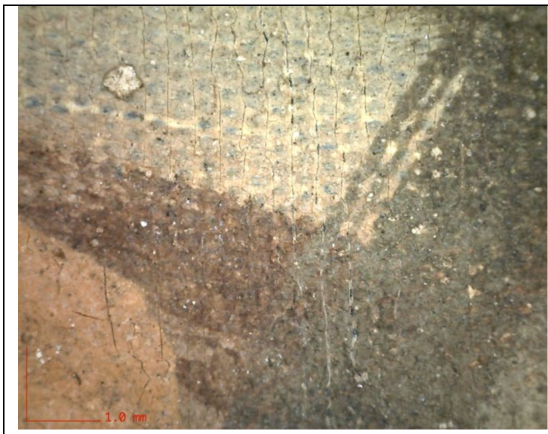


Figure 23. Metal Workers' DinoLite detail of wet-on-dry paint application (20x)

Figure 24. Metal Workers' DinoLite detail of wet-on-dry paint application and white protrussions (20x)

Figure 25. Metal Workers' DinoLite detail of whote protrussions on coal scuttle (20x)

Figure 26. Metal Workers' DinoLite detail of paint stripped by rolling whilst wet (20x)

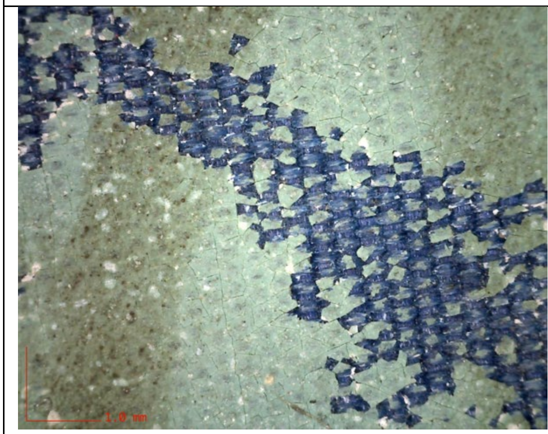


Figure 27. Metal Workers' DinoLite detail of paint loss associated to creases (20x)

Figure 28. Metal Workers' white bloom over the orbe

	
Figure 29. Metal Workers' splatters of alien liquid over side B	Figure 30. Metal Workers' white bloom over the sea

Silvering	
Description* *Besides the wording, silvering is identical on sides A and B	Upper scroll (also called ribbon) and peripheral decoration: Three-banded composite red scroll with gilded block capitals, separated by two bi-coloured slim returns and finished on both ends with thick silvered returns. The scroll is surrounded by phytomorphic designs at each side and one open acanthus flower in the centre.
	Frames and peripheral decorations: The central frame is formed by alternating rolls and acanthus leaves with a red oval element in the middle. Peripheral frames and decorations are formed by phytomorphic shapes with extended acanthus leaves towards their ends.
	Lower scroll (also called ribbon) and decoration: Semi-arched white scroll with black Roman capitals, finished with two bi-coloured rolls at each end and a fragment of a fitomorphic element at the centre.
Layers on each side** ** Numbered by order of application	1. Size layer (seen as an external outline impregnating about 6 mm of the textile, clearly seen on both sides) 2. White ground 3. Metal leaf 4. Coloured coating 1 (golden) 5. Coloured coating 2 (purple) and coloured coating 3 (sepia) 6. Black paint (finishing lines) **** Only for the upper scroll: 1. Size layer (seen as an external outline impregnating about 6 mm of the textile, clearly seen on both sides) 2. White ground 3. Red paint 4. ***Possible gold-size (only for the gilding) 5. ***Metal leaf (silver and golden) 6. ***Burnt red paint (only around the gilding) 7. Coloured coating 1 (golden) 8. Coloured coating 2 (purple) and coloured coating 3 (sepia) 9. Black paint (finishing lines) *** see gilding table for details
Thickness	Metal leaf approximately 1-2µm; ground side A 85.56µm; ground side B 62.10µm; yellow glaze side B 7.59µm; silvered scroll both sides 239.78µm (digitally measured).
Preparatory drawing	Inferred (not seen) by the restricted application of the metal leaf and its almost perfect matching on both sides. Probably traced with the method of pouncing suggested by Kelly (Kelly, 1911).
Palette	Gold (translucent), black, red (translucent), sepia (translucent), red, dark red

Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); animal glue (size) (FTIR/SYPRO RUBY); yellow lake pigment (alum based), yellow ochre, artificial orpiment, barium sulphate, lead white, barium sulphate, calcium carbonate, aluminium leaf (SEM-EDX).
Appearance under UV light	The metal leaf has a dark purple colour in the uncoated areas, highlighting the absence of an overall coating. The three coloured coatings show an intense and distinctive fluorescence: the yellow-coloured coating has a bright-yellow fluorescence colour, which could be associated to the presence of the resin gamboge (Figures 31 and 32). The red coloured coating has a bright orange fluorescence colour, usually associated with shellac, but in some areas, it has a bright red hue, which could also be associated to the fluorescent response of madder lake (Figures 33 and 34). The sepia-coloured coating has a different fluorescence colour of a greenish hue, which could be associated to the presence of drying oil and/or terpenic resin as binding media (Figures 37 and 38). In some areas there seems to be another (uncoloured) coating, identified by its greenish fluorescence colour usually attributed to terpenic resins (Figures 35 and 36).

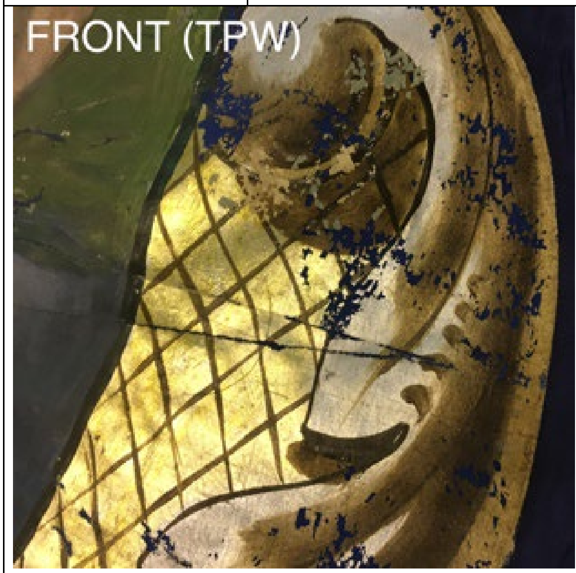


Figure 31. Metal Workers' detail of silvered frame under normal light

Figure 32. Metal Workers' detail of silvered frame under UV light

Figure 33. Metal Workers' detail of silvered decorations under normal light, side B

Figure 34. Metal Workers' detail of silvered decorations under UV light, side B

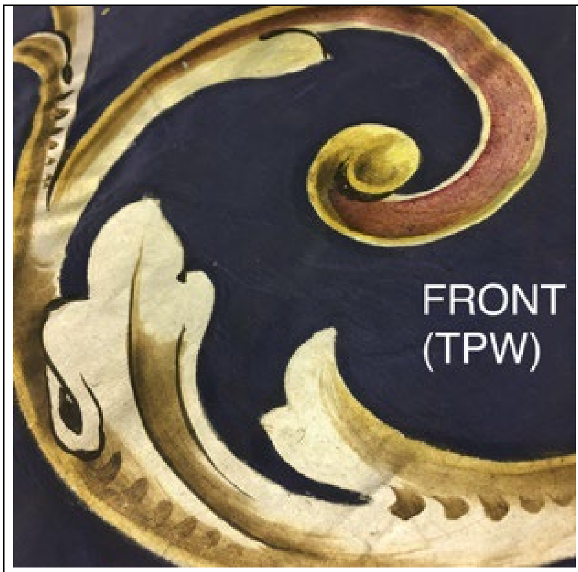


Figure 35. Metal Workers' detail of silvered decorations under normal light, side A

Figure 36. Metal Workers' detail of silvered decorations under UV light, side A

Figure 37. Metal Workers' detail of top scroll under normal light, side B

Figure 38. Metal Workers' detail of top scroll under UV light, side B

Structure	There is a darker outline suggesting impregnation of the textile of about 1 cm exceeding both scrolls (Figure 39), indicating the probable application of size for impeding the spread of the oily ground, as recommended by Gibson and Kelly (Gibson, 1870; Kelly, 1911). A thin layer of white ground is applied on top. For the peripheral decorations, this white layer seems to have been used as gold-size in itself to adhere the possibly aluminium leaf, as suggested by Kelly for silk banners (Kelly, 1911) (Figure 48). A thick layer of red paint is applied over the white ground on the scrolls (both bands and returns). It seems to have been used as gold-size to adhere the aluminium leaf to the returns, and possibly with translucent gold-size for the gilded letters as there was no evidence apart form a slightly darker colour of the red surface underneath (Figure 47). After the metal leaf was applied, the coloured coatings and black paint seem to have been added in the following order: golden, red, sepia and black paint (Figures 45 and 46).

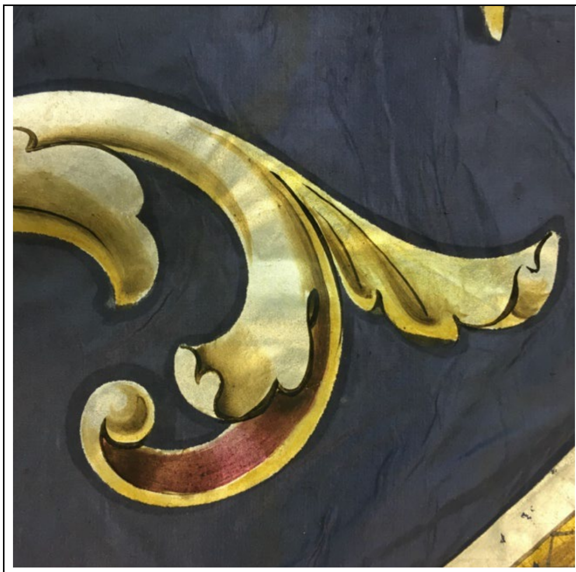


Figure 39.

Figure 40.

Condition	The silvering has a very contrasting condition, with some areas in a very good state (Figure 39) and others very unstable (Figures 41-44). Their craquelure pattern does not follow the weave of the textile as in the three George Kenning banners, breaking either tangentially or perpendicularly to the ribs. This possibly highlights an increased thickness of the metal leaf (aluminium). There are also many wrinkles caused by the application of the metal leaf. The loses on the upper third are mostly related to the formation of creases and splits on the textile. The major losses are located around the main frame and on both lower scrolls. In those sections the metal leaf detaches along with the white ground layer, leaving the exposed textile “clean” (Figure 48). The silvering shows cupping and tenting in the damaged areas, suggesting a direct humidity damage (Figures 43 and 44). All the other areas without evidence of either water or mechanical damages have a very firm attach to the potentially sized fabric. There is an imprinted texture of one of the loops’ weaves in the upper back decoration, indicating the side painted last and thus slightly fresh when the banner got rolled for delivery. Side B is also the side in worst condition.

Figure 41. Metal Workers’ unstable condition of the silvering around the frame

Figure 42. Metal Workers’ unstable condition of the silvering in the signed scroll

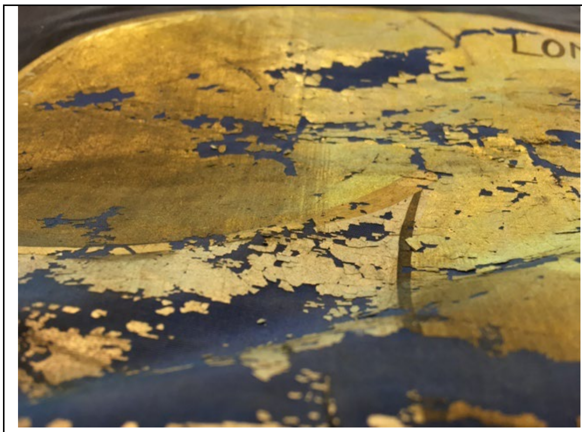


Figure 43. Metal Workers' raking light photography of the cupped flakes of paint in the area of the signature

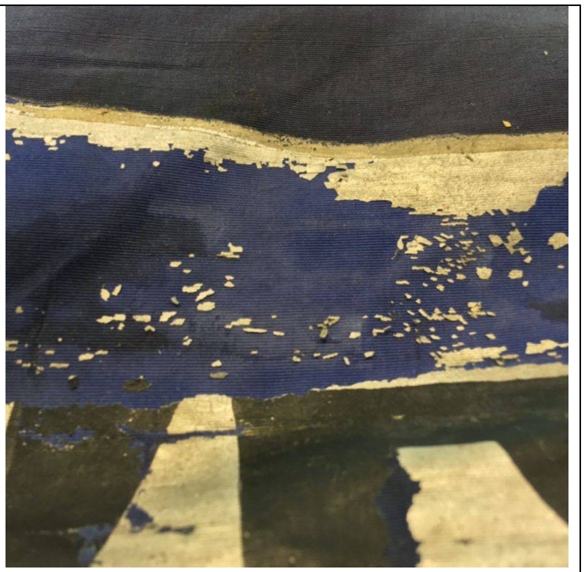


Figure 44. Metal Workers' raking light photography of the cupped flakes of paint in the top scroll

Figure 45. Metal Workers' DinoLite detail of sepia glaze applied over metal leaf (20x)

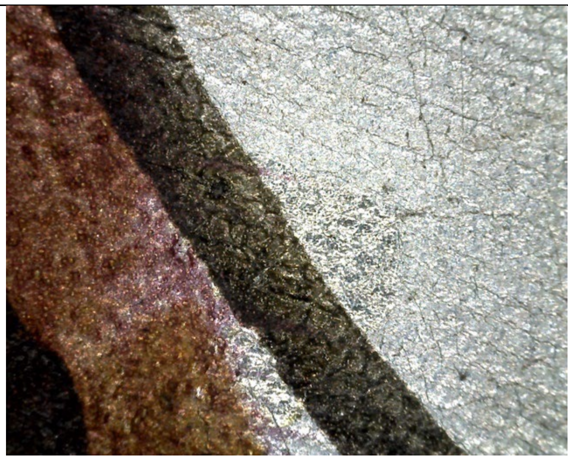


Figure 46. Metal Workers' DinoLite detail of red glaze applied over metal leaf and black lines on top (20x)

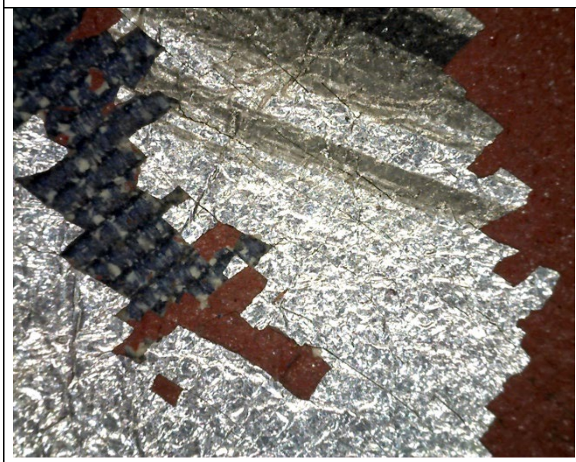


Figure 47. Metal Workers' DinoLite detail of sequence of application of silvering in top scrolls (20x)

Figure 48. Metal Workers' DinoLite detail of sequence of application in peripheral decoration (20x)

Gilding	
Description* *Gilding is identical on both sides	Upper scroll: Three-banded composite red scroll with gilded block capitals, separated by two bi-coloured slim returns and finished on both ends with a thick silvered return.
Layers on each side** **Numbered by order of application	1. Size layer (seen as an external outline impregnating about 6 mm of the textile, clearly seen on both sides) 2. White ground 3. Red paint 4. Possible gold-size layer (applied only under the lettering) 5. Possible gold leaf 6. Dark red paint
Thickness	Not measured.
Preparatory drawing	Inferred (not seen) by the restricted application of the metal leaf on the letters and the invasion of the shading colour (indicating the metal leaf was applied before the paint). Potentially traced with chalk lines, as recommended by several sources on sign painting (Callingham, 1863; Gibson, 1870; Gardiner, 1871; Scranton, 1899; Kelly, 1911).
Palette	Bright red, dark red, black
Materials	Partly heat-bodied linseed oil with traces of pine resin (GC/MS); lead white, barium sulphate and calcium carbonate (ground) (SEM-EDX); animal glue (size) (FTIR/SYPRO RUBY); rest not analysed.
Appearance under UV light	The potential gold leaf shows a dark purple colour, highlighting the absence of any type of coating (Figures 50 and 52). Sections of the scroll show a strong pink-orange fluorescence colour, which could be attributed to the pigment used (Figures 50 and 52). This indicate areas of repairs that are considered original, since the dark paint of the shadowing is seen on top of them (Figure 50, indicated with white arrows). Areas of the exposed white ground have a very strong pale-yellow fluorescence, regularly associated with the presence of lead white. Images of the same areas under mnormal light are included for comparison (Figures 49 and 51).

Figure 49. Metal Workers' area of the top scroll under normal light, side B (low quality image cropped from general photograph in absence of another image)

Figure 50. Metal Workers' area of the top scroll of side B under UV light (white arrows indicate the original repairs with darker fluorescence)

Figure 51. Metal Workers' area of the top scroll under normal light, side A (low quality image cropped from general photograph in absence of another image)

Figure 52. Metal Workers' area of the top scroll of side A under UV light

Structure	A thin layer of white ground was applied onto the possible size layer. A thick layer of red paint was applied on top of the white ground in the bands and returns of the scroll (Figure 47), but not on the fitomorphic decoration surrounding them (Figure 48). A layer of what appears to be translucent gold-size (unfortunately not identified) is seen applied only under the letters, following the design supposedly sketched with chalk. There is a white matt layer surrounding the golden letters on the front, which could be attributed to the whiting recommended to prevent the adhesion of metal leaf over freshly painted areas (Callingham, 1863). Alternatively, it could be bloom associated with the migration of metal soaps to the surface. The gold leaf is adhered to the possible gold-size layer and some corrections were made with red paint to their surroundings, seen under UV light as a darker fluorescence tone (Figure 50). The shading was lastly applied, as it is seen on top of the repairs/corrections,

	confirming they are original. For the silvered returns see silvering table.
Condition	The gilding has a firm attachment to the base layers and only has losses associated with folds and direct abrasions of the banner (Figure 49). It is not tarnished at all, suggesting that it is mostly gold. It shows long cracks, usually seen in thick layers of paint as a response to the movement of a textile support. The top layer of paint (red and burnt red shadings) has some areas of delamination, associated with folds and direct abrasions (Figure 54). There is some soiling on the surface. The white bloom seen on the red scroll of side A is not seen on side B (Figure 53), which could indicate that either the whiting was not applied on that side or there is no bloom happening.
 Figure 53. Metal Workers' top scroll of side b showing a lack of bloom or whiting on top of the red (white bits are glossy areas of paint)	 Figure 54. Detail of top scroll of side B showing the white appearance of the red possibly due to bloom formation (related to metal soaps migration)

Pole	
Description	Top hanging wooden pole, maroon stained and varnished, with one decorative brass end cap at each end. The brass ends have iron pins screwed at each side, both with wing nut fittings. These indicate the use of side poles, of which only one supposed original survived (see box table for details).
Dimensions	2940 x 60 mm
Inventory number	Same as banner
Materials* *Not analysed but inferred by their appearance	Pole: conifer wood (due to the pattern associated with the formation of tree rings) with possible shellac varnish End caps: brass Pins and fittings: cast-iron
Appearance under UV light	The varnish has a strong orange fluorescence colour, regularly associated with shellac (Figure 56).
Condition	The coating (varnish and maroon stain) has areas of abrasion exposing the wood. The pole is slightly bent towards the middle and is perforated by 11 tacks that fix the pole loops into position (Figure 55). Both end caps and fittings show a mild corrosion and rests of adhesive tape (Figures 57 and 58).

Figure 55. Metal Workers' top pole with measurements

Figure 56. Metal Workers' top pole under UV light

Figure 57. Metal Workers' right-side brass end cap of top pole

Figure 58. Metal Workers' pole right-side cast-iron fittings with wingnut

<table>
<tr><th colspan="3">Box</th></tr>
<tr><td>Description</td><td colspan="2">Narrow wooden box with lid, forged iron hinges and locks. It contains a set of two wooden side poles with jute braided cords; one side pole with iron screw in eye, leather strap and decorative wooden top; two sets of bi-coloured braided woollen cords (blue and yellow); a loose brass banner tag with the information of George Kenning & Son company (including their branches in London, Liverpool, Manchester, Glasgow & Coventry); a paper label of the National Union of Sheet Metal Workers & Coppersmiths; a cast iron crowbar; and a worn out fragment of blue herringbone ribbon, similar to the guides of the National Union of Vehicle Builders' banner. Just another Kenning box was located at the People's History Museum Manchester, having the same measurements and construction.</td></tr>
<tr><td>Contents</td><td colspan="2">Set of 2 side poles, 1 decorated side pole, 2 bi-coloured cords, 1 banner tag, 1 label, 1 crowbar and 1 fragment of herringbone ribbon.</td></tr>
<tr><td rowspan="5">Dimensions</td><td>Box: 3650 x 130 x 140 mm</td><td>Set of side poles: 2340 x 30 mm</td></tr>
<tr><td>Decorated side pole: 1740 x 30 mm</td><td>Bi-coloured cords: 9690 mm</td></tr>
<tr><td>Banner tag: 35 x 35 mm</td><td>Label: 120 x 100 mm</td></tr>
<tr><td>Crowbar: 150 x 25 mm</td><td rowspan="2">Herringbone weave ribbon: 30 x 89 mm</td></tr>
<tr><td>Leather harness: not measured</td></tr>
<tr><td>Inventory number</td><td colspan="2">Same as banner</td></tr>
<tr><td>Materials*

*Not analysed but inferred by their appearance</td><td colspan="2">*Box: conifer wood (due to the pattern associated with the formation of tree rings) with forged-iron hinges, iron locks, iron tacks and nails
*Set of side poles: conifer wood (due to the pattern associated with the formation of tree rings) , with possible terpenic resin varnish and jute cords
*Decorated side pole: conifer wood (due to the pattern associated with the formation of tree rings) with possible shellac varnish
*Bi-coloured cords: wool
*Banner tag: brass
*Label: paper and ink (non-polar)
*Crowbar: cast-iron
*Herringbone weave ribbon: cotton
*Leather harness with cup for carrying the side poles (Figure 65)</td></tr>
<tr><td>Appearance under UV light</td><td colspan="2">The varnish of the decorated side pole has a strong orange fluorescence colour, regularly associated with shellac. The varnish of the set of side poles has a greenish fluorescence colour, regularly associated with terpenic resins. There is evidence of a label (now missing) having been placed on one of the sides of the box, possibly containing the information of the banner maker and caring instructions, like the one included in a George Tutill's banner box (Clark, 2001). Unfortunately, neither this one nor the other located Kenning box at the People's History Museum Manchester, belonging to the Hither Green banner, have their original label and there are no other surviving Kenning labels nor boxes known to date.</td></tr>
<tr><td>Condition</td><td colspan="2">The box is in a very poor condition, severely soiled, with separated sections, partially broken and with missing fragments (Figures 59-62). All hinges, nails and locks are oxidised, with active iron corrosion products (red) (Figure 62). The remaining fragments of the lid are also distorted. The contents in the box are in varied conditions: the crowbar is in good condition (Figure 67), without signs of corrosion. The label has some stains related to humidity and the</td></tr>
</table>

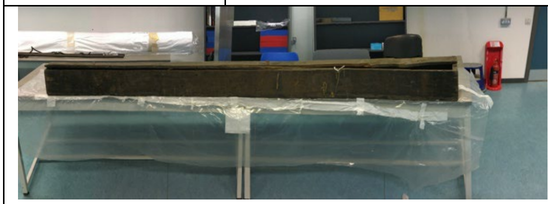
	associated growth of microorganisms (Figure 60). The fragment of herringbone ribbon is very friable (almost powdery in sections) and has fraying in one of the edges. Both cords (woollen and jute) have ingrained soiling and some fraying associated to use (Figures 64 and 68). All the wooden poles show evidence of direct abrasion due to usage, revealing the unvarnished wood (Figure 63). The banner tag has signs of active copper corrosion (green) and ingrained soiling (Figure 66).
 Figure 59. Metal Workers' banner box, general view	 Figure 60. Metal Workers' banner box inside with trade union label
 Figure 61. Metal Workers' banner box-lid, showing the separation between boards	 Figure 62. Metal Workers' forged hinges showing active corrosion (red)
 Figure 63. Metal Workers' banner top of side pole showing abraded areas and unvarnished wood	 Figure 64. Metal Workers' side pole with possible jute cords attached.

Figure 65. Metal Workers' leather harness detail

Figure 66. Metal Worker's banner tag separated in pieces

Figure 67. Cast-iron crowbar found inside the box

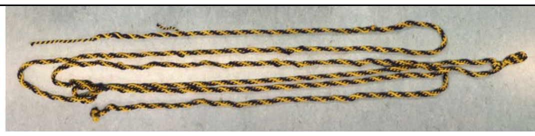


Figure 68. Metal Workers' braided guide-cords

9.2 Appendix II. Sampling protocols

9.2.1 II.1 The Glasgow Typographical Society banner

Table II.1 Sampling protocol of *The Glasgow Typographical Society* banner			
Inventory	PP.1973.14.1	Sample code	TS
Dimensions	2,410 mm (H)/2,250 mm (W)		
Dates of sampling	18th March, 19th March 2019		
Responsible of sampling	Daniel Sanchez Villavicencio, Christina Young (XRF), Margaret Smith (XRF)		
Location diagram (Side A)			

Table II.1 (continued) Sampling protocol of *The Glasgow Typographical Society* banner

Location diagram (Side B)

Y

(0, 0 mm) X

Relation of samples

Number	Name	Location (X mm, Y mm)	Side	Type
TS01	Fabric warp 3rd strip	(1165, 1130)	**A**	Fibre (large)
TS02	Fabric weft 3rd strip	(938, 1150)	**A**	Fibre
TS03	Sewing thread 2nd seam left	(315, 1182)	**A**	Fibre
TS04	12th loop weft	Not located	**B**	Fibre (large)
TS05	12th loop warp	Not located	**B**	Fibre
TS06	Fringe red outer coating	(1455, 60)	**A**	Fibre
TS07	Fringe white inner part	(1455, 0)	**A**	Fibre

Table II.1 (continued) Sampling protocol of *The Glasgow Typographical Society* banner

Relation of samples				
Number	Name	Location (X mm, Y mm)	Side	Type
TS08*	Lower scroll right end roll	Not located	**A B**	Full cross-section
TS10	Green leaf lower right garland	(1414, 323)	**B**	Paint + XRF
TS11	Pink rose lower right garland	(1782, 500)	**B**	Paint +XRF
TS18	Flesh tone right man	(1540, 1212)	**B**	Paint +XRF
TS19	Beige background left centre	(590, 1212)	**B**	Paint (large) + XRF
TS20	Red banding bottom scroll	(395, 410)	**B**	Paint + XRF
TS21	Brown line lower frame	(1355, 380)	**B**	Paint +XRF
TS22	Golden coating top scroll	(1215, 2640)	**B**	Paint + XRF
TS23	Golden metal leaf lower frame	(1230, 420)	**B**	Paint
TS24	Brown leaf lower left garland	(756, 530)	**B**	Paint
TS25	Faded fringe outer coating	(845, 0)	**A**	Fibre
TS26	Faded fringe inner part	(845, 0)	**A**	Fibre
TS27	Loose black paint & metal leaf	Not located	**B**	Paint
TS30	Light red of left man cape	(970, 1212)	**B**	Paint + XRF
TS31	Light yellow of left man toga	(1060, 1212)	**B**	Paint + XRF
TS32	Light magenta of right man	(1515, 1212)	**B**	Paint + XRF
TS33	Dark magenta of right man	(1623, 1212)	**B**	Paint + XRF
TS34	Light blue of right man cape	(1473, 1340)	**B**	Paint + XRF
TS35	Dark blue of right man cape	(2608, 1212)	**B**	Paint + XRF
TS36	Dark red of left man cape	(985, 1212)	**B**	Paint + XRF
TS37	Olive green leaf lower right	(1925, 665)	**A**	Paint + XRF
TS38	Upper scene right man cheek	(1460, 1360)	**A**	Paint + XRF
**TS40	Beige background/red cape	Not located	**A B**	Full cross-section

Table II.1 (continued) Sampling protocol of *The Glasgow Typographical Society* banner

Comments:

*TS08 was taken from side A, showing a smooth appearance and a jagged white contour from the spreading of the white ground. Side B has the metal leaf applied up to the edge and a tarnished appearance. These differences will allow the distinction between sides during the microscopic inspection.

**TS40 was taken from beige background of side A with red cape of character of side B.

Skips on numeration between TS11 and TS18 are due to a different sequence on the portable XRF (see Relation of XRF points).

Skips on numeration between TS24 and TS27 are due to the labelling of an unexpected loose sample.

Skips on numeration between TS27 and TS30 are due to a new start of the sampling sequence.

Fabric (large) = 10 mm length for extraction needed for LC dye analysis

Paint (large) = 2 x 2 mm, for extraction and derivatisation needed for GC-MS binding media analysis.

TOTAL NUMBER OF SAMPLES - 30

Relation of XRF points				
Number	Name	Location (X mm, Y mm)	Side	Sample relation
TSXRF_1	Background measurement (table)	Not located	n/a	*97
TSXRF_2	Background measurement (table)	Not located	n/a	*98
TSXRF_3	Background measurement (table)	Not located	n/a	*99
TSXRF10	Green leaf lower right garland	(1414, 323)	**B**	TS10 / *96
TSRXF11	Pink rose lower right garland	(1782, 500)	**B**	TS11 / 100*
TSXRF12	Black lettering from 7 in 1817	Not located	**B**	*101
TSXRF13	Tarnishing next to 7 in 1817	Not located	**B**	*102
TSXRF14	Red banding next to 7 in 1817	Not located	**B**	*103
TSXRF15	Silk background over 7 in 1817	Not located	**B**	*104
TSXRF16	Brown line scroll next to 1817	Not located	**B**	*105
TSXRF17	Tarnishing next to brown line	Not located	**B**	*106
TSXRF20	Red banding bottom scroll	(395, 410)	**B**	TS20 / *107
TSXRF21	Brown line lower frame	(1355, 380)	**B**	TS21 / *109
TSXRF22	Golden coating top scroll	(1215, 2640)	**B**	TS22 / *108, 110

Table II.1 (continued) Sampling protocol of *The Glasgow Typographical Society* banner

Relation of XRF points				
TSXRF30	Light red of left man cape	(970, 1212)	**B**	TS30 / *111
TSXRF31	Light yellow of left man toga	(1060, 1212)	**B**	TS31 / *112
TSXRF32	Light magenta of right man	(1515, 1212)	**B**	TS32 / *114
TSXRF33	Dark magenta of right man	(1623, 1212)	**B**	TS33 / *115
TSXRF34	Light blue of right man cape	(1473, 1340)	**B**	TS34 /*116
TSXRF35	Dark blue of right man cape	(2608, 1212)	**B**	TS35 / *117
TSXRF36	Dark red of left man cape	(985,1212)	**B**	TS36 /*113
TSXRF40	Flesh tone right man	(1540, 1212)	**B**	TS18 /*120
TSRXF41	Beige background left centre	(590, 1212)	**B**	TS19 /*121
TSXRF42	Supposed purple retouching	Not located	**B**	*122
TSXRF43	Grey scrollwork right side	Not located	**A**	*123
TSXRF44	Red banding on full cross-section area	Not located	**A**	TS08 / *124
TSXRF45	Olive green leaf lower right	(1925, 665)	**A**	TS37 / *125
TSXRF46	Upper scene right man cheek	(1460, 1360)	**A**	TS38 / *126

Comments:

Skips on numeration between TSXRF17 and TSXRF20 are due to a new start of the sampling sequence.

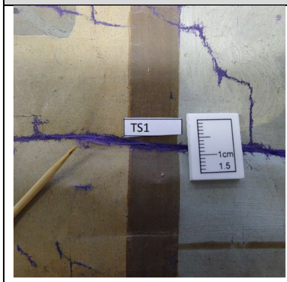
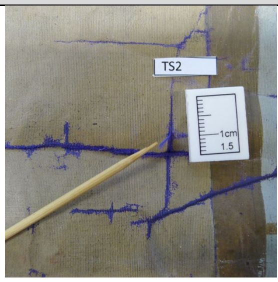
Skips on numeration between TSXRF22 and TSXRF30 are due to a new start of the sampling sequence.

Skips on numeration between TSXRF35 and TSXRF40 are due to a new start of the sampling sequence.

* Indicates spectrum number as recorded on the XRF device and labelled in the graphs.

Black textboxes in diagrams are only for XRF points without corresponding sample. The remaining points coincide with the samples in white textboxes (see sample relation column).

TOTAL NUMBER OF POINTS - 29

<table>
<tr><td colspan="4">Table II.1 (continued) Sampling protocol of The Glasgow Typographical Society banner</td></tr>
<tr><th colspan="4">Photographic record of samples' location</th></tr>
<tr>
<td>Sample TS01</td>
<td>Sample TS02</td>
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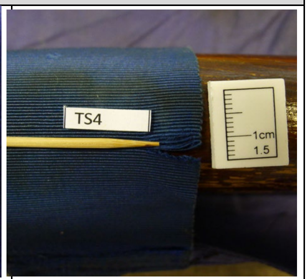
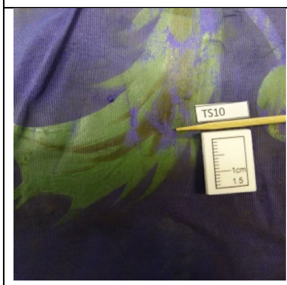
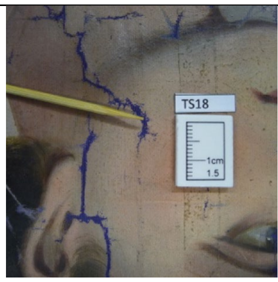
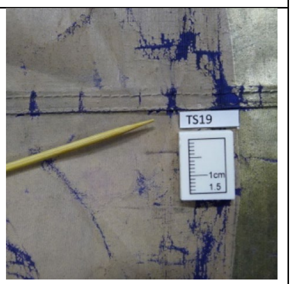
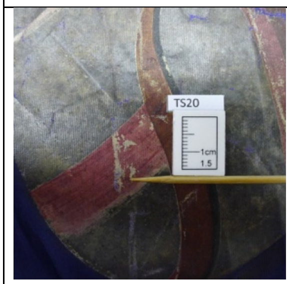
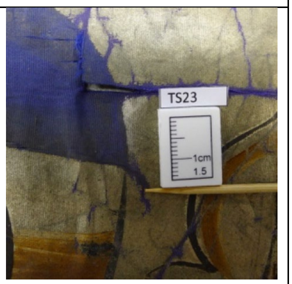
<td>Sample TS04</td>
</tr>
<tr>
<td>Sample TS05</td>
<td>Sample TS06</td>
<td>Sample TS07</td>
<td>Sample TS08</td>
</tr>
<tr>
<td>Sample TS10</td>
<td>Sample TS11</td>
<td>Sample TS18</td>
<td>Sample TS19</td>
</tr>
<tr>
<td>Sample TS20</td>
<td>Sample TS21</td>
<td>Sample TS22</td>
<td>Sample TS23</td>
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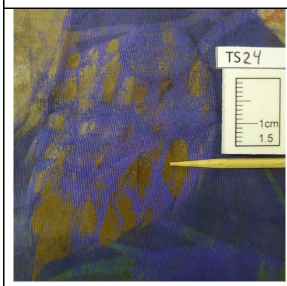
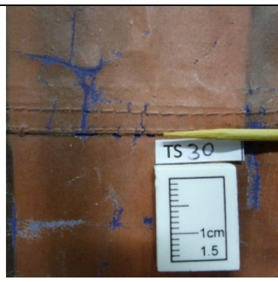
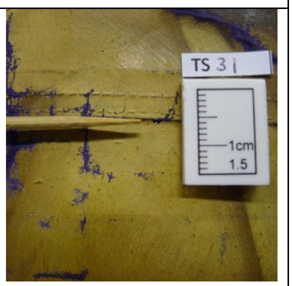
<td>Sample TS24</td>
<td>Samples TS25 and TS26</td>
<td>Sample TS30</td>
<td>Sample TS31</td>
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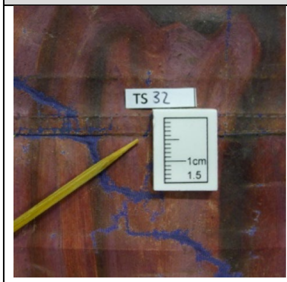
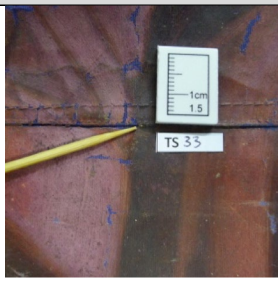
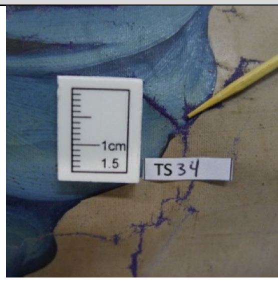
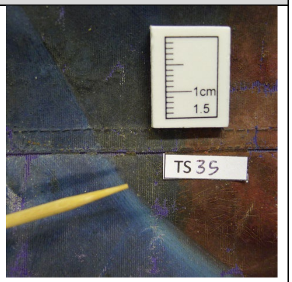
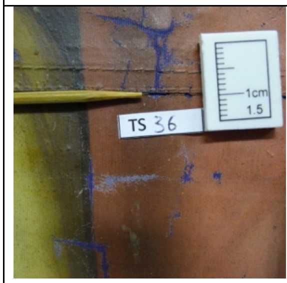
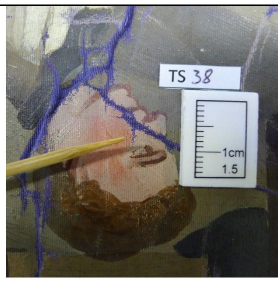
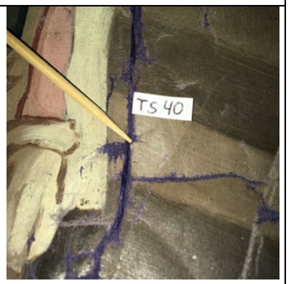
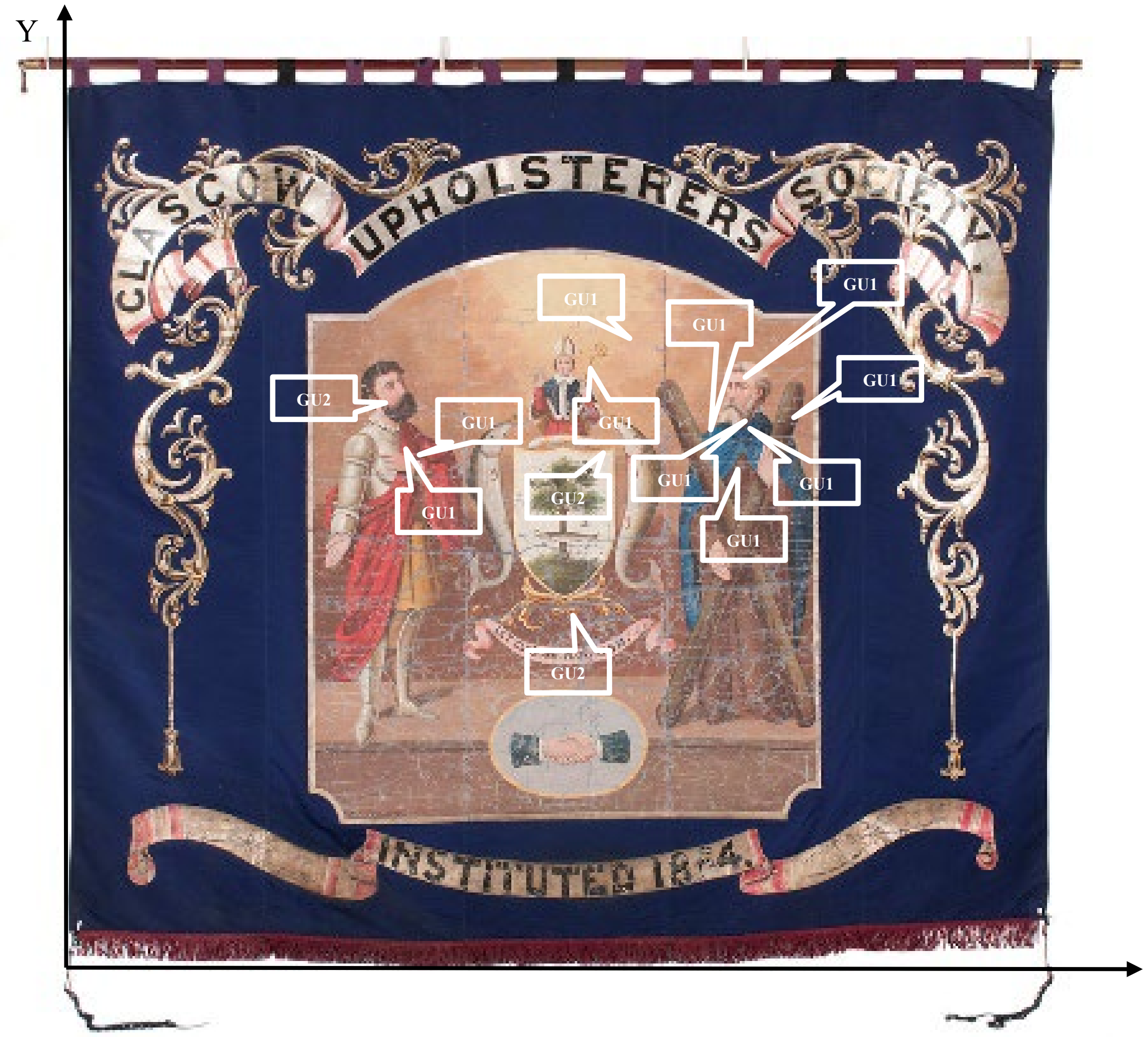
Table II.1 (continued) Sampling protocol of *The Glasgow Typographical Society* banner			
Photographic record of samples' location			
 Sample TS32	 Sample TS33	 Sample TS34	 Sample TS35
 Sample TS36	 Sample TS37	 Sample TS38	 Sample TS40

9.2.2 II.2 The Glasgow Upholsterers Society banner

Table II.2 Sampling protocol of *The Glasgow Upholsterers Society* banner			
Inventory	PP.1973.4.1	Sample code	GU
Dimensions	2,620 mm (H)/2,914 mm (W)		
Dates of sampling	21st March, 25th March 2019.		
Responsible of sampling	Daniel Sanchez Villavicencio		
Location diagram (Side A)			



(0, 0 mm) X

Table II.2 (continued) Sampling protocol of *The Glasgow Upholsterers Society* banner

Location diagram (Side B)

(0, 0 mm) X

Relation of samples

Number	Name	Location (X mm, Y mm)	Side	Type
GU01	Fabric warp from 4th strip	(2215, 710)	**B**	Fibre (large)
GU02	Fabric weft from 4th strip	(955, 1130)	**B**	Fibre
GU03	Sewing thread seam 2nd strip	(378, 440)	**B**	Fibre
GU04	15th loop warp	(2850, 2620)	**B**	Fibre
GU05	15th loop weft	(2850, 2620)	**B**	Fibre
GU06	Fringe red outer coating	(2875, 30)	**B**	Fibre (large)
GU07	Fringe grey inner part	(2875, 0)	**B**	Fibre

Table II.2 (continued) Sampling protocol of *The Glasgow Upholsterers Society* banner

Relation of samples				
Number	Name	Location (X mm, Y mm)	Side	Type
GU08*	Edge of lower scroll under AND	(1900, 275)	**A B**	Full cross-section
GU09	Pale blue sky next to 2nd seam	(1163, 1855)	**A B**	Full cross-section
GU10	St Paul's cape light red	(1020, 1550)	**A**	Paint
GU11	St Paul's cape dark red	(1070, 1520)	**A**	Paint
GU12	St Mungo's ochre stick	(1576, 1730)	**A**	Paint
GU13	St Andrew's grey beard	(2000, 1890)	**A**	Paint
GU14	St Andrew's cape light blue	(1935, 1550)	**A**	Paint
GU15	St Andrew's cape dark blue	(2030, 1891)	**A**	Paint
GU16	St Andrew's gown light brown	(1990, 1735)	**A**	Paint
GU17	St Andrew's cross dark brown	(2170, 1950)	**A**	Paint
GU18	St Andrew's pale flesh tone	(2015, 1965)	**A**	Paint
GU19	Pale yellow background	(1640, 2064)	**A**	Paint
GU20	Golden leaf from upper right scutcheon	(1575, 1520)	**A**	Paint
GU21	Brown coating from bottom mantle	(1510, 1070)	**A**	Paint
GU22	Purple curtain left side	(774, 1382)	**B**	Paint
GU23	Green grass next to 2nd seam	(1170, 925)	**B**	Paint
GU24	Red banding bottom scroll left	(890, 225)	**B**	Paint
GU25	Yellow coating on left pendant	(220, 1086)	**B**	Paint
GU26	Golden coating upper scroll 1st seam	(570, 2260)	**B**	Paint
GU27	Loose black paint & metal leaf	Not located	**A**	Paint
GU28	St Paul's red flesh tone	(960, 1660)	**A**	Paint
GU29	Purple paint upper left curtain	Not located	**B**	Paint (large)

Table II.2 (continued) Sampling protocol of *The Glasgow Upholsterers Society* banner

Relation of samples

Comments:

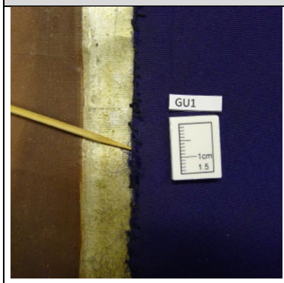
*GU08 was taken from side B, having a smoothest golden coloured side than side A. Side A was slightly tarnished. The differences will allow the distinction between sides during the microscopic inspection.

Fabric (large) = 10 mm length for extraction needed for LC dye analysis

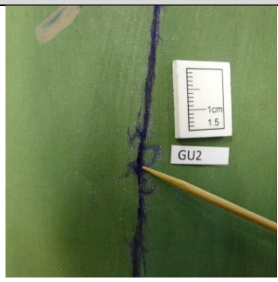
Paint (large) = 2 x 2 mm, for extraction and derivatisation for GC-MS binding media analysis.

TOTAL NUMBER OF SAMPLES - 29

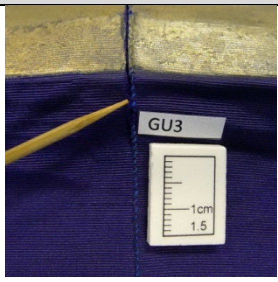
Photographic record of samples' location



Sample GU01



Sample GU02



Sample GU03

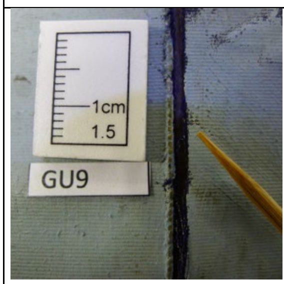
Sample GU04

Sample GU05

Sample GU06

Sample GU07

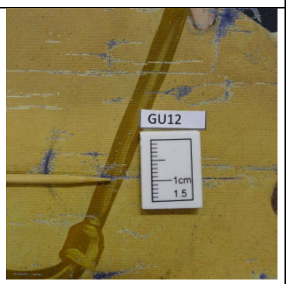
Sample GU08



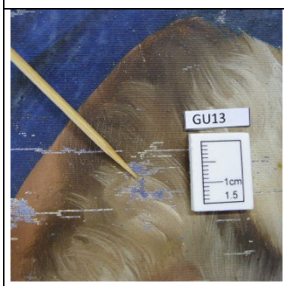
Sample GU09

Sample GU10

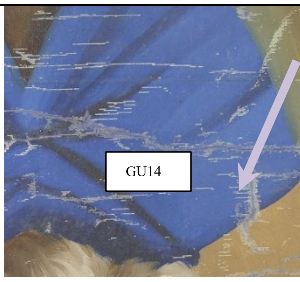
Sample GU11



Sample GU12

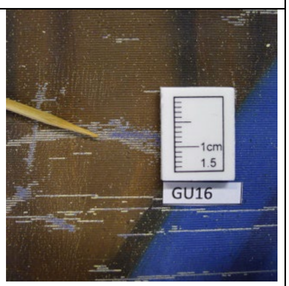


Sample GU13



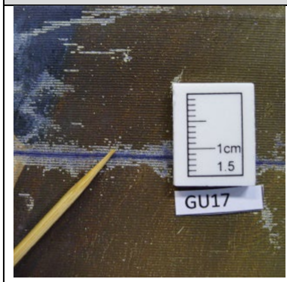
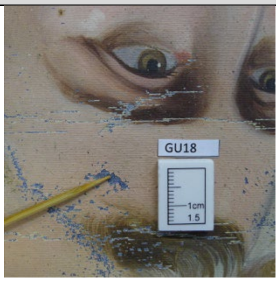
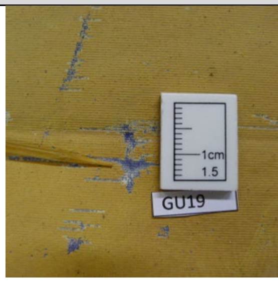
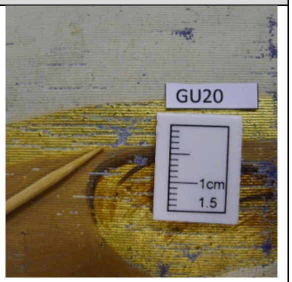
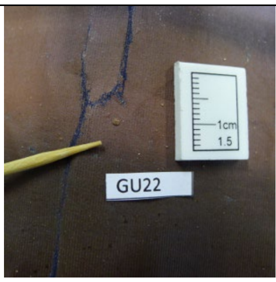
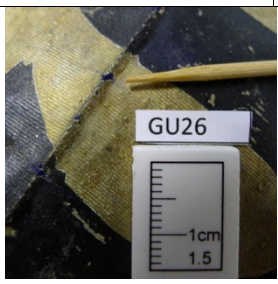
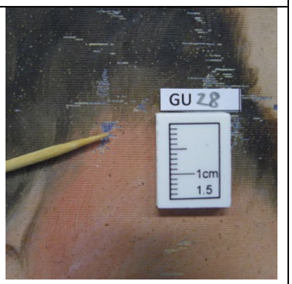
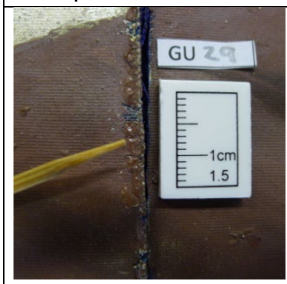
Sample GU14

Sample GU15



Sample GU16

Table II.2 (continued) Sampling protocol of *The Glasgow Upholsterers Society* banner

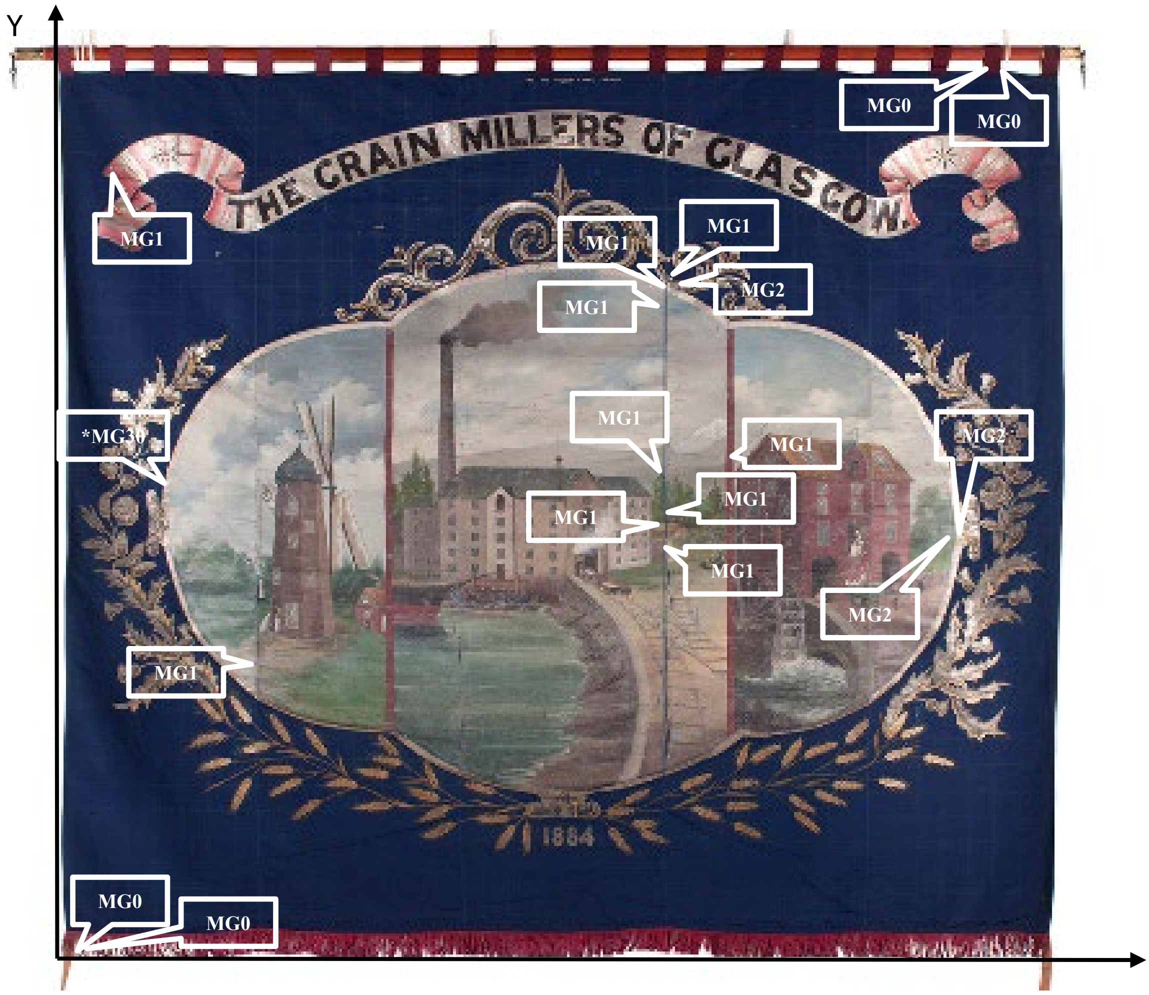
Photographic record of samples' location			
 Sample GU17	 Sample GU18	 Sample GU19	 Sample GU20
 Sample GU21	 Sample GU22	 Sample GU23	 Sample GU24
 Sample GU25	 Sample GU26	NOT LOCATED Sample GU27	 Sample GU28
 Sample GU29			

9.2.3 II.3 The Grain Millers of Glasgow banner

Table II.3 Sampling protocol of *The Grain Millers of Glasgow* banner			
Inventory	PP.1988.43.1	Sample code	MG
Dimensions	2,650 mm (H)/2,870 mm (W)		
Dates of sampling	27th March, 28th March 2019.		
Responsible of sampling	Daniel Sanchez Villavicencio		
Location diagram (Side A)			
			
(0, 0 mm)		X	

Table II.3 (continued) Sampling protocol of *The Grain Millers of Glasgow* banner

Location diagram (Side B)



(0, 0 mm) X

Relation of samples

Number	Name	Location (X mm, Y mm)	Side	Type
MG01*	Fabric warp from MG22	Not located	**B**	Fibre
MG02*	Fabric weft from MG22	Not located	n/a	Fibre
MG03	Sewing thread left hemmed edge	(2870, 2550)	**A**	Fibre
MG04	18th loop warp	(180, 2590)	**B**	Fibre
MG05	18th loop weft	(180, 2590)	**B**	Fibre (large)
MG06	Fringe red outer coating	(85, 10)	**B**	Fibre (large)
MG07	Fringe white inner part	(85, 0)	**B**	Fibre

Table II.3 (continued) Sampling protocol of *The Grain Millers of Glasgow* banner

Relation of samples				
Number	Name	Location (X mm, Y mm)	Side	Type
MG08	Right guide tape	(20, 0)	**A**	Fibre (large)
MG10	Windmill soil next to 1st seam	(570, 855)	**A B**	Full cross-section
MG11	2nd red line upper part	(1950, 1520)	**B**	Paint
MG12	Foliage green next to 3rd seam	(1750, 1380)	**B**	Paint
MG13	Yellow foliage next to 3rd seam	(1750, 1260)	**B**	Paint
MG14	Hut roof ochre next to 3rd seam	(1750, 1280)	**B**	Paint
MG15	Beige building next to 3rd seam	(1750, 1230)	**B**	Paint (large)
MG16	Blue sky next to 3rd seam	(1750, 1910)	**B**	Paint
MG17	Red banding upper scroll left	(150, 2320)	**B**	Paint
MG18	Yellow coating on scrollwork 3rd seam	(1749, 1960)	**B**	Paint
MG19	Golden coating frame next 3rd seam	(1750, 1950)	**B**	Paint
MG20	Black paint and metal leaf	(1751, 1965)	**B**	Paint
MG21	Pink scroll	(1165, 1845)	**A**	Paint (large)
MG22	Detached fabric 5th strip hemmed edge	(2870, 2550)	**A**	Fibre (large)
MG23	Tape inside 5th strip hemmed edge	(2870, 2550)	**A**	Fibre (large)
MG24	Orange base under roller mill	(1165, 780)	**A**	Paint
MG25	Light yellow right millstone	(2350, 1090)	**A**	Paint
MG26	Added red layer under the ground	Not located	**A B**	Full cross-section
MG27	Bloom over green paint	Not located	**B**	Paint
MG28	Added brown layer over ground (gold-size)	Not located	**A**	Paint
MG29**	Added brown layer over ground, other area	Not located	**B**	Micrograph
MG30**	Added red layer under the ground, other area	Not located	**B**	Micrograph

Table II.3 (continued) Sampling protocol of *The Grain Millers of Glasgow* banner

Comments:

*MG01 and MG02 were extracted from sample MG22, thus their location coincides with the latter.

Fabric (large) = 10 mm length for extraction needed for LC dye analysis

Sample MG09 was not taken at the end, hence the skip in numeration.

Sample MG10 was taken from side B (green-yellow colour). Opposite side A is pale blue background.

Sample MG26 was taken from side B showing the unusual red layer underneath the silver leaf. Opposite side A had no evidence of an added red layer.

Paint (large) = 2 x 2 mm, for extraction and derivatisation for GC-MS binding media analysis.

Since the banner is between a nylon net (part of a previous conservation treatment not performed at Glasgow Museums), sampling was restricted to the areas opened by textile conservator Helen Hughes, located along the seam of the net and through two purposely made cuts. All opened areas were patched and re-stitched by the conservator after sampling, using a similarly blue-dyed nylon net and polyester thread.

** indicates areas only registered with the DinoLite for comparison, not samples taken.

TOTAL NUMBER OF SAMPLES - 25

Photographic record of samples' location

Sample MG03

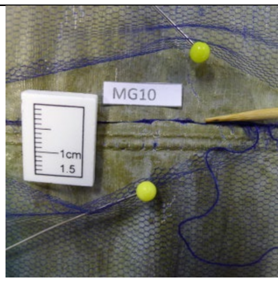
Sample MG04

Sample MG05

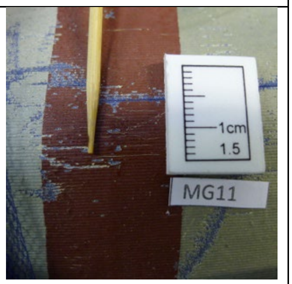
Sample MG06

Sample MG07

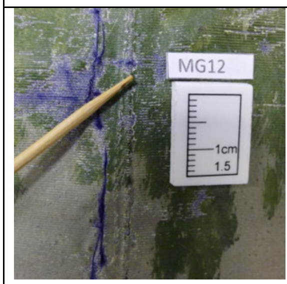
Sample MG08



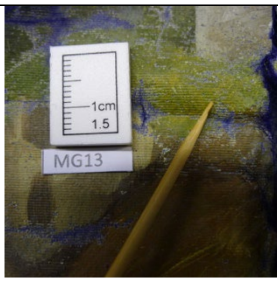
Sample MG10



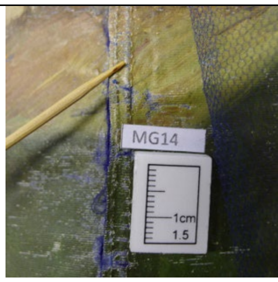
Sample MG11



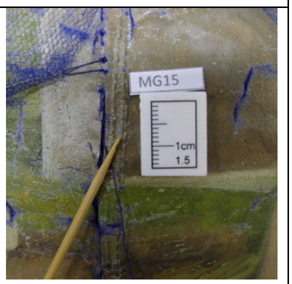
Sample MG12



Sample MG13

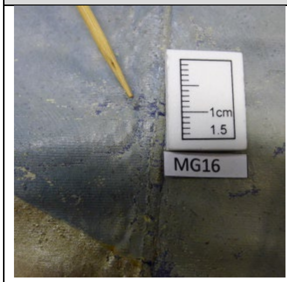
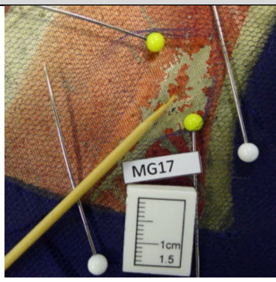
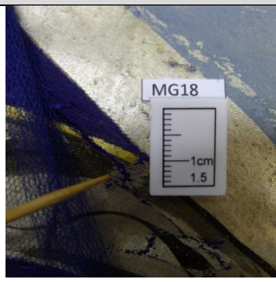
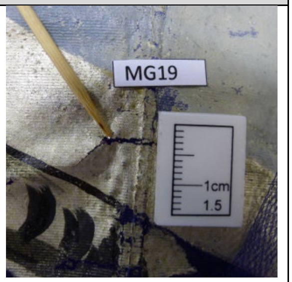
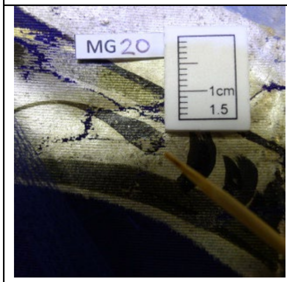
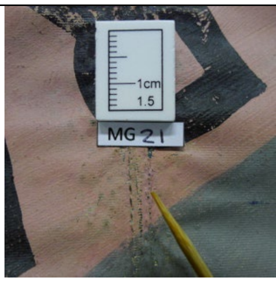
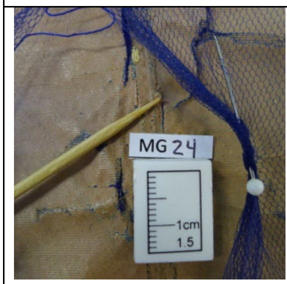
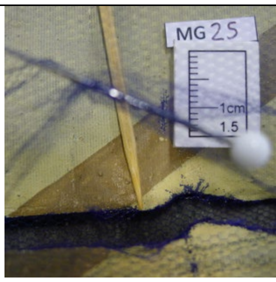
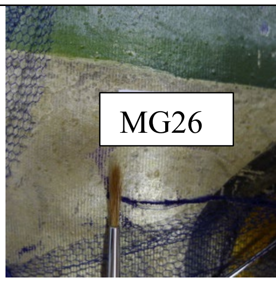
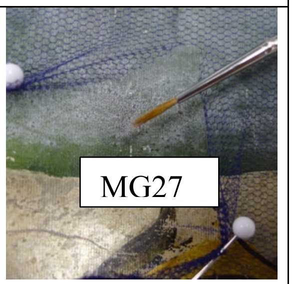
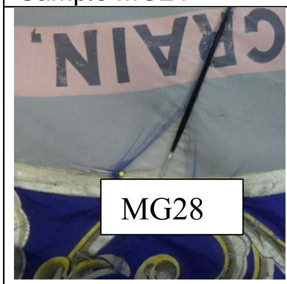


Sample MG14



Sample MG15

Table II.3 (continued) Sampling protocol of *The Grain Millers of Glasgow* banner

Photographic record of samples' location			
 Sample MG16	 Sample MG17	 Sample MG18	 Sample MG19
 Sample MG20	 Sample MG21	 Sample MG22	 Sample MG23
 Sample MG24	 Sample MG25	 Sample MG26	 Sample MG27
 Sample MG28			

9.2.4 II.4 The National Union of Vehicle Builders, Glasgow Branch

Table II.4 Sampling protocol of *The National Union of Vehicle Builders, Glasgow Branch* banner			
Inventory	PP.1973.16	Sample code	VB
Dimensions	2,710 mm (H)/2,610 mm (W)		
Dates of sampling	23rd April, 24th April 2019.		
Responsible of sampling	Daniel Sanchez Villavicencio		
Location diagram (Side A)			
 (0, 0 mm) X			

Table II.4 (continued) Sampling protocol of *The National Union of Vehicle Builders, Glasgow Branch* banner

Location diagram (Side B)

(0, 0 mm) X

Relation of samples

Number	Name	Location (X mm, Y mm)	Side	Type
VB01	Fabric warp 4th strip	(605, 485)	**A**	Fibre (large)
VB02	Fabric weft 4th strip	(590, 485)	**A**	Fibre
VB03	Sewing thread 3rd seam	(2525, 742)	**A**	Fibre
VB04	12th loop warp	(2485, 2610)	**A**	Fibre
VB05	12th loop weft	(2485, 2610)	**A**	Fibre
VB06	Yellow fringe	(225, 25)	**A**	Fibre (large)
VB07	Blue fringe	(1640, 30)	**A**	Fibre (large)
VB08	Right side guide tape warp	Not located	**A**	Fibre

Table II.4 (continued) Sampling protocol of *The National Union of Vehicle Builders, Glasgow Branch* banner

Relation of samples				
Number	Name	Location (X mm, Y mm)	Side	Type
VB09*	Red of upper scroll right	(2602, 2551)	**A B**	Full cross-section
VB10*	Lower-right scroll green paint	(1895, 360)	**A B**	Full cross-section
VB11*	Lower scroll metal leaf	(940, 485)	**A B**	Full cross-section
VB12*	Central painting red car	(1792, 2566)	**A B**	Full cross-section
VB13	Lower-right scene tramcar yellow	(2574, 720)	**A**	Paint
VB14*	Golden coating lower-right scene	(2584, 850)	**A**	Full cross-section
VB15	Gold leaf letter S of BUILDERS	(2593, 2659)	**A**	Paint
VB16	Emerald green from coach	(2577, 2618)	**A**	Paint
VB17	Cream colour tire	(2534, 940)	**A**	Paint
VB18	Gold of left scutcheon	(1374, 2644)	**A**	Paint
VB19	Upper-left scroll ochre	(203, 2220)	**B**	Paint
VB20	Middle scroll yellow	(915, 1960)	**B**	Paint
VB21	Light blue coach	(925, 1350)	**B**	Paint
VB22	Dark blue coach	(1280, 1160)	**B**	Paint
VB23	Red coach wheel	(1755, 1125)	**B**	Paint
VB24	Brown right horse	(1495, 2651)	**B**	Paint
VB25	Purple dress lower left scene	(379, 720)	**B**	Paint
VB26	Gold leaf of original wording	(2250, 2120)	**B**	Paint
VB27	Purple coating berry	(335, 1135)	**B**	Paint
VB28	Flesh tone clasped hands	(315, 1710)	**B**	Paint
VB29	Coat of arms blue	(1434, 2050)	**B**	Paint
VB30	Beige background	(1445, 730)	**B**	Paint (large)
VB31	Right side guide tape weft	Not located	**A**	Fibre

Table II.4 (continued) Sampling protocol of *The National Union of Vehicle Builders, Glasgow Branch* banner

Relation of samples				
Number	Name	Location (X mm, Y mm)	Side	Type
VB32	Yellow of car headlight	(2535, 2564)	**A**	Paint
VB33	Overlapped gildings in O of NATIO	(486, 2125)	**B**	Paint

Comments:

*VB09 sample was taken from and abraded surface on side A. Side B has a smoother and redder appearance. The differences will allow their distinction during its microscopic inspection.

*VB10 sample was taken from side A, showing an abraded surface of white and some green paint. Side B shows less paint layers. The differences will allow their distinction during its microscopic inspection.

*VB11 sample was taken from side A, thus having black paint. Side B has only metal leaf. The differences will allow their distinction during its microscopic inspection.

*VB12 sample was taken from side A, thus having the red of the car. Side B has the beige of the background. The differences will allow their distinction during its microscopic inspection.

*VB14 sample was taken from side A, having a smooth golden surface. Side B is further abraded. The differences will allow their distinction during its microscopic inspection.

Fabric (large) = 10 mm length for extraction needed for LC dye analysis

Paint (large) = 2 x 2 mm, for extraction and derivatisation needed for GC-MS binding media analysis.

TOTAL NUMBER OF SAMPLES - 33

Photographic record of samples' location

Sample VB01

Sample VB02

Sample VB03

Sample VB04

Sample VB05

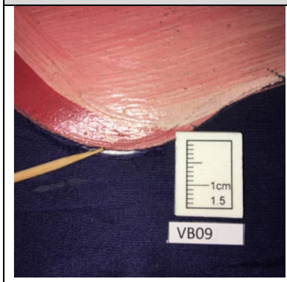
Sample VB06

Sample VB07

Sample VB08

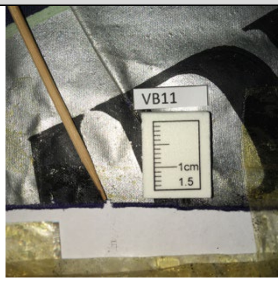
Table II.4 (continued) Sampling protocol of *The National Union of Vehicle Builders, Glasgow Branch* banner

Photographic record of samples' location

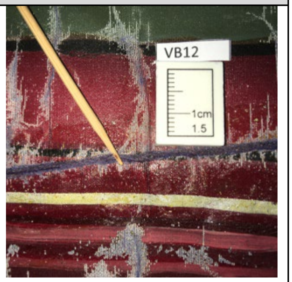


Sample VB09

Sample VB10

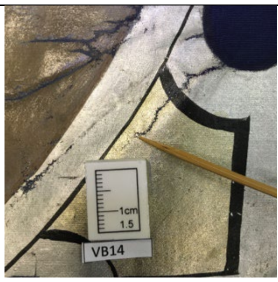


Sample VB11



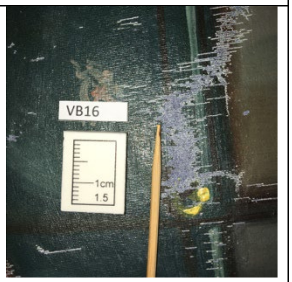
Sample VB12

Sample VB13



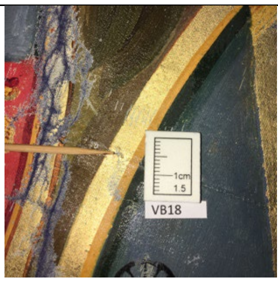
Sample VB14

Sample VB15

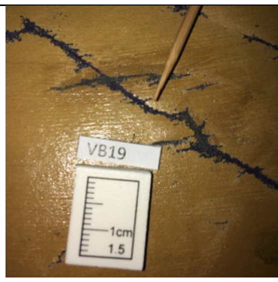


Sample VB16

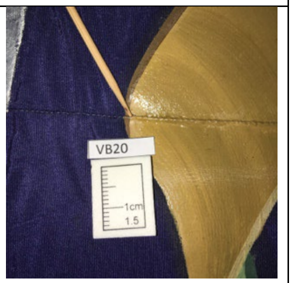
Sample VB17



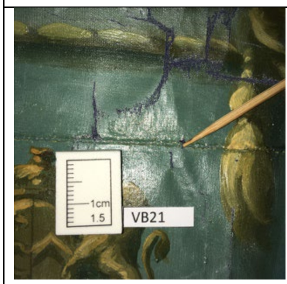
Sample VB18



Sample VB19

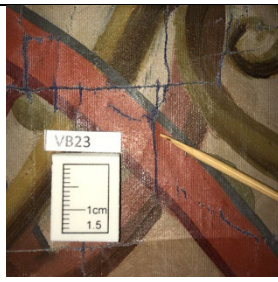


Sample VB20



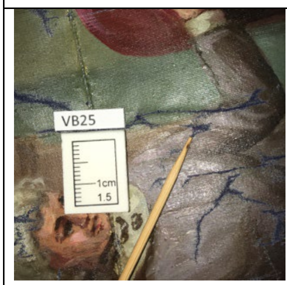
Sample VB21

Sample VB22



Sample VB23

Sample VB24



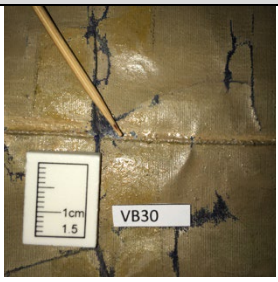
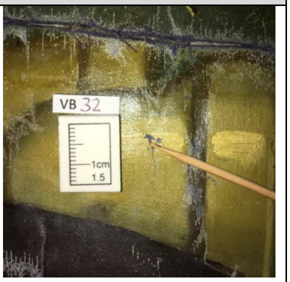
Sample VB25

Sample VB26

Sample VB27

Sample VB28

Table II.4 (continued) Sampling protocol of *The National Union of Vehicle Builders, Glasgow Branch* banner

Photographic record of samples' location			
 Sample VB29	 Sample VB30	 Sample VB31	 Sample VB32
 Sample VB33			

9.2.5 II.5 The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner

Table II.5 Sampling protocol of *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* banner			
Inventory	PP. 1981. 11 [1]	Sample code	SM
Dimensions	2,400 mm (H)/2,660 mm (W)		
Dates of sampling	25th April 2019.		
Responsible of sampling	Daniel Sanchez Villavicencio		
Location diagram (Side A)			

(0, 0 mm) X

Table II.5 (continued) Sampling protocol of *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* banner

Location diagram (Side B)

(0, 0 mm) X

Relation of samples

Number	Name	Location (X mm, Y mm)	Side	Type
SM01	Fabric warp	(320, 95)	**B**	Fibre (large)
SM02	Fabric weft	(320, 95)	**B**	Fibre
SM03	Sewing thread left hemmed edge	(5, 1985)	**B**	Fibre
SM04	8th Loop warp	(1820, 2400)	**B**	Fibre
SM05	8th Loop weft	(1820, 2400)	**B**	Fibre (large)
SM06	Right side guide tape	Not located	**B**	Fibre
SM07	Pale yellow of dress	(1675, 950)	**A**	Paint
SM10	Magenta of oil lamp	(335, 1400)	**A**	Paint

Table II.5 (continued) Sampling protocol of *The Scottish Tin Plate Braziers and Sheet Metal Workers' Society* banner

Relation of samples				
Number	Name	Location (X mm, Y mm)	Side	Type
SM11	Bright green of right mountain	(1930, 970)	**A**	Paint
SM12	Orange ship flag	(1830, 946)	**A**	Paint
SM13	Pink of the belt	(1470, 1150)	**A**	Paint
SM14	Brass colour of right lamp	(2365, 1570)	**A**	Paint
SM15	Green of bathtub	(258, 1345)	**B**	Paint
SM16*	Blue from window	(1692, 1398)	**A B**	Full cross-section
SM17	Flesh tone	(1090, 665)	**B**	Paint
SM18	Brown gas meter	(340, 938)	**B**	Paint
SM19	Ochre background	(1482, 385)	**B**	Paint
SM20	White from back bathtub	(412, 1388)	**B**	Paint
SM21*	Lower scroll metal leaf	(1361, 265)	**A B**	Full cross-section
SM22*	Red top scroll right side	(2478, 1738)	**A B**	Full cross-section
SM23	Frame golden grid decoration	(1970, 940)	**A**	Paint
SM24	Yellow coating of volute	(2630, 1600)	**B**	Paint
SM25	Magenta coating of volute	(734, 1470)	**B**	Paint
SM26	Sepia coating of volute	(2641, 1455)	**B**	Paint
SM27	Gold lettering of top scroll	(1400, 1840)	**B**	Paint
SM28	Red outline of top scroll	(927, 1650)	**B**	Paint (large)
SM29	Red coating around gold letters	(1855, 1980)	**B**	Paint
SM30	Yellow background upper-left scene	(287, 1500)	**B**	Paint
SM31	White impasto central scene	(1346, 345)	**B**	Paint (large)
SM32**	Golden coating top scrollwork	(1140, 1940)	**B**	Paint (large)

Table II.5 (continued) Sampling protocol of The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner

Comments:

Samples 8 and 9 were not taken at the end, hence the skip in numeration.

*SM16 sample was taken from side B, thus it has a deep blue paint layer. Side A has a lighter blue paint layer. The differences will allow their distinction during its microscopic inspection.

*SM21 sample was taken from side B, thus it has a yellow coating. Side A has an uncoated metal leaf. The differences will allow their distinction during its microscopic inspection.

*SM22 sample was taken from side B. Although both sides are red, side A is paler due to the presence of bloom and it appears more abraded in the sample. The differences will allow their distinction during its microscopic inspection.

Fabric (large) = 10 mm length for extraction needed for LC dye analysis

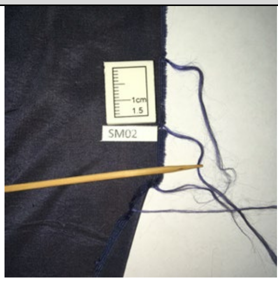
Paint (large) = 2 x 2 mm, for extraction and derivatisation needed for GC-MS binding media analysis.

**SM32 sample was not planned to be large. It delaminated suddenly from the red paint of the scroll, showing a white laser underneath that could correspond with white gold-size (to be confirmed with technical analysis).

TOTAL NUMBER OF SAMPLES - 30

Photographic record of samples' location


Sample SM01

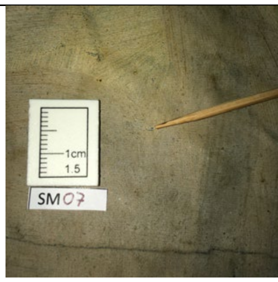

Sample SM02

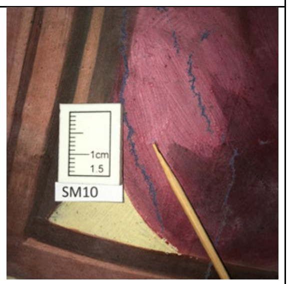
Sample SM03

Sample SM04

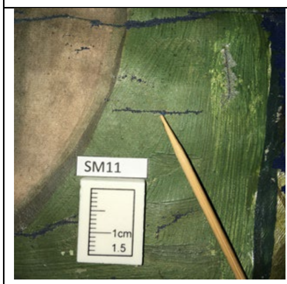
Sample SM05


Sample SM06

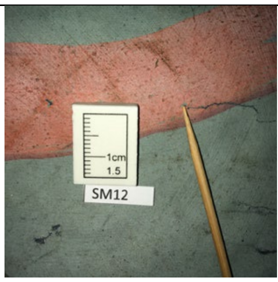

Sample SM07



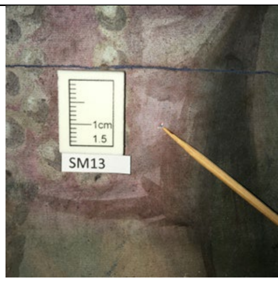
Sample SM10



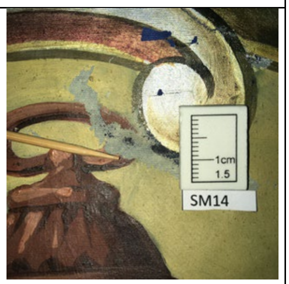
Sample SM11



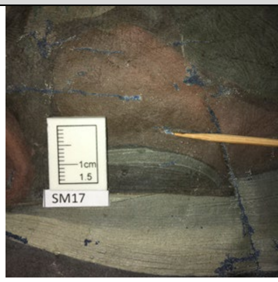
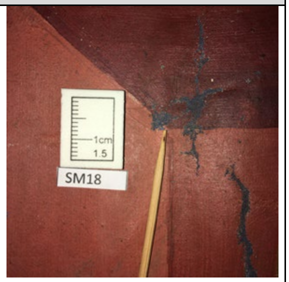
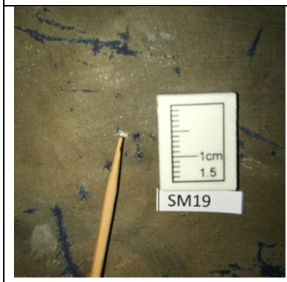
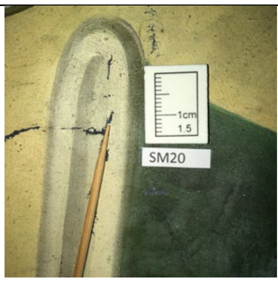
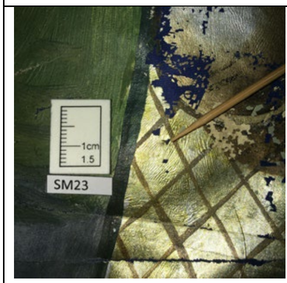
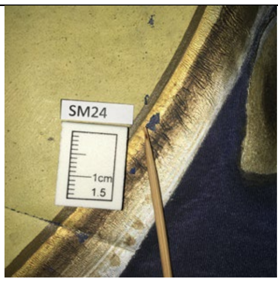
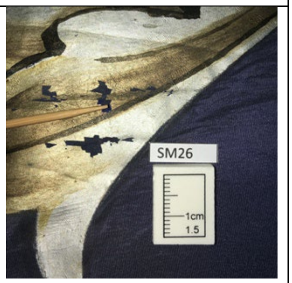
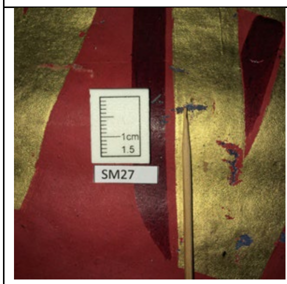
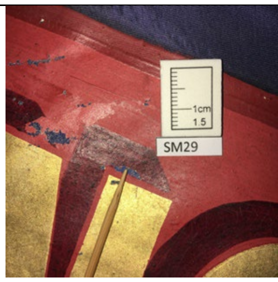
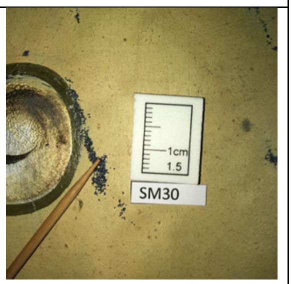
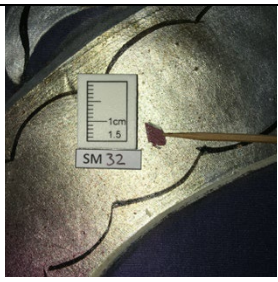
Sample SM12



Sample SM13



Sample SM14

Table II.5 (continued) Sampling protocol of The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner			
Photographic record of samples' location			
 Sample SM15	 Sample SM16	 Sample SM17	 Sample SM18
 Sample SM19	 Sample SM20	 Sample SM21	 Sample SM22
 Sample SM23	 Sample SM24	 Sample SM25	 Sample SM26
 Sample SM27	 Sample SM28	 Sample SM29	 Sample SM30
 Sample SM31	 Sample SM32		

9.3 Appendix III. Analytical results

9.3.1 III.1 FTIR-ATR

9.3.1.1 III.1.1 Lists of standards

9.3.1.1.1 III.1.1.1 Organic materials

Table III.1 Organic standards used for comparison in FTIR-ATR analysis

Material	Code name	Depository	Responsible
Silk faille (undyed and unbleached) Broadwick Silks, London	Soho warp	CTCTAH	Daniel Sanchez Villavicencio
Rabbit skin glue J. Cornelissen & Son, London	Rabbit skin glue std	TAHMD	Dr Margaret Smith
Stand linseed oil Winsor & Newton, London	Mid amber colour	TAHMD	Dr Margaret Smith
Mastic resin A. F. Sutter & Co, London	MASTIC_RESIN	CTCTAH	Daniel Sanchez Villavicencio
Rosin resin A. F. Sutter & Co, London	ROSIN_RESIN	CTCTAH	Daniel Sanchez Villavicencio

TAHMD (Technical Art History Material Database) and CTCTAH (Centre for Textile Conservation and Technical Art History), University of Glasgow.

All materials were analysed using a Perkin Elmer Spectrum 1 FTIR Spectrometer with Spectrum software version 5.0.1 fitted with a Universal ATR Sampling Accessory and a diamond/thallium-bromoiodide (C/KRS-5) with sampling depth of up to 2 µm. Spectra were recorded over the range 4000-400 cm-1, with a resolution of 4 cm-1 and averaged over 32 scans; a nominal pressure of 30N was applied to the sample by the ATR anvil.

9.3.1.1.2 III.1.1.2 Inorganic materials

Table III.2 Inorganic standards used for comparison in FTIR-ATR analysis

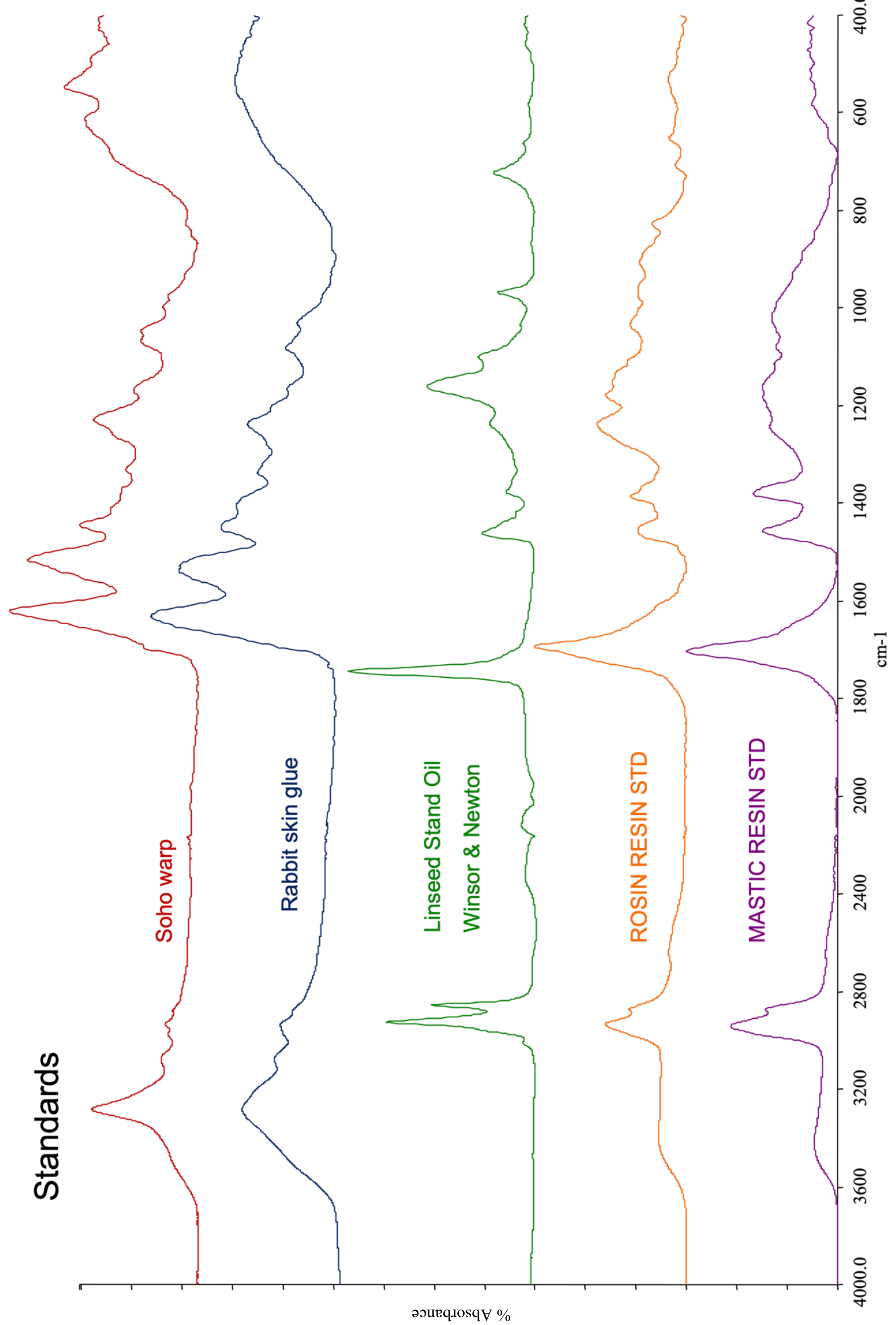
Material	Code name	Depository	Responsible
Lead white pigment L. Cornelissen & Son, London	Lead White Std.spc	TAHMD	Dr Margaret Smith
Calcium carbonate Sigma-Aldrich	Calcium carbonate	TAHMD	Dr Margaret Smith
Gypsum Sigma-Aldrich	Calcium sulphate slaked	TAHMD	Dr Margaret Smith
Barium sulphate Sigma-Aldrich	Barium sulphate Perkin Elmer Std	TAHMD	Dr Margaret Smith

TAHMD (Technical Art History Material Database) and CTCTAH (Centre for Textile Conservation and Technical Art History), University of Glasgow.

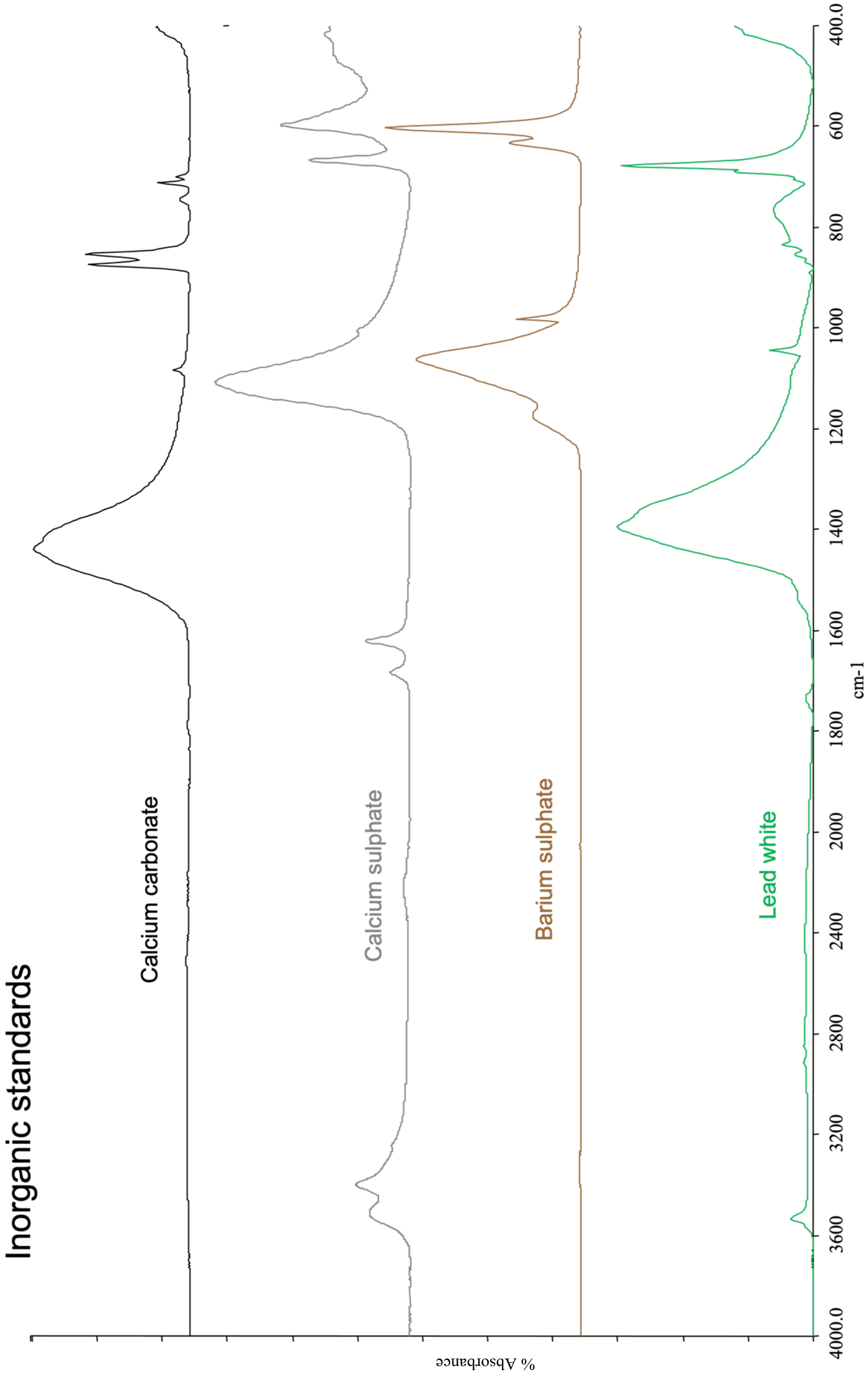
All materials were analised using a Perkin Elmer Spectrum 1 FTIR Spectrometer with Spectrum software version 5.0.1 fitted with a Universal ATR Sampling Accessory and a diamond/thallium-bromoiodide (C/KRS-5) with sampling depth of up to 2 µm. Spectra were recorded over the range 4000-400 cm-1, with a resolution of 4 cm-1 and averaged over 32 scans; a nominal pressure of 30N was applied to the sample by the ATR anvil.

9.3.1.2 III.1.2 Standards reference spectra

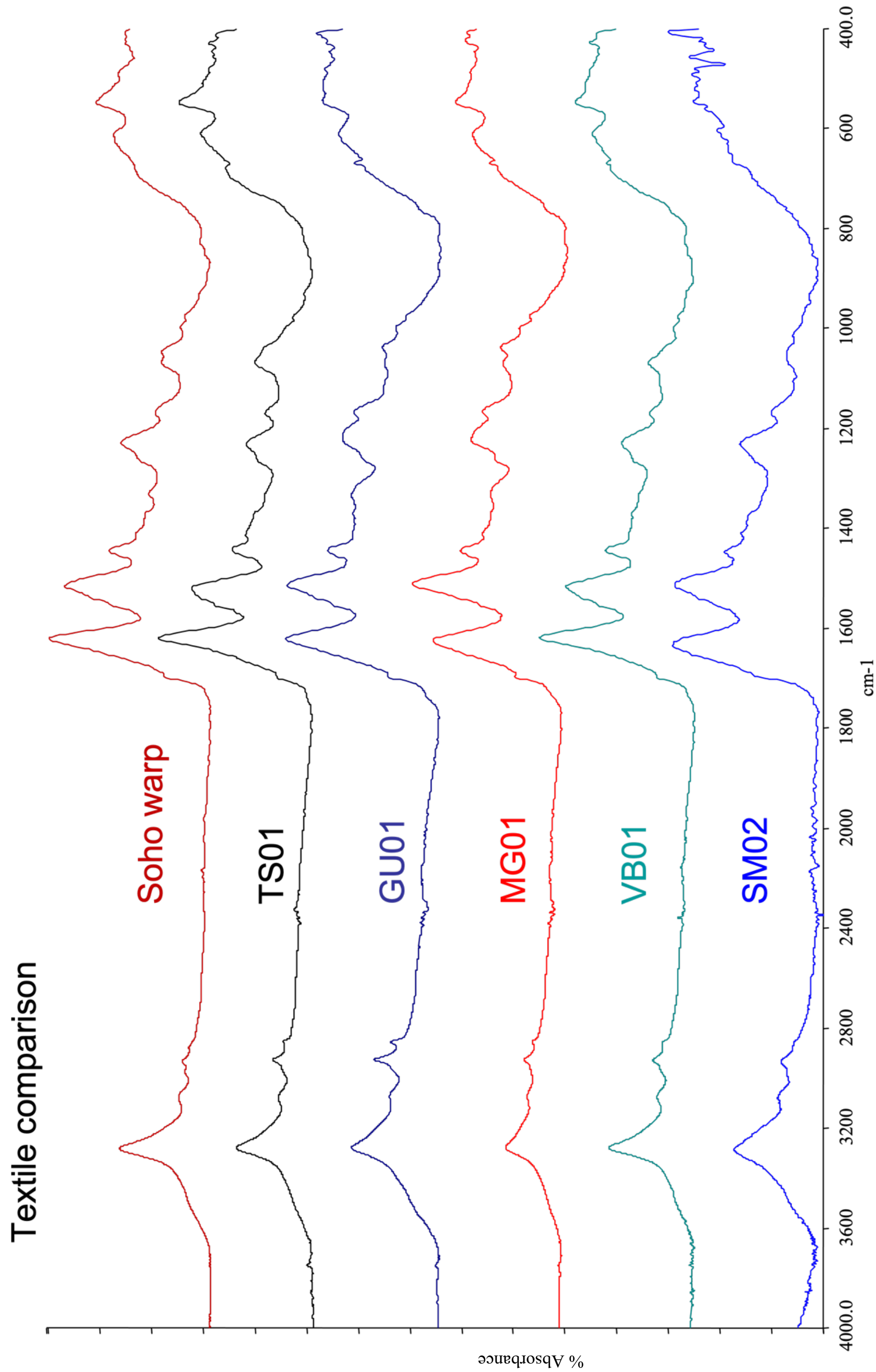
9.3.1.2.1 III.1.2.1 Organic materials



9.3.1.2.2 III.1.2.2 Inorganic materials

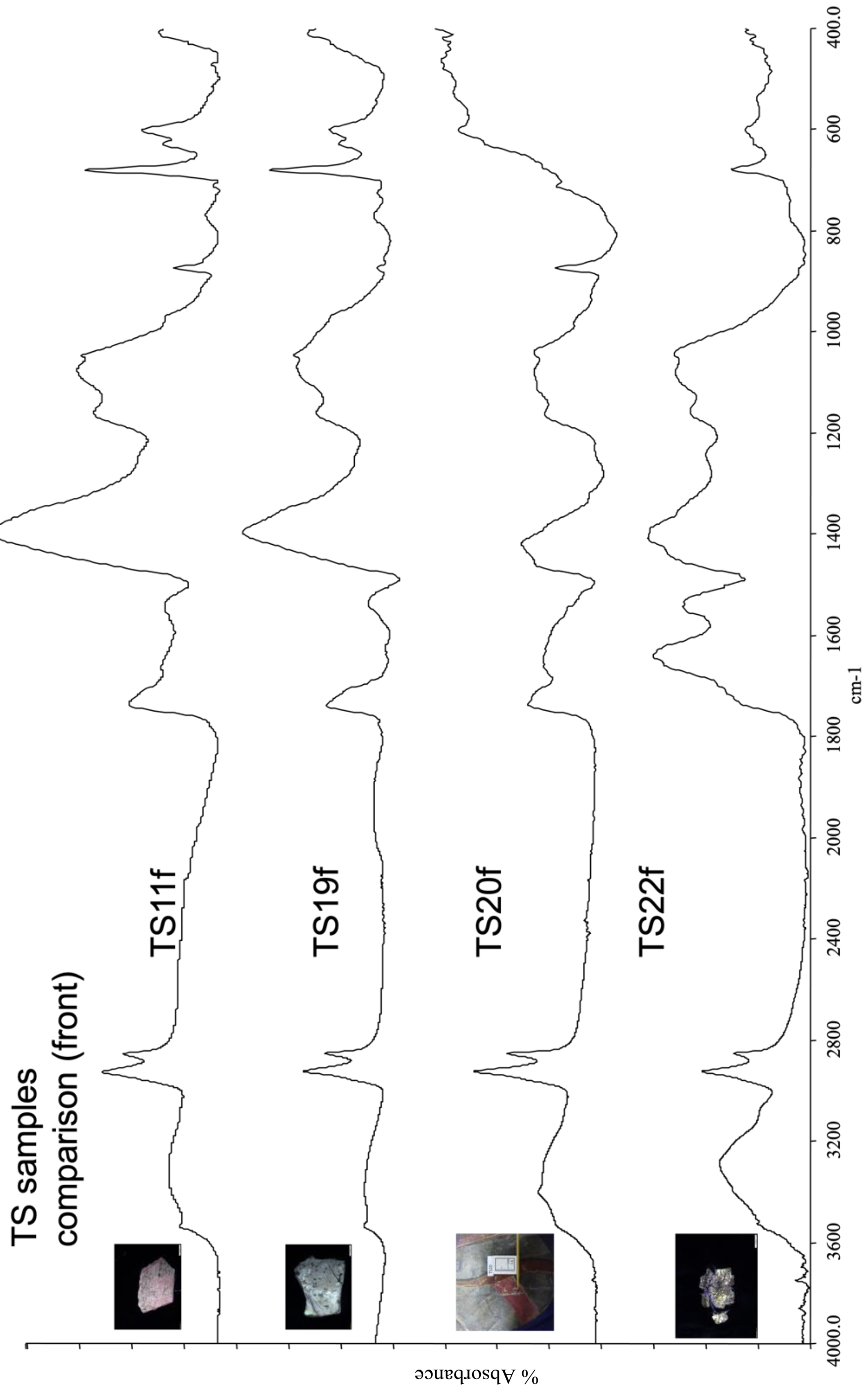


9.3.1.3 III.1.3 Kenning's banners textile samples FTIR spectra



Identification of silk on the five Kenning banners of Glasgow Museums Collection and the reconstruction textile

9.3.1.4 III.1.4 The Glasgow Typographical Society banner FTIR spectra



TS11f - Calcium carbonate, Lead white, Barium sulphate, Linseed oil

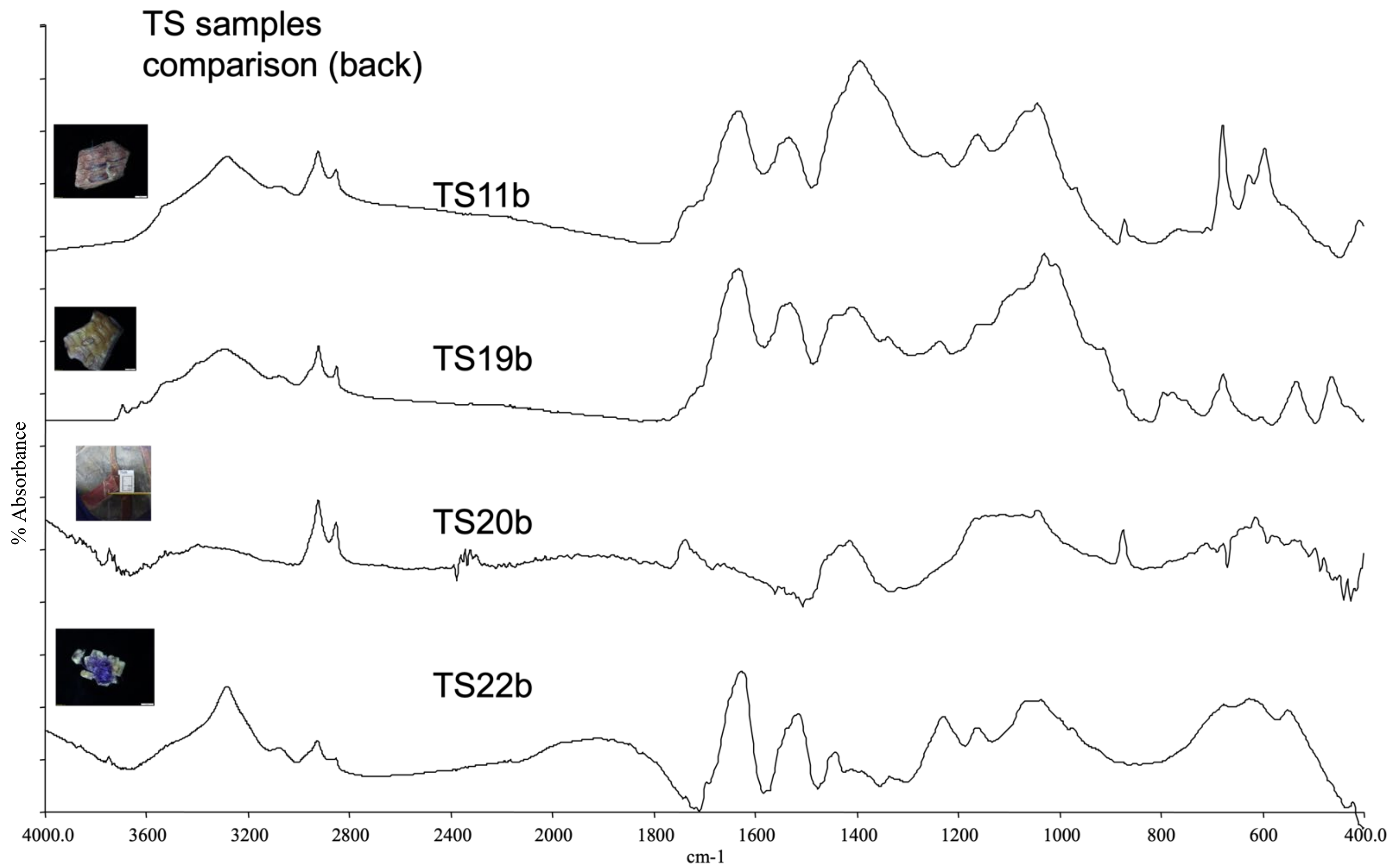
TS19f - Calcium carbonate, Lead white, Barium sulphate, Linseed oil

TS20f - Calcium carbonate, Lead white, Linseed oil

TS22f - Lead white, Linseed oil, Rabbit skin glue

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.



TS11b - Calcium carbonate, Lead white, Barium sulphate, Linseed oil, Rabbit skin glue

TS19b - Lead white, Linseed oil, Rabbit skin glue

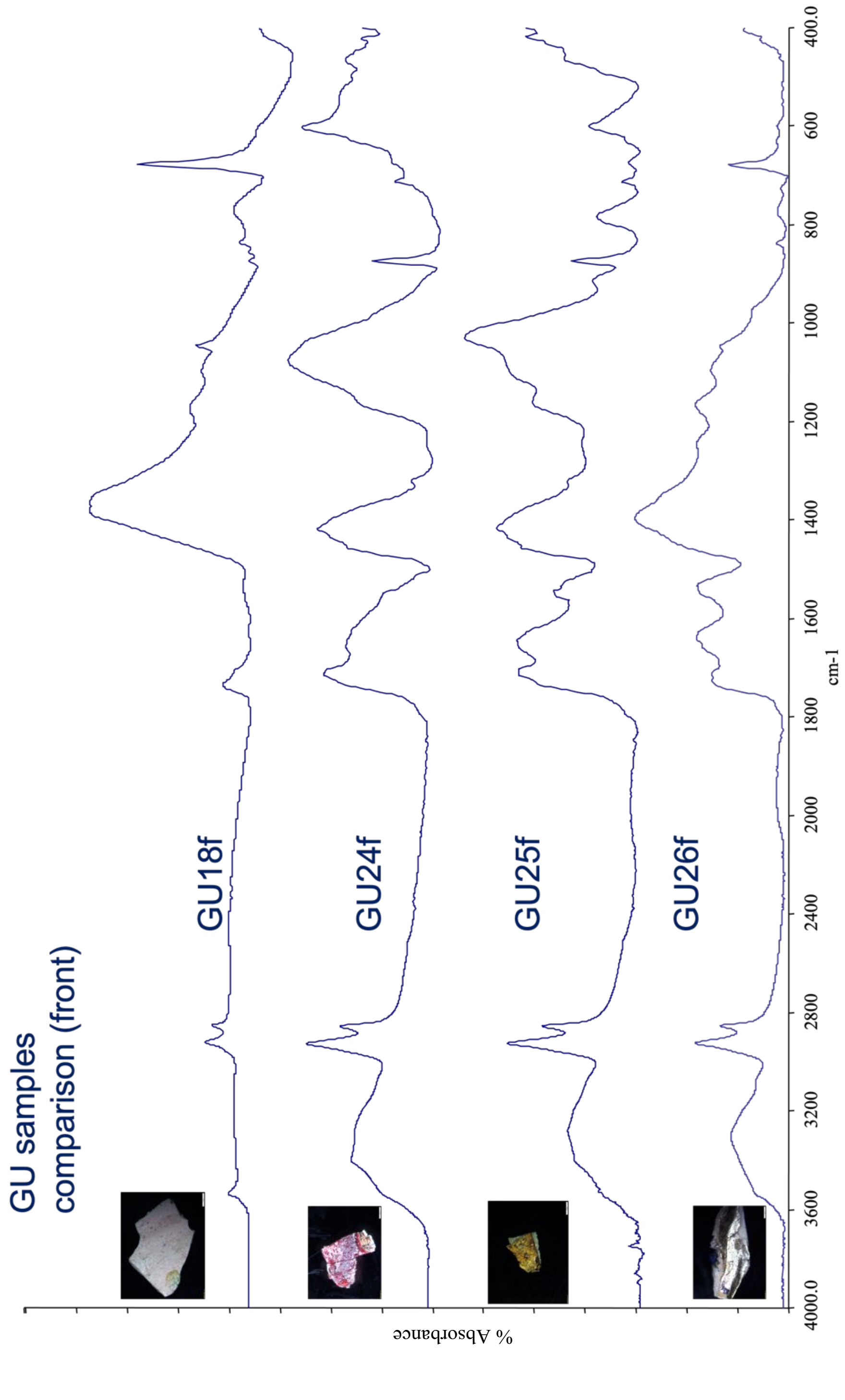
TS20 b - Calcium carbonate, Linseed oil

TS22b – Silk

*Thumbnails are only indicative. Full-size images in section III.1.9

** Spectra were recorded from the centre of the sample where it was considered more uniform.

9.3.1.5 III.1.5 The Glasgow Upholsterers Society banner FTIR spectra



GU18f - Lead white, Linseed oil

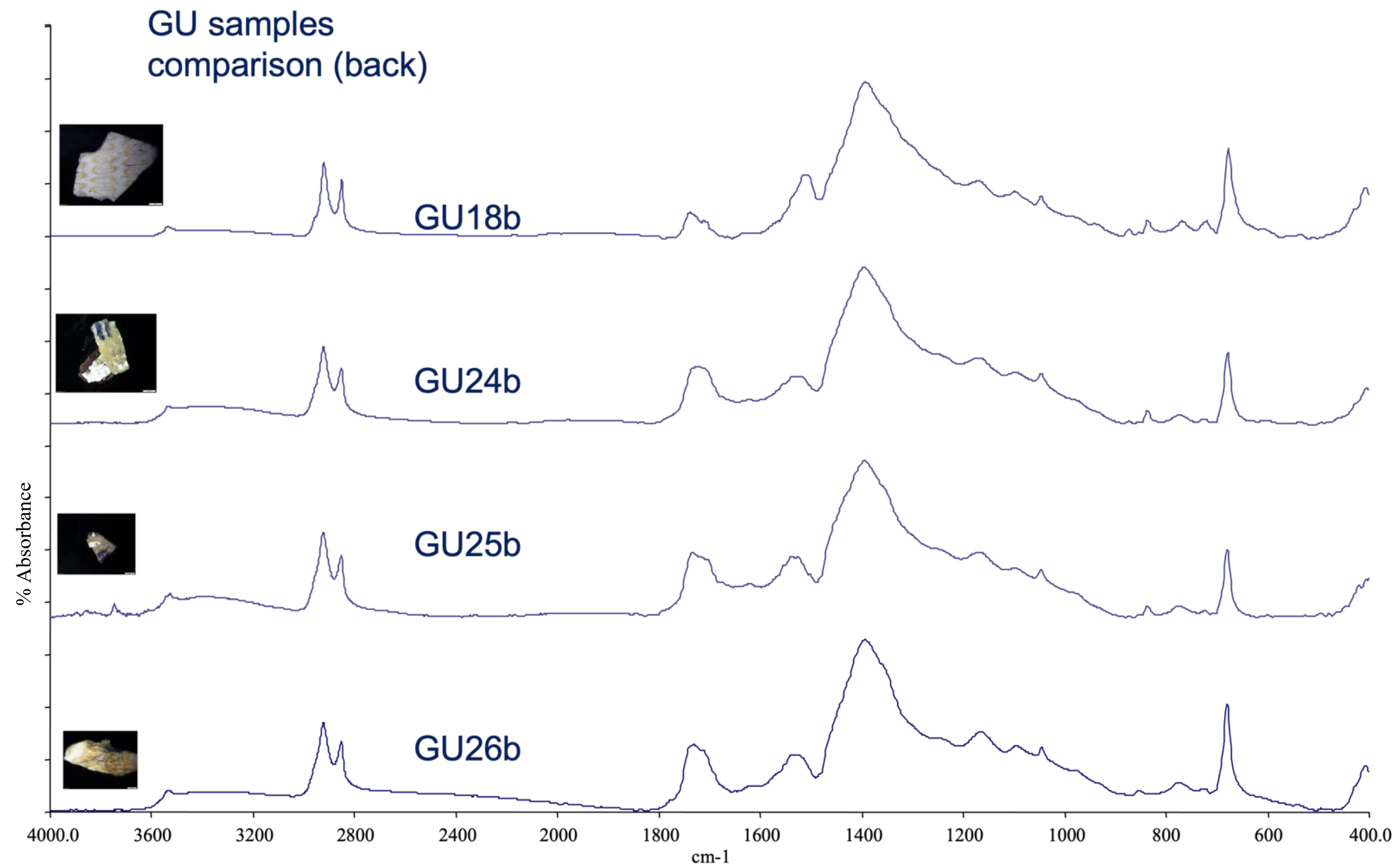
GU24f - Calcium carbonate, Lead white, Barium sulphate, Linseed oil

GU25f - Calcium carbonate, Lead white, Barium sulphate, Linseed oil, Rabbit skin glue

GU26f - Lead white, Rosin resin, Linseed oil, Rabbit skin glue

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.



GU18b - Calcium carbonate, Lead white, Linseed oil

GU24b - Calcium carbonate, Lead white, Linseed oil

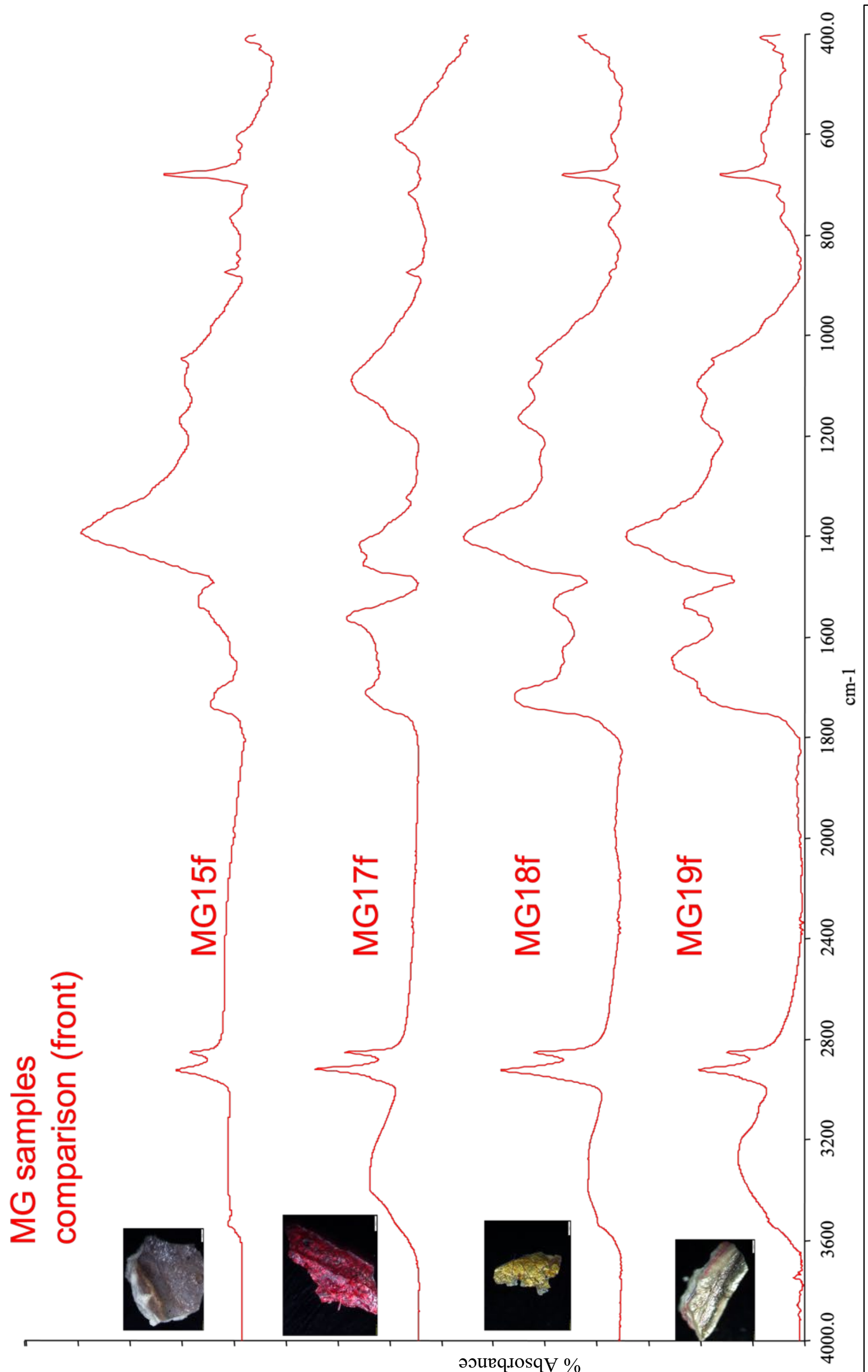
GU25b - Lead white, Linseed oil

GU26b - Lead white, Linseed oil

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.

9.3.1.6 III.1.6 The Grain Millers of Glasgow banner FTIR spectra



MG15f - Calcium carbonate, Lead white, Linseed oil

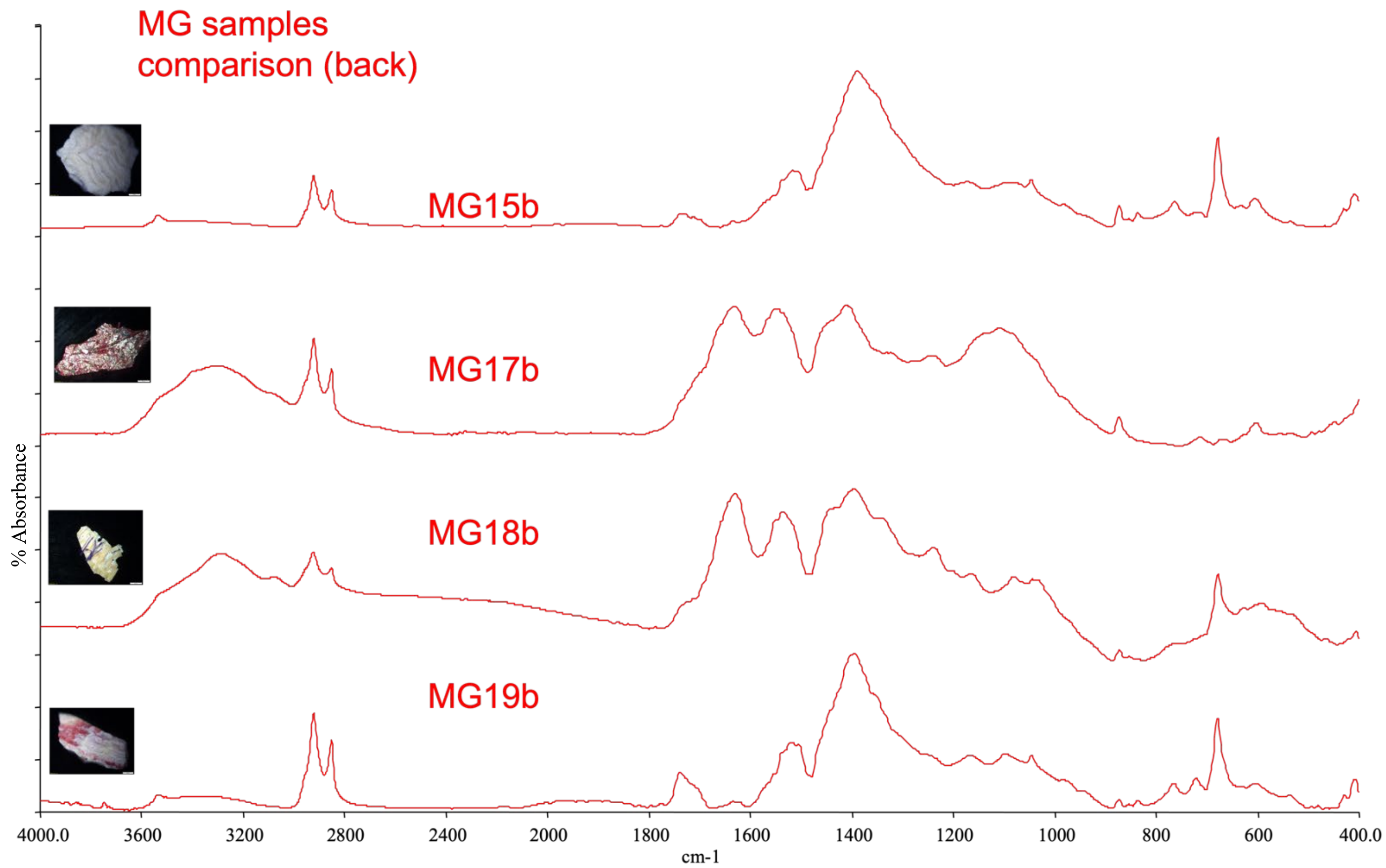
MG17f - Calcium carbonate, Barium sulphate, Linseed oil

MG18f - Lead white, Linseed oil, Rabbit skin glue

MG19f -Lead white, Linseed oil, Rabbit skin glue

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.



MG15b - Calcium carbonate, Lead white, Barium sulphate, Linseed oil

MG17b - Calcium carbonate, Barium sulphate, Linseed oil, Rabbit skin glue

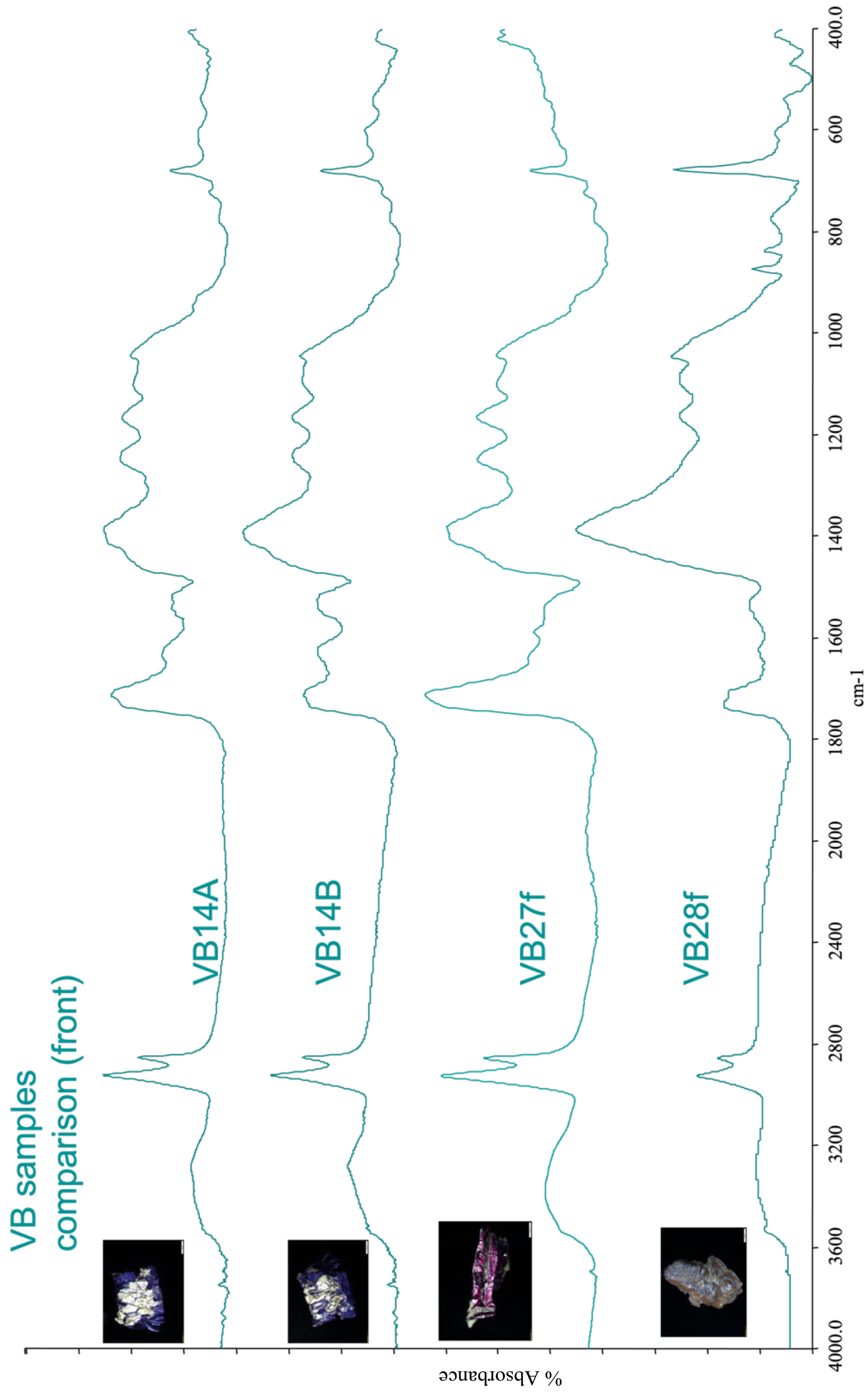
MG18b - Calcium carbonate, Lead white, Linseed oil, Rabbit skin glue

MG19b - Calcium carbonate, Lead white, Linseed oil

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.

9.3.1.7 III.1.7 The National Union of Vehicle Builders banner FTIR spectra



VB14A - Lead white, Rosin resin, Linseed oil, Rabbit skin glue

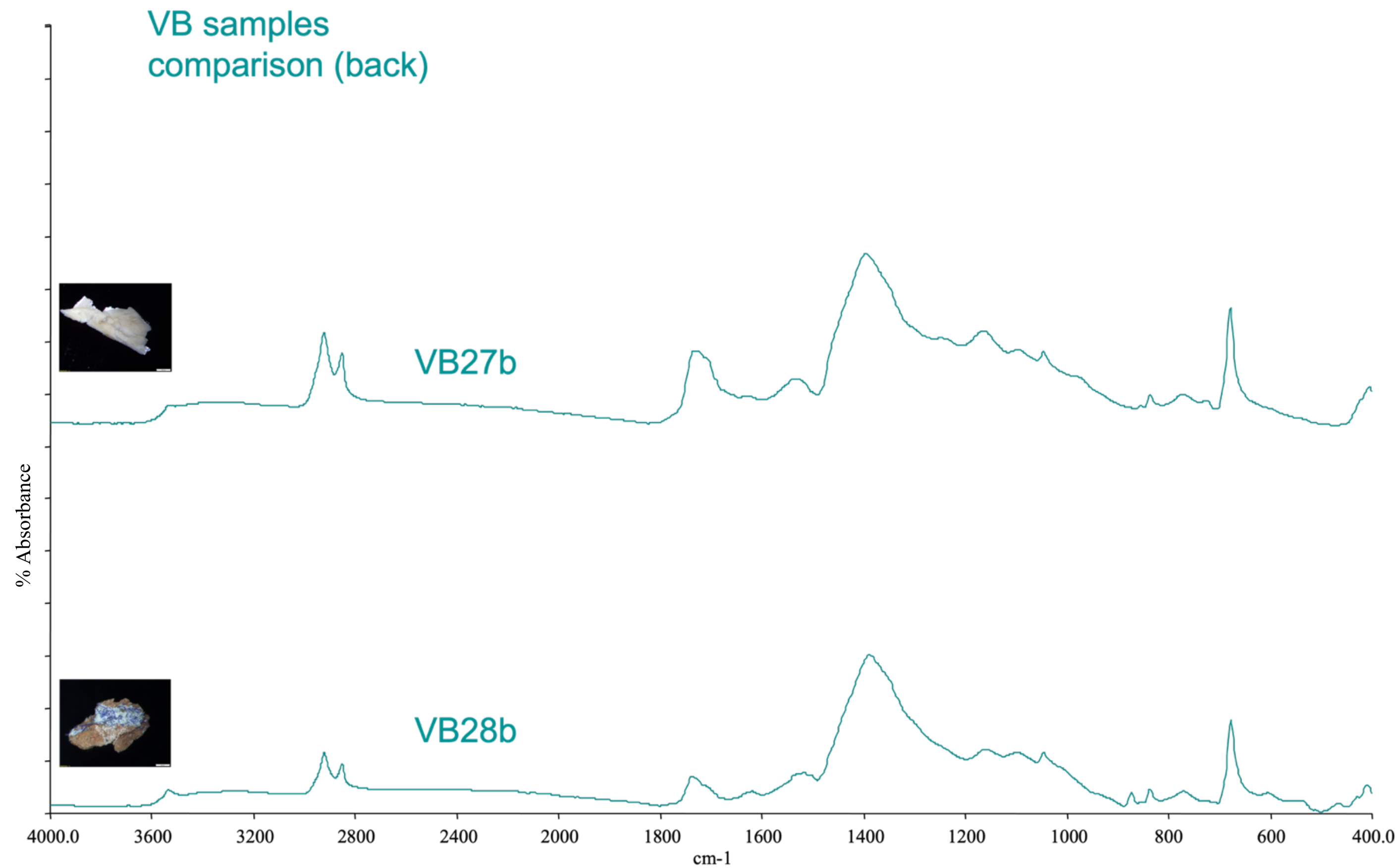
VB14B - Lead white, Rosin resin, Linseed oil, Rabbit skin glue

VB27f - Lead white, Rosin resin, Linseed oil

VB28f -Calcium carbonate, Lead white, Linseed oil, Silk

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.



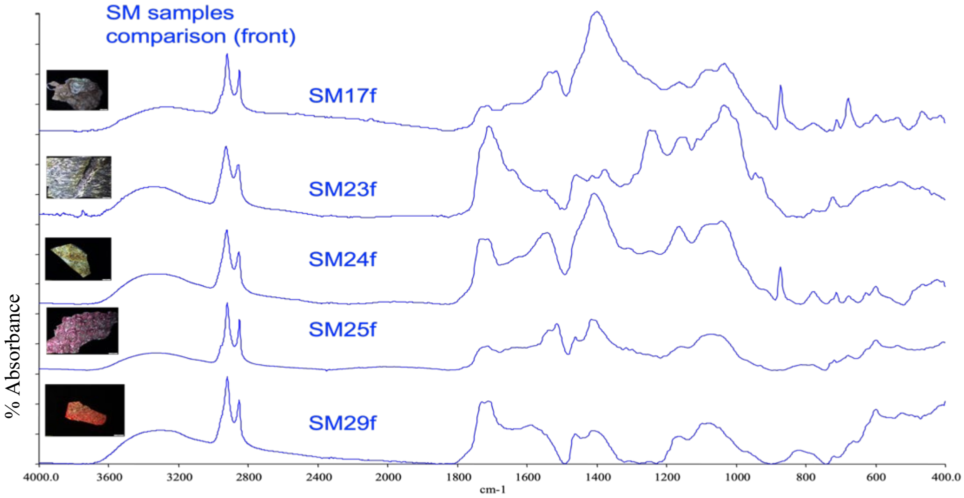
VB27b - Lead white, Linseed oil

VB28b - Lead white, Linseed oil

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.

9.3.1.8 III.1.8 The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner FTIR spectra



SM17f - Calcium carbonate, Lead white, Barium sulphate, Linseed oil

SM23f - Rosin resin, Linseed oil

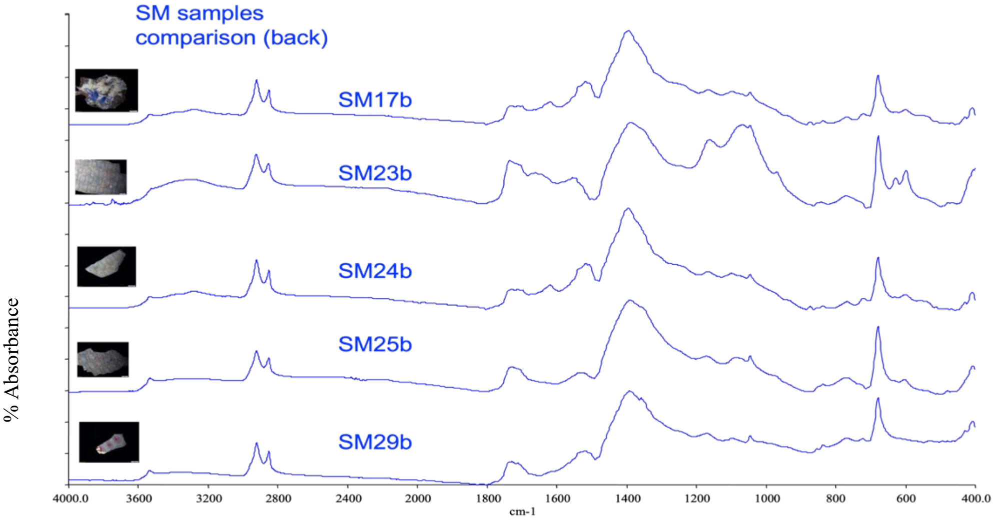
SM24f - Calcium carbonate, Lead white, Barium sulphate, Linseed oil

SM25f - Lead white, Barium sulphate, Linseed oil

SM29f - Barium sulphate, Linseed oil

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.



SM17b - Lead white, Linseed oil

SM23b - Lead white, Barium sulphate, Linseed oil, Rabbit skin glue

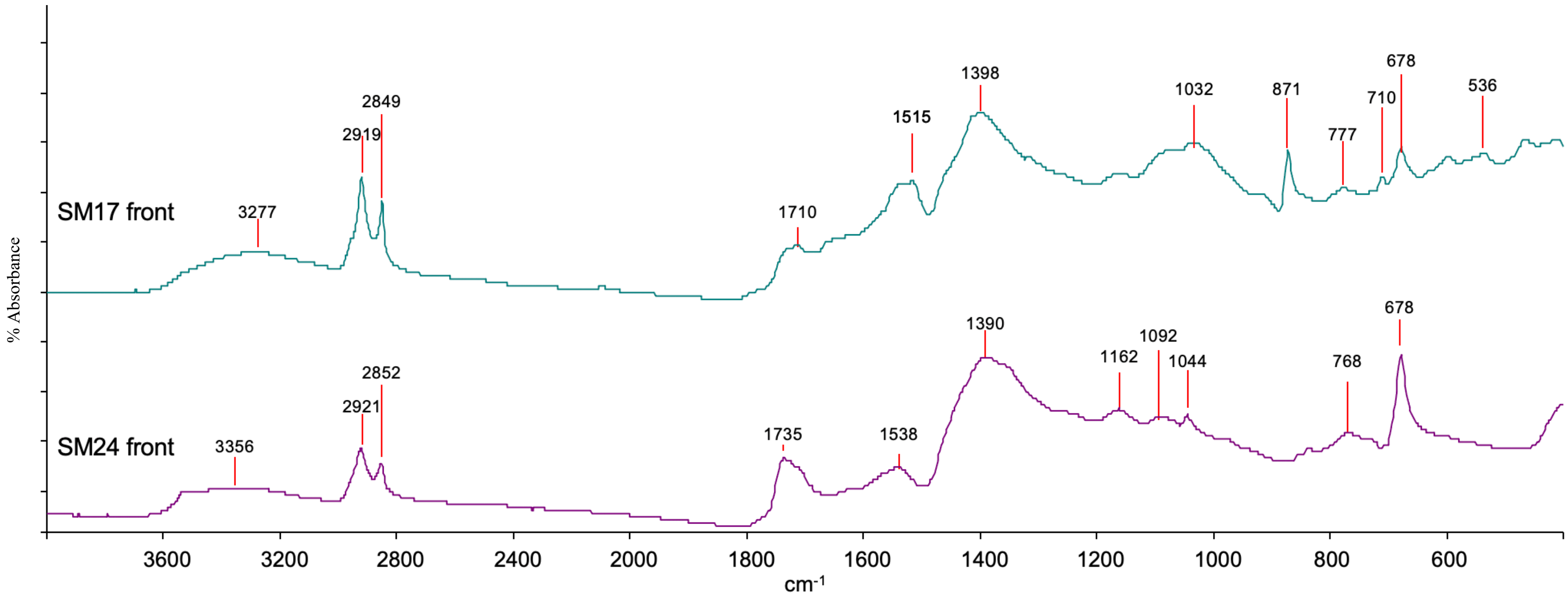
SM24b - Calcium carbonate, Lead white, Linseed oil

SM25b - Lead white, Linseed oil

SM29b - Lead white, Linseed oil

*Thumbnails are only indicative. Full-size images in section III.1.9

**Spectra were recorded from the centre of the sample where it was considered more uniform.



SM17f and SM24f – main peaks identification for comparison against Table 1 of Izzo et al. 2021 for potential lead soap location (Izzo et al., 2021, p. 913)

**Spectra were recorded from the centre of the sample where it was considered more uniform.

9.3.1.9 III.1.9 FTIR samples documentation

Unless otherwise indicated the scale bar on the images of the following tables represents a length of 200 µm.

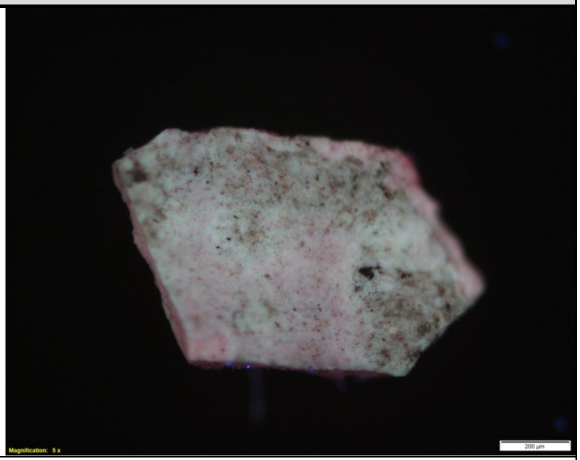
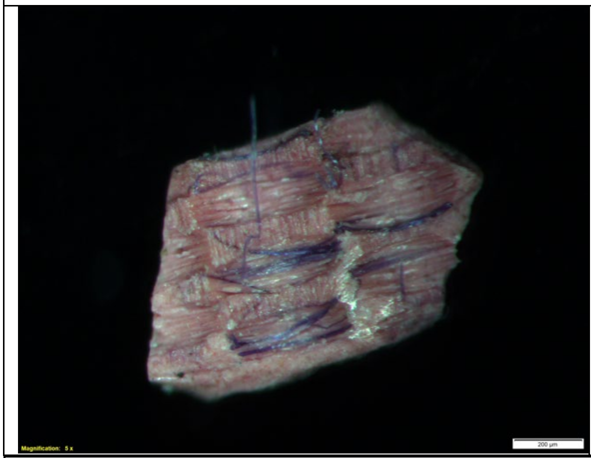
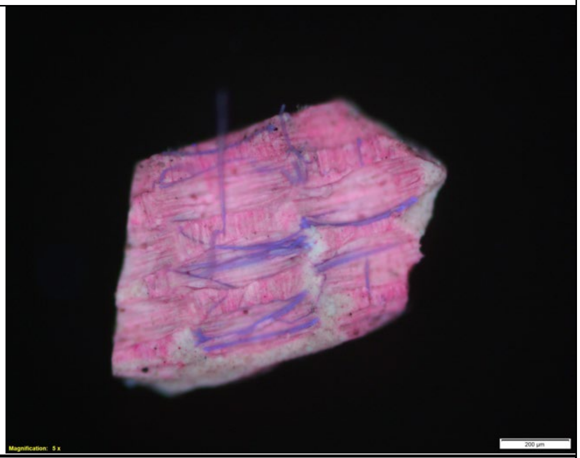
<table>
<tr><td colspan="6">Table III.3 Micrographs of paint sample TS11</td></tr>
<tr><td>BANNER</td><td colspan="5">The Glasgow Typographical Society</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning</td><td>YEAR</td><td>1883</td><td>SAMPLE</td><td>TS11</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td colspan="6">FRONT</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td colspan="6">BACK</td></tr>
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Table III.4 Micrographs of paint sample TS19

BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS19

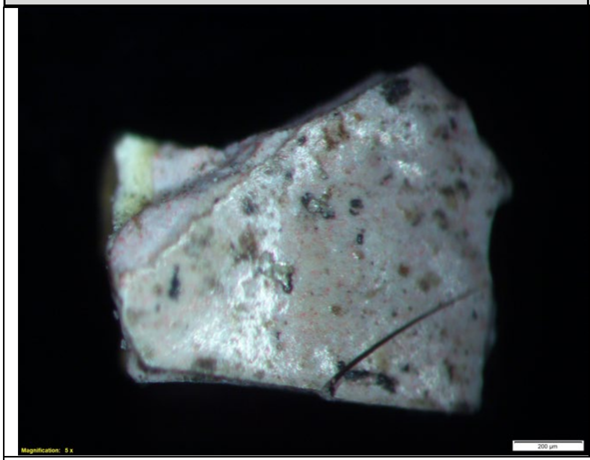
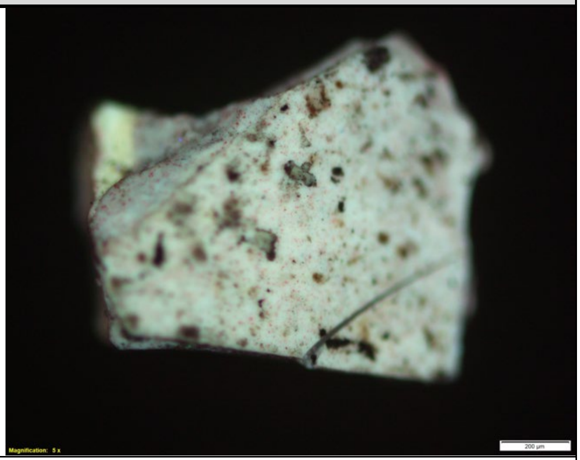
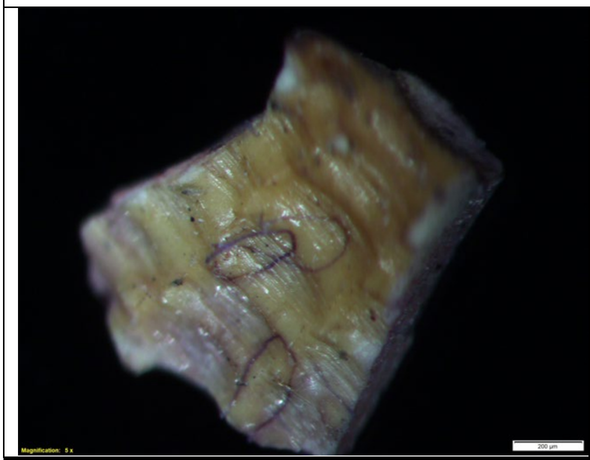
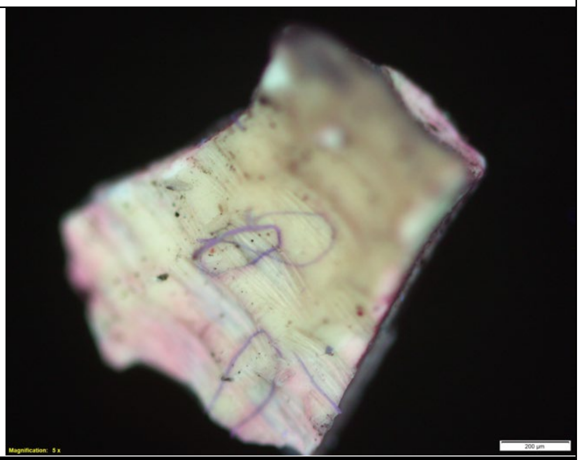
Micrographs acquired under Olympus BX41 microscope at 50×	
Dark field-crossed polarisers	UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)
	
FRONT	
	
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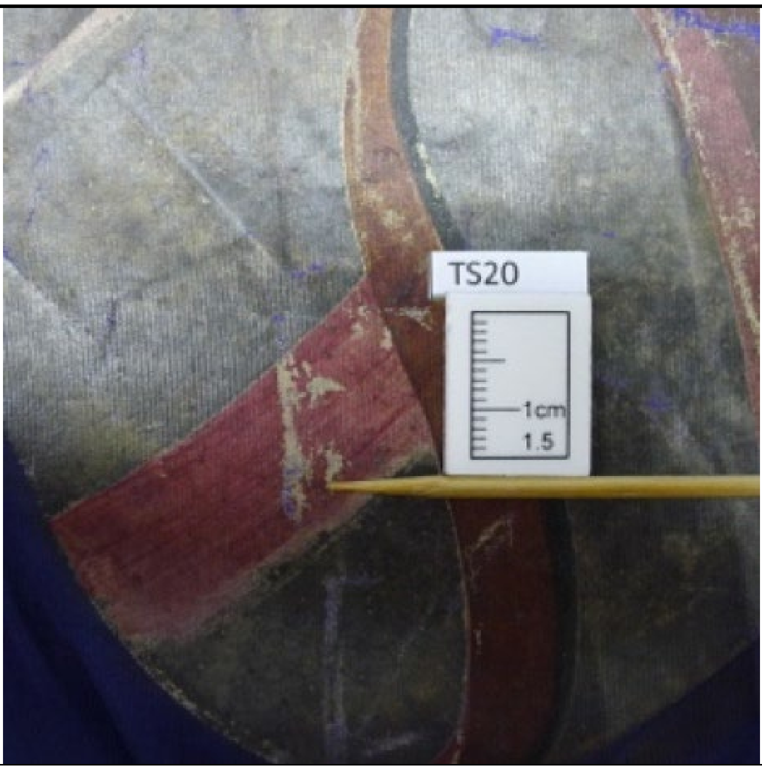
Table III.5 Location photograph of red glaze sample TS20					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS20
Photograph taken with Lumix DMC-LX5					



*The micrograph files of this sample got corrupted and unfortunately lost.

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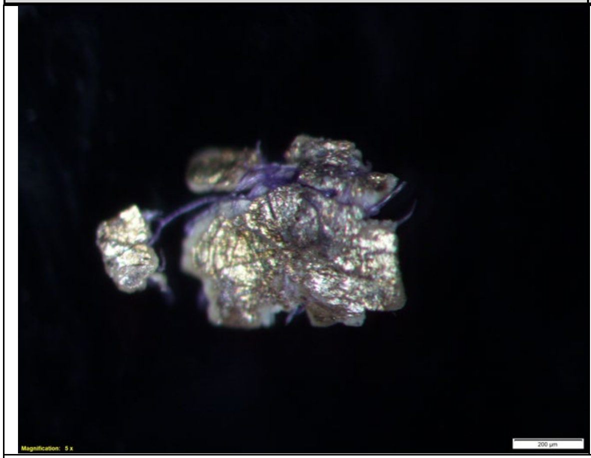
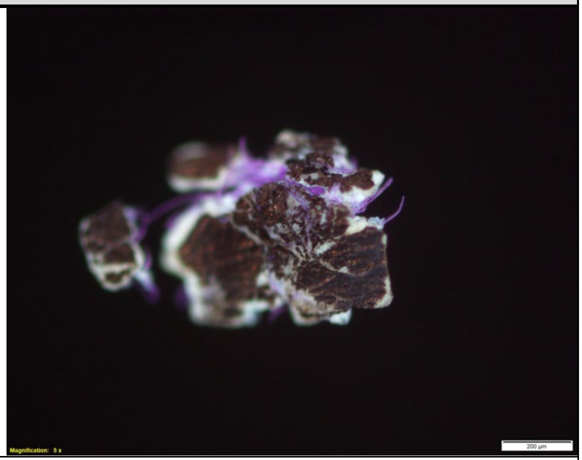
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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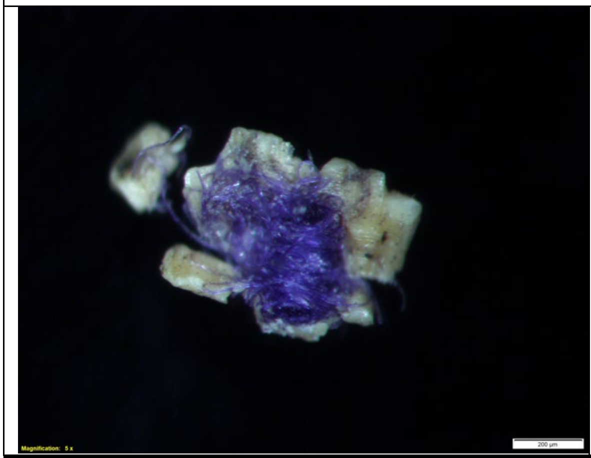
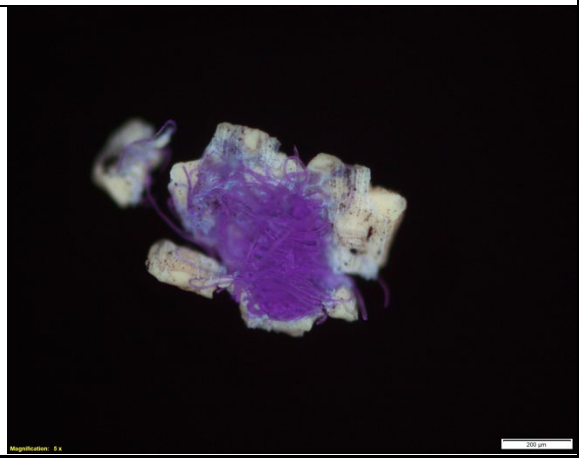
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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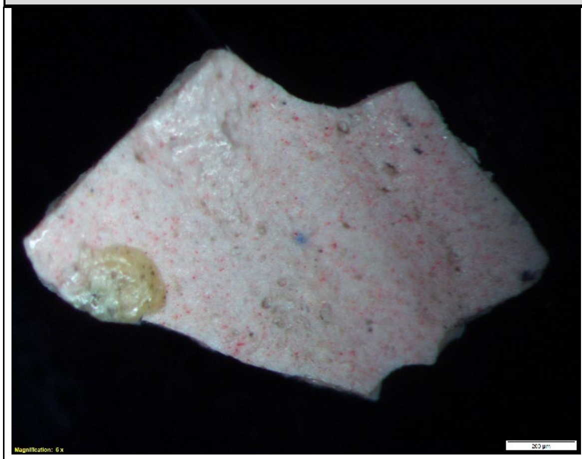
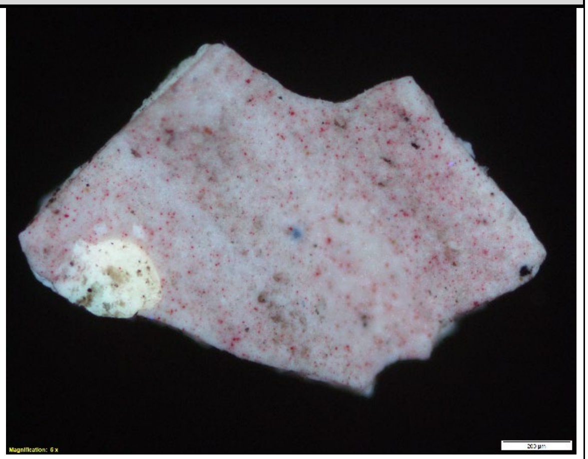
Table III.7 Micrographs of paint sample GU18					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU18
Micrographs acquired under Olympus BX41 microscope at 50×					
Dark field-crossed polarisers			UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)		
					
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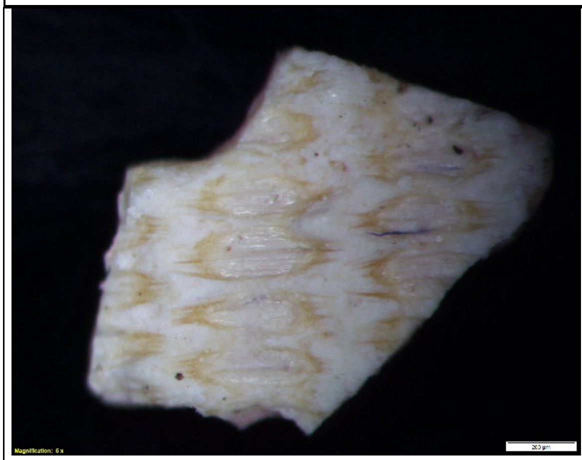			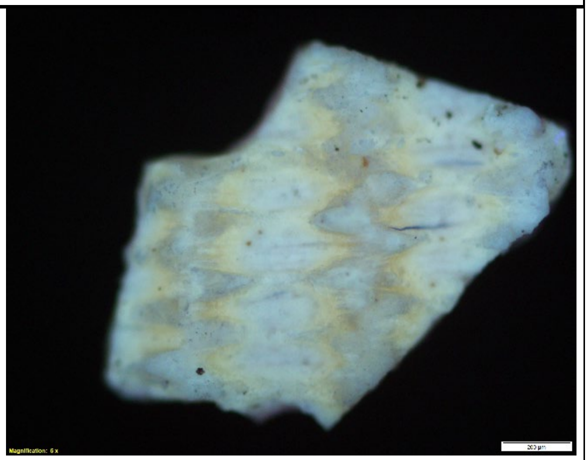		
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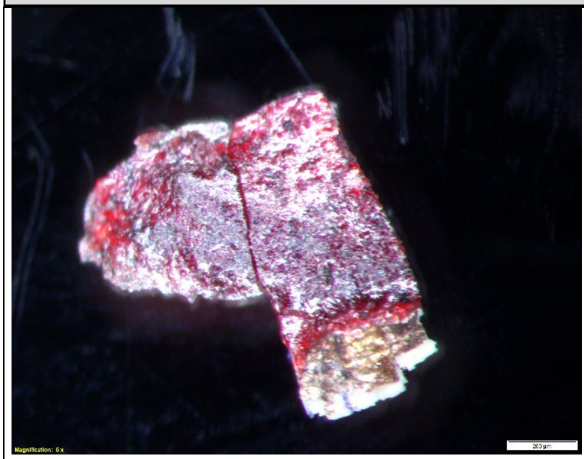
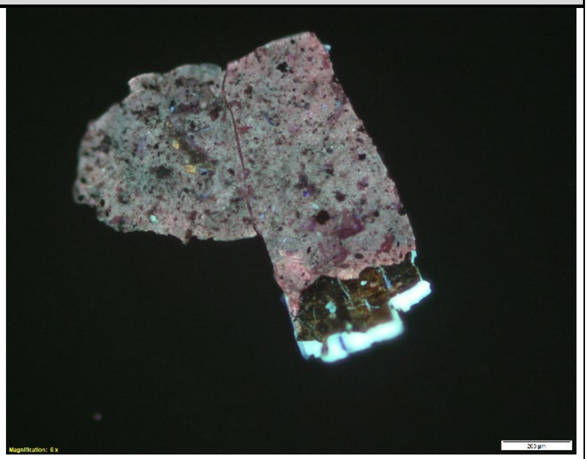
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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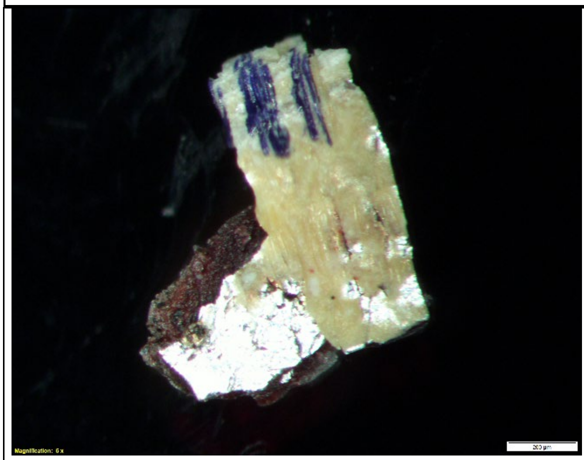
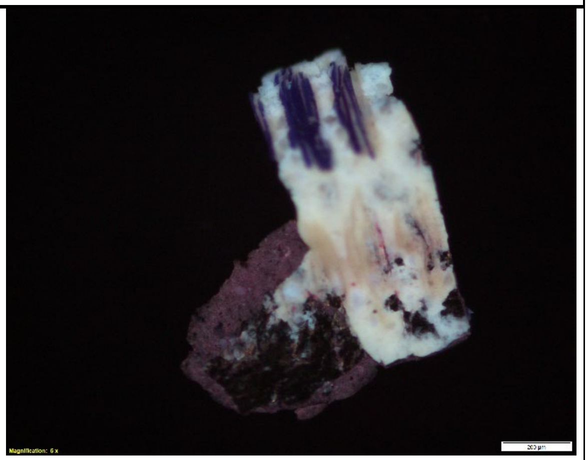
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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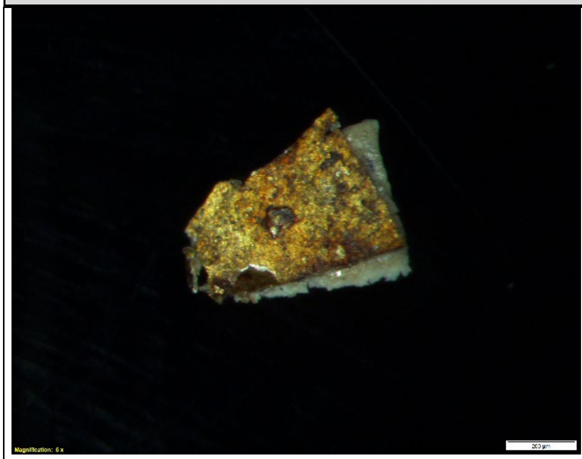
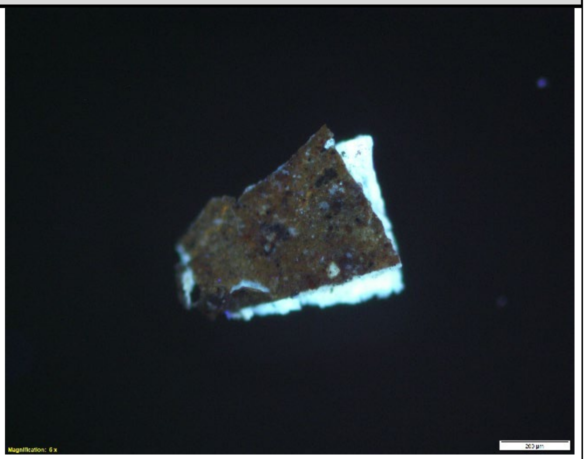
Table III.9 Micrographs of yellow glaze scroll sample GU25					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU25

Micrographs acquired under Olympus BX41 microscope at 50×	
Dark field-crossed polarisers	UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)
	
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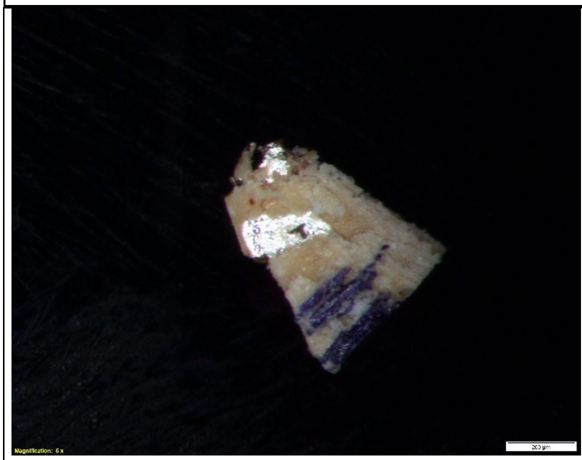	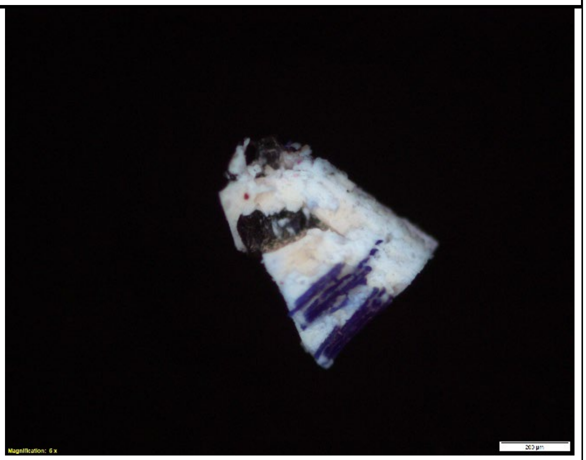
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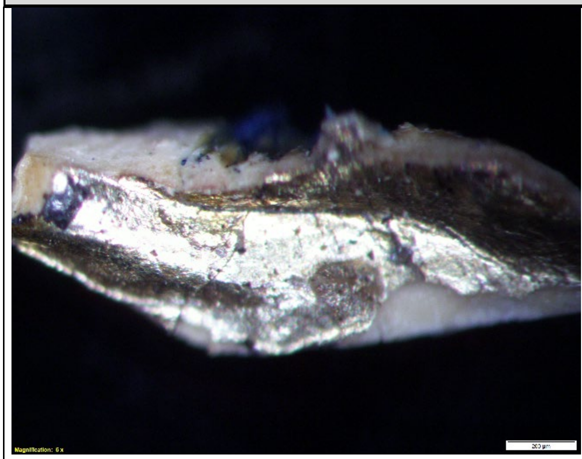
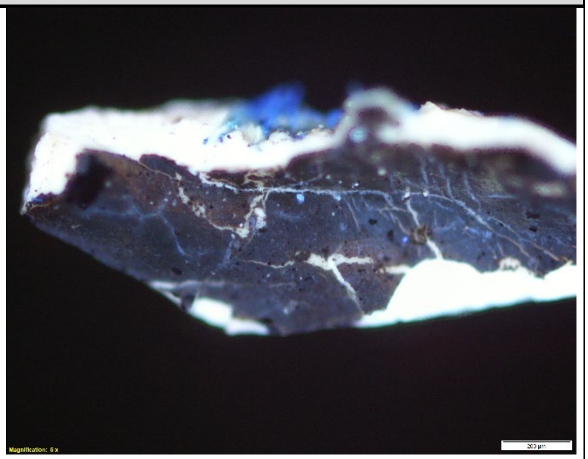
<tr><td>MANUFACTURER</td><td>George Kenning</td><td>YEAR</td><td>1884</td><td>SAMPLE</td><td>GU26</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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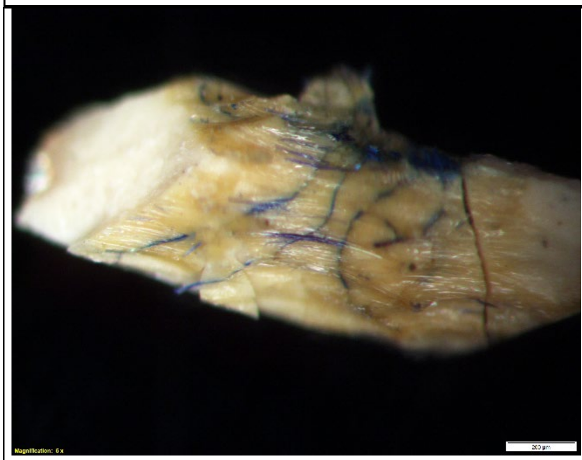
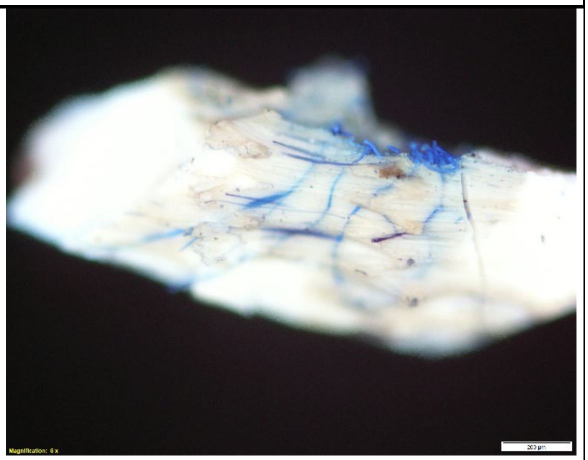
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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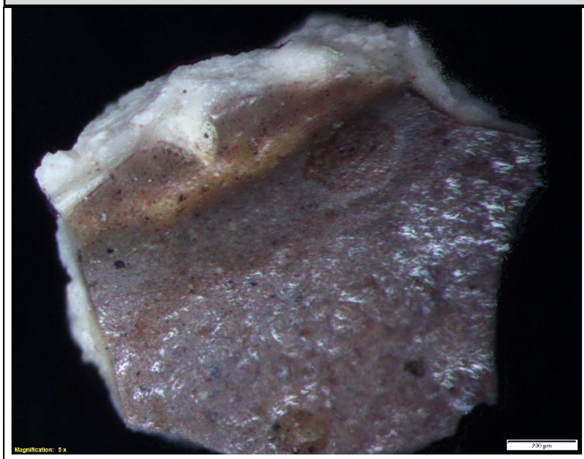
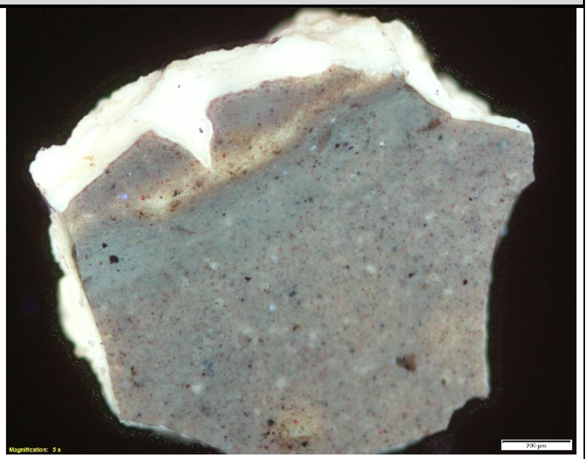
<tr><td>MANUFACTURER</td><td>George Kenning</td><td>YEAR</td><td>1884</td><td>SAMPLE</td><td>MG15</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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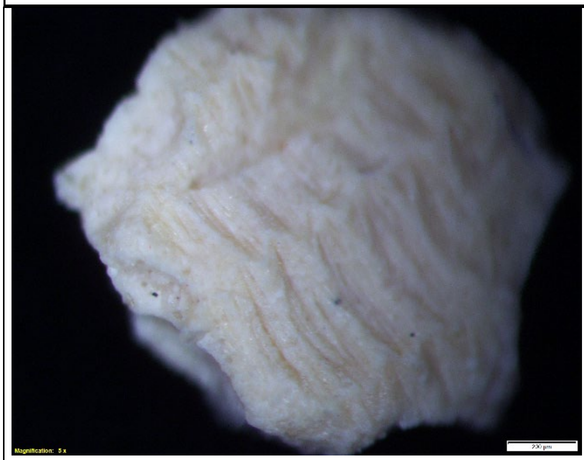
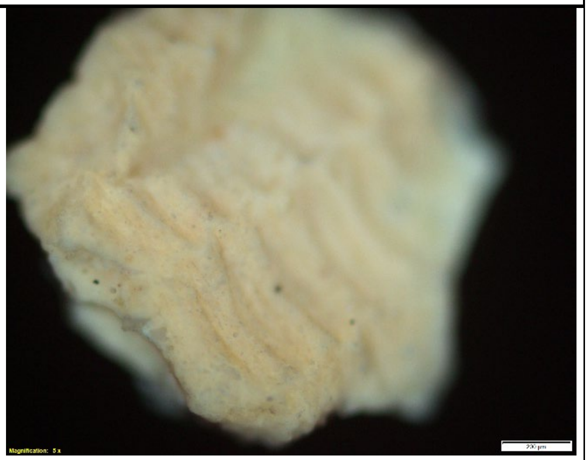
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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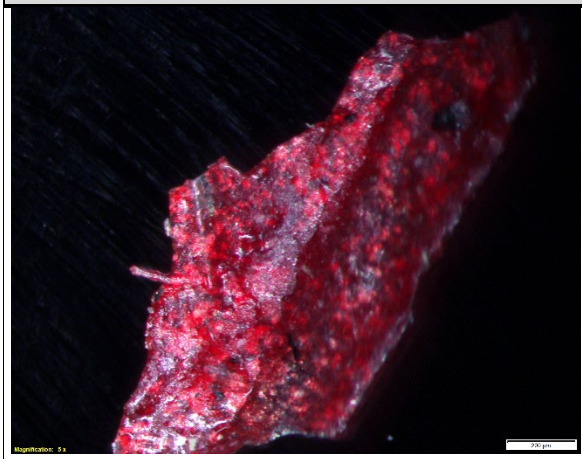
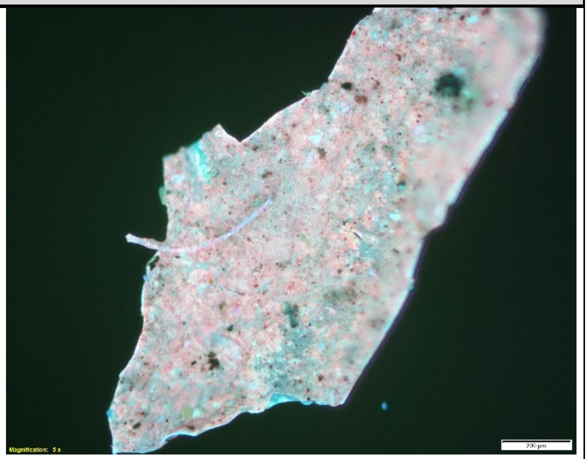
Table III.12 Micrographs of red glaze sample MG17					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG17
Micrographs acquired under Olympus BX41 microscope at 50×					
Dark field-crossed polarisers			UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)		
					
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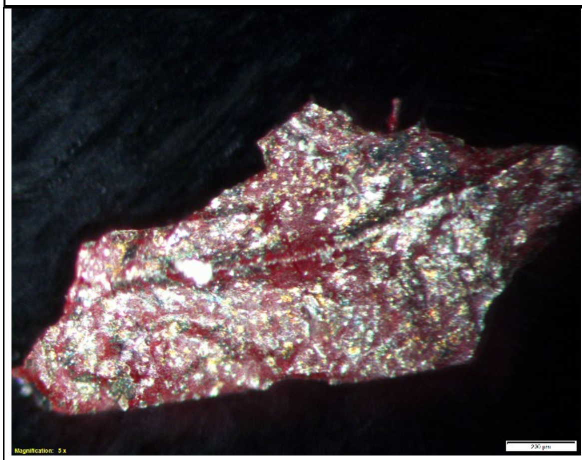			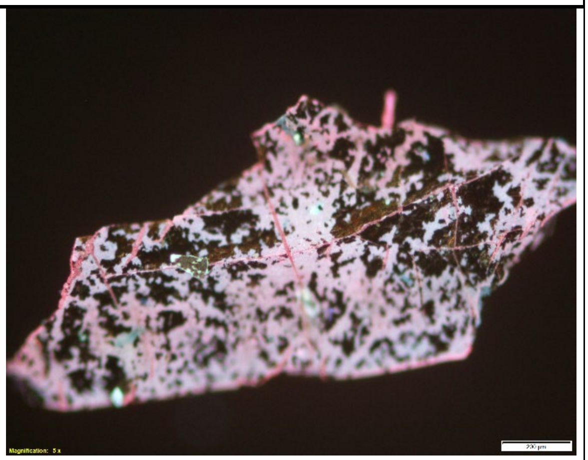		
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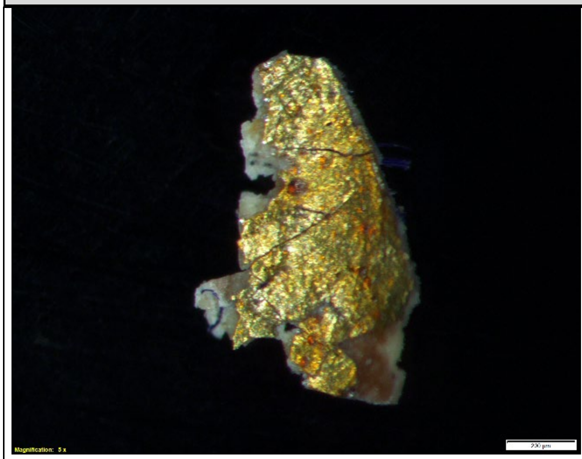
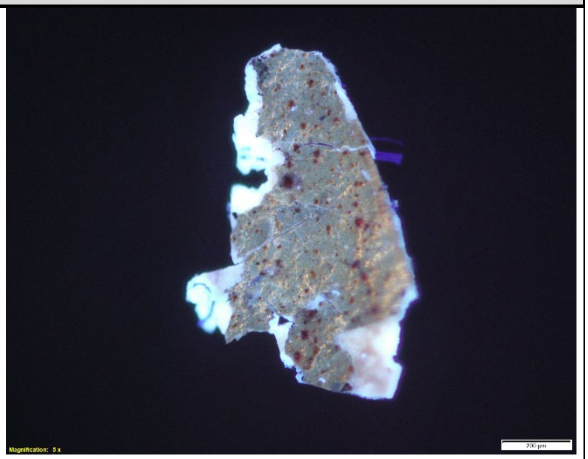
<tr><td>BANNER</td><td colspan="5">The Grain Millers of Glasgow</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning</td><td>YEAR</td><td>1884</td><td>SAMPLE</td><td>MG18</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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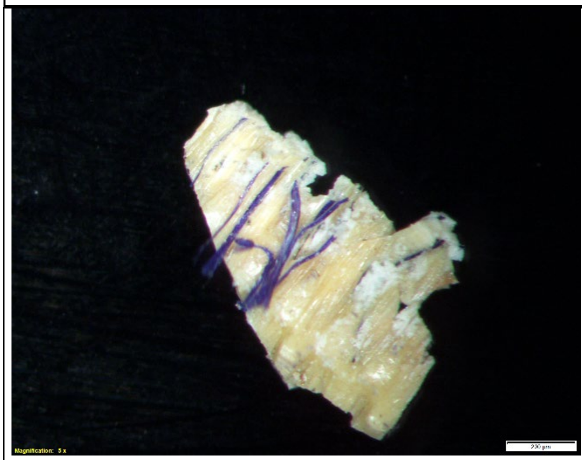
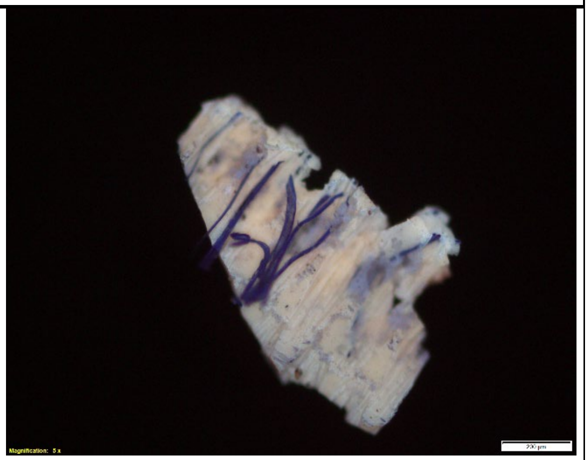
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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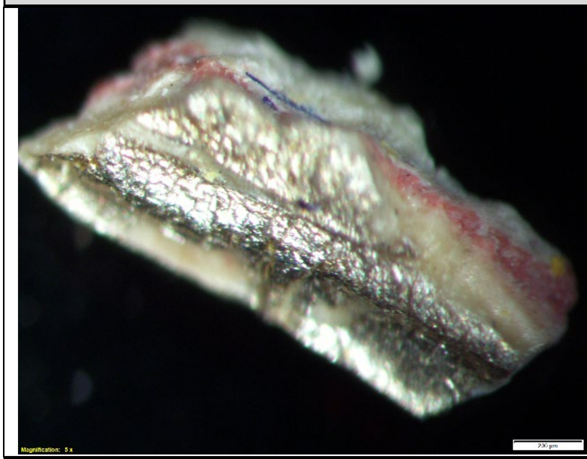
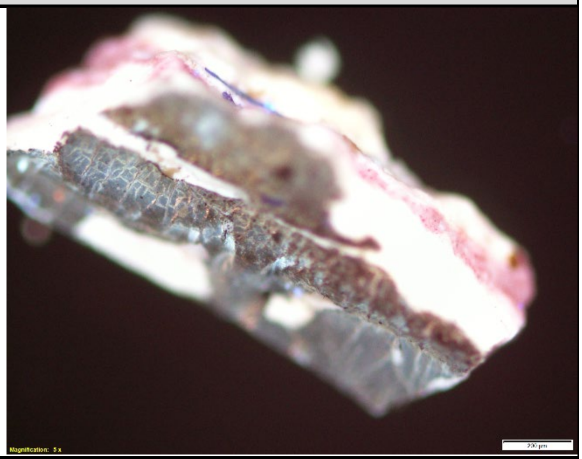
Table III.14 Micrographs of golden glaze scroll sample MG19					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG19

Micrographs acquired under Olympus BX41 microscope at 50×	
Dark field-crossed polarisers	UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)

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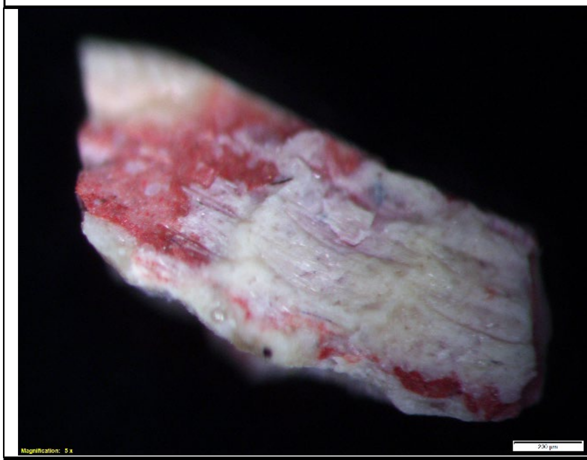
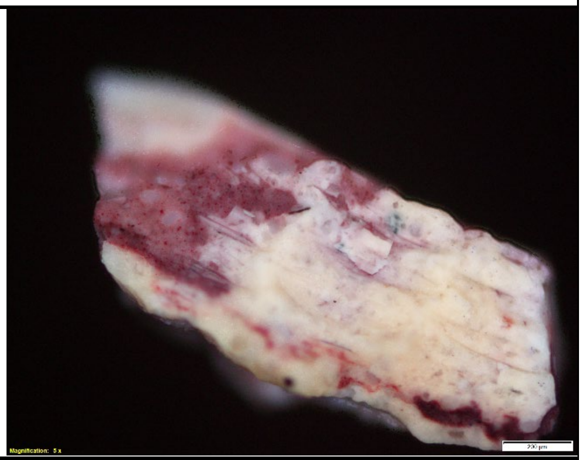

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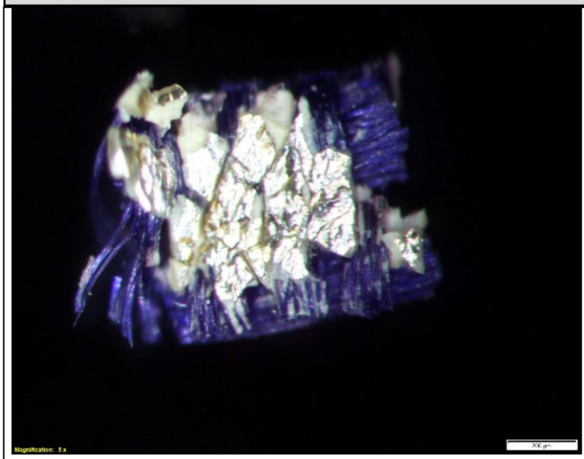
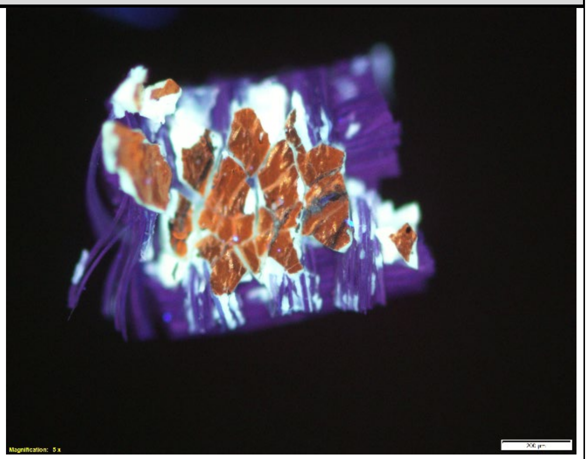
<tr><td colspan="6">Table III.15 Micrographs of scroll sample VB14</td></tr>
<tr><td>BANNER</td><td colspan="5">The National Union of Vehicle Builders, Glasgow Branch</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning & Son</td><td>YEAR</td><td>1914</td><td>SAMPLE</td><td>VB14</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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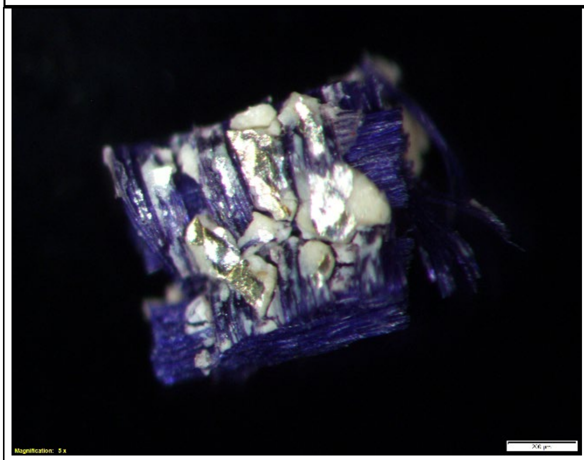
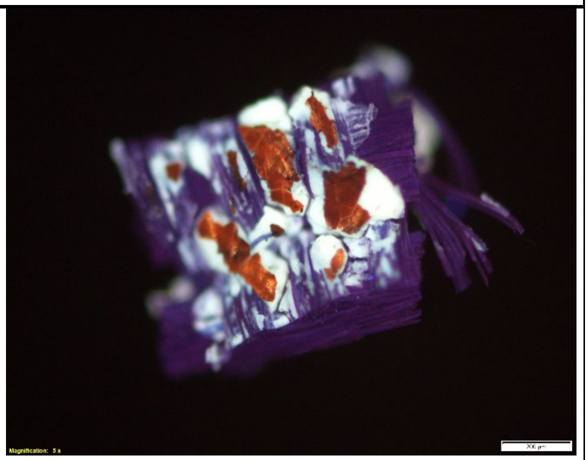
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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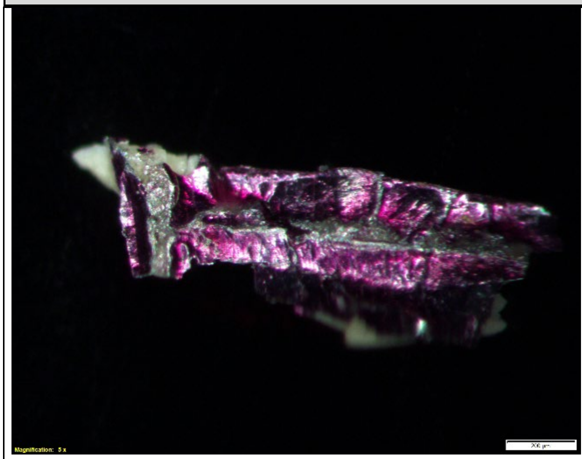
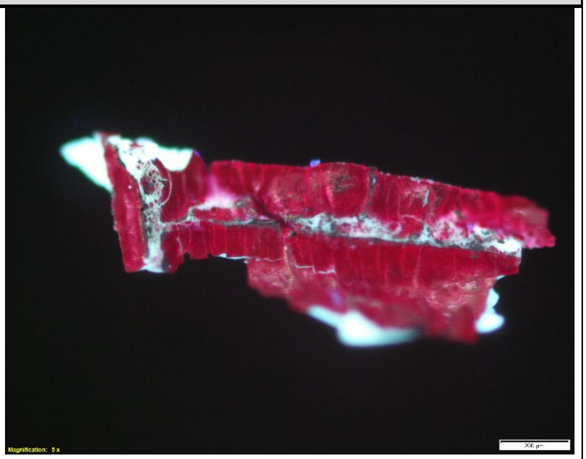
Table III.16 Micrographs of purple glaze scroll sample VB27

BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB27

Micrographs acquired under Olympus BX41 microscope at 50×

Dark field-crossed polarisers	UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)
	
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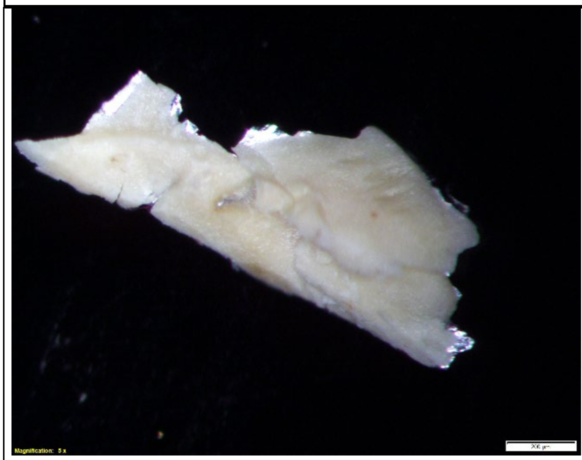	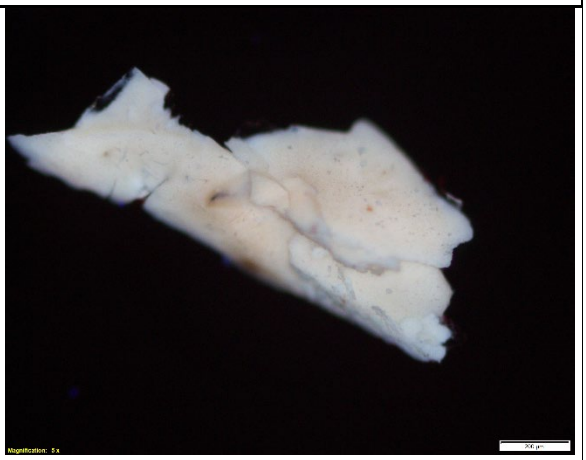
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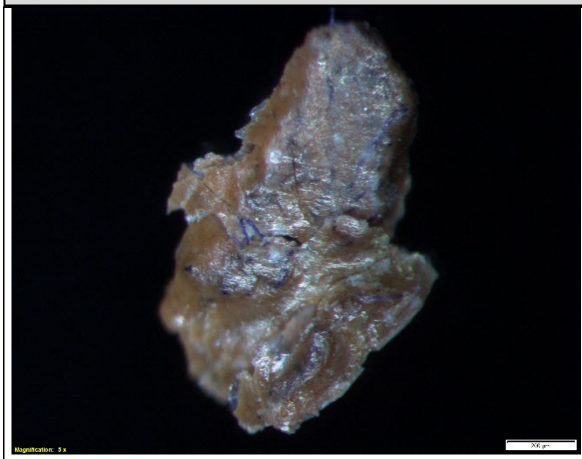
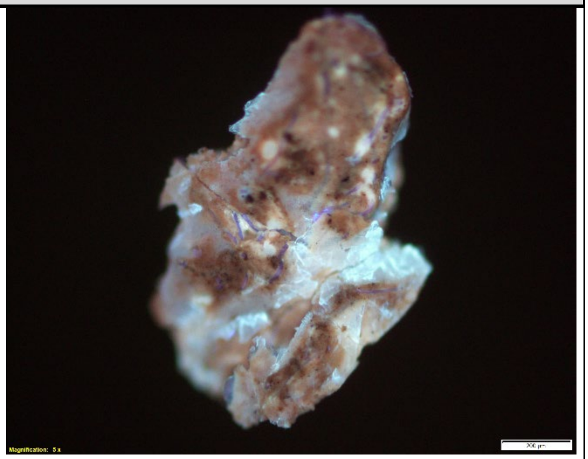
<tr><td>BANNER</td><td colspan="5">The National Union of Vehicle Builders, Glasgow Branch</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning & Son</td><td>YEAR</td><td>1914</td><td>SAMPLE</td><td>VB28</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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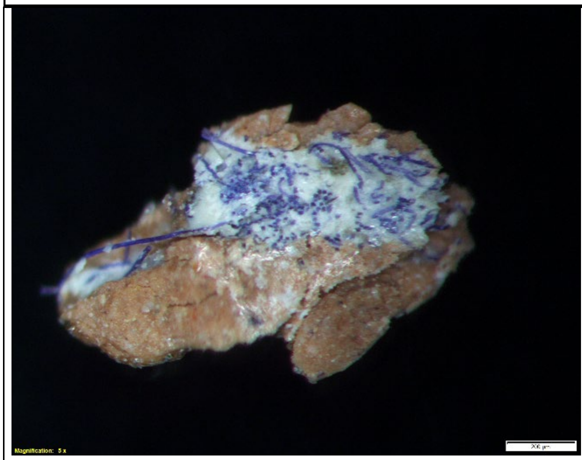
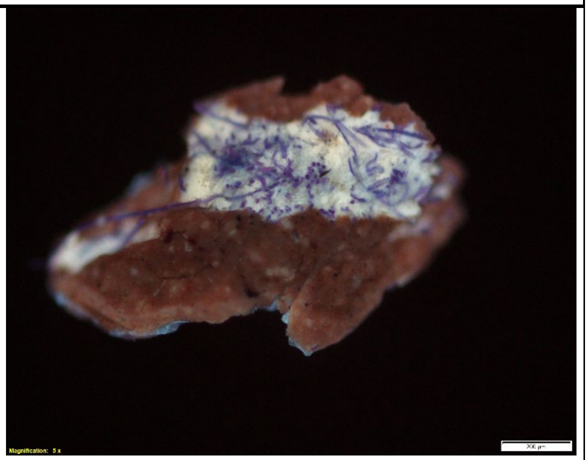
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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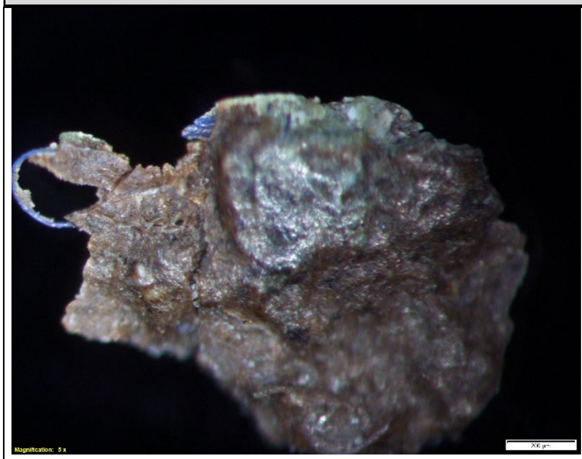
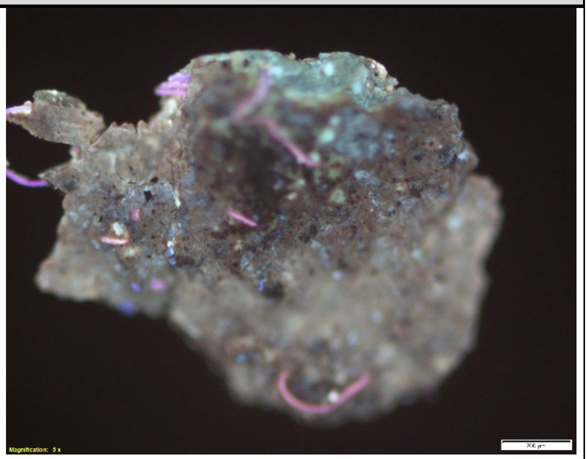
Table III.18 Micrographs of paint sample SM17

BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers’ Society				
MANUFACTURER	George Kenning & Son	YEAR	c.1916	SAMPLE	SM17

Micrographs acquired under Olympus BX41 microscope at 50×

Dark field-crossed polarisers	UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)
	
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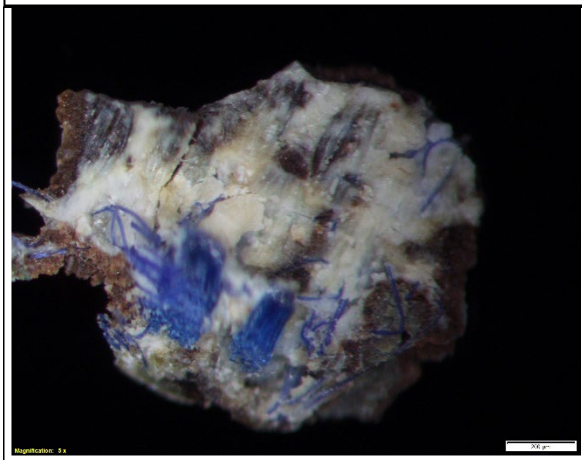	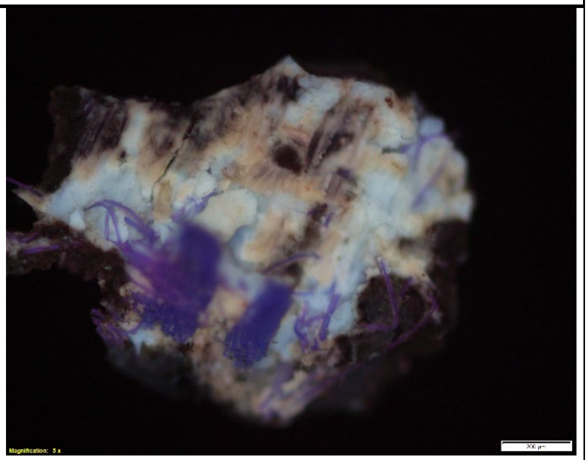
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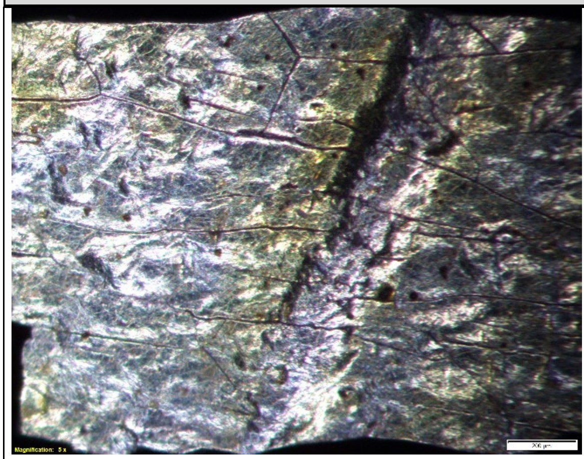
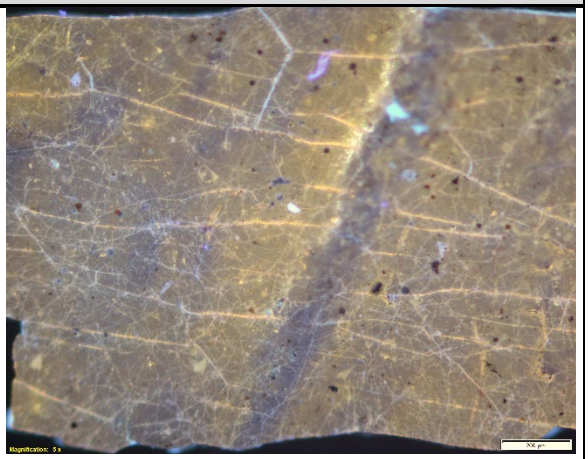
<tr><td>BANNER</td><td colspan="5">The Scottish Tin Plate Braziers and Sheet Metal Workers’ Society</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning & Son</td><td>YEAR</td><td>c.1916</td><td>SAMPLE</td><td>SM23</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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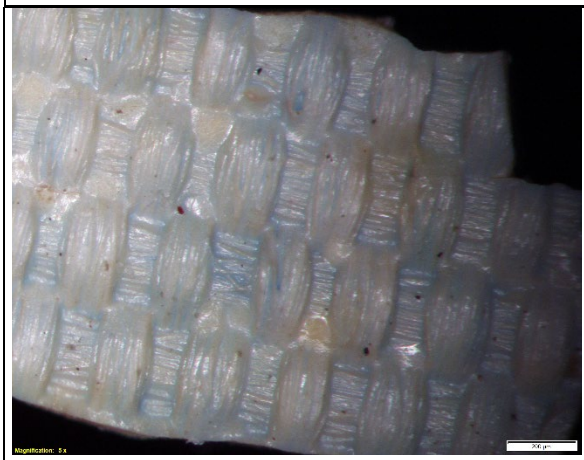
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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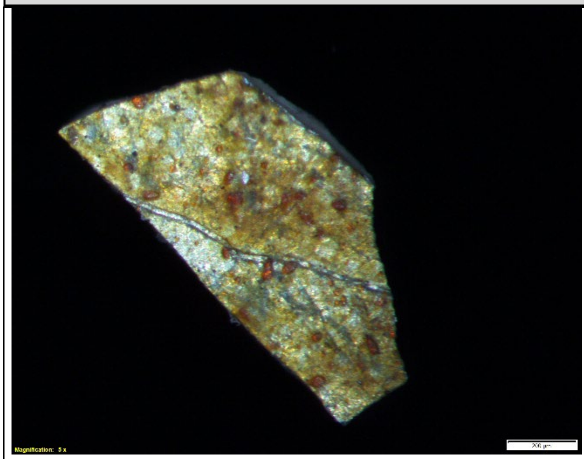
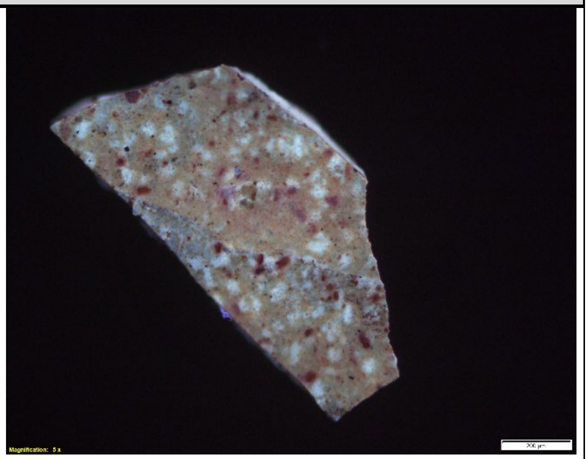
Table III.20 Micrographs of yellow glaze scroll sample SM24					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c.1916	SAMPLE	SM24
Micrographs acquired under Olympus BX41 microscope at 50×					
Dark field-crossed polarisers			UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)		
					
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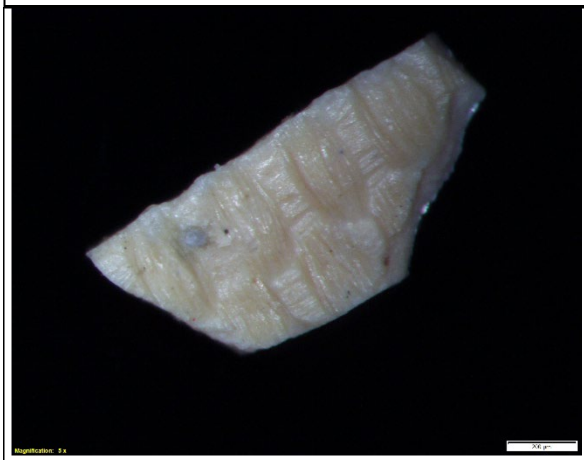			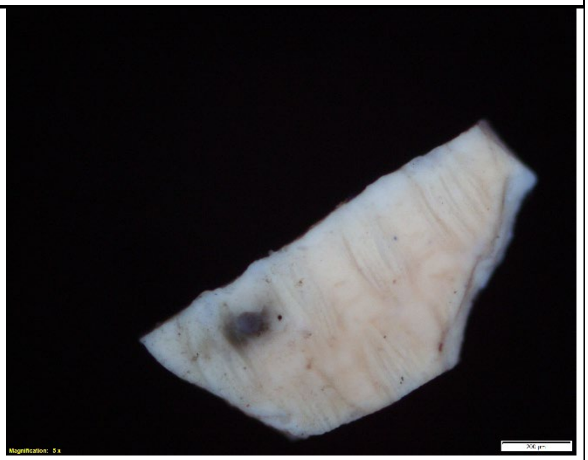		
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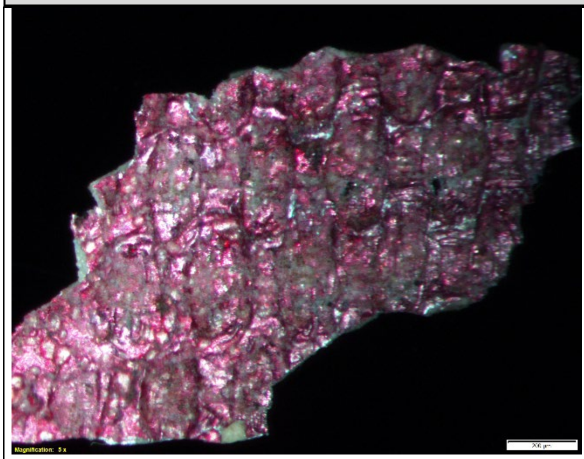
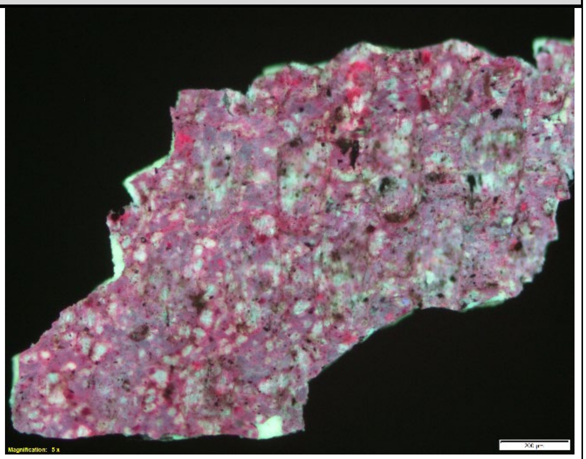
Table III.21 Micrographs of purple glaze scroll sample SM25					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c.1916	SAMPLE	SM25
Micrographs acquired under Olympus BX41 microscope at 50×					
Dark field-crossed polarisers			UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)		
					
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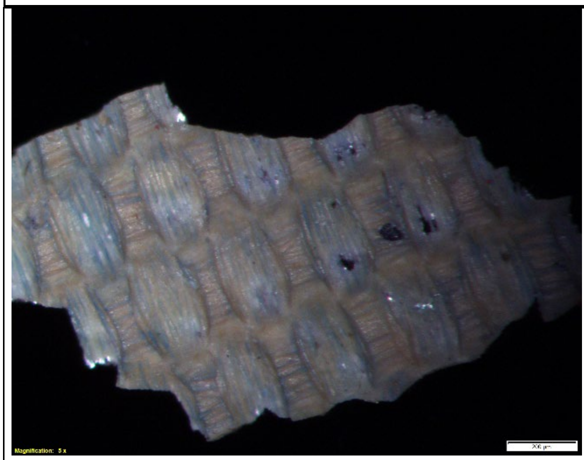			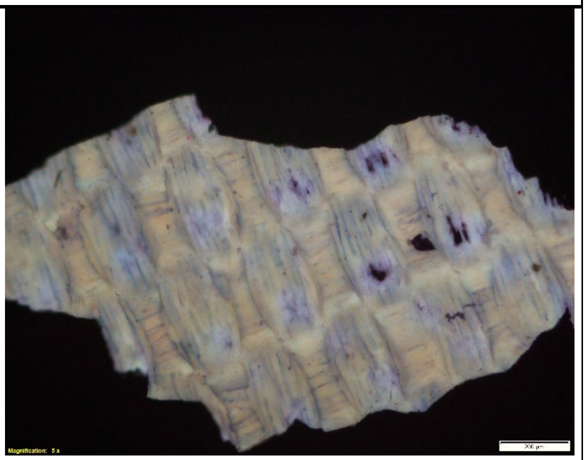		
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<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
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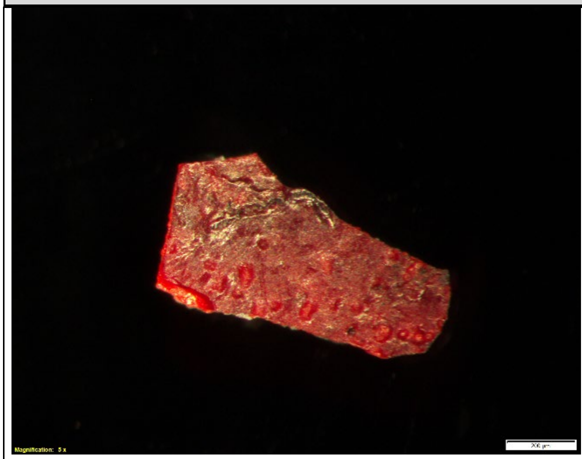
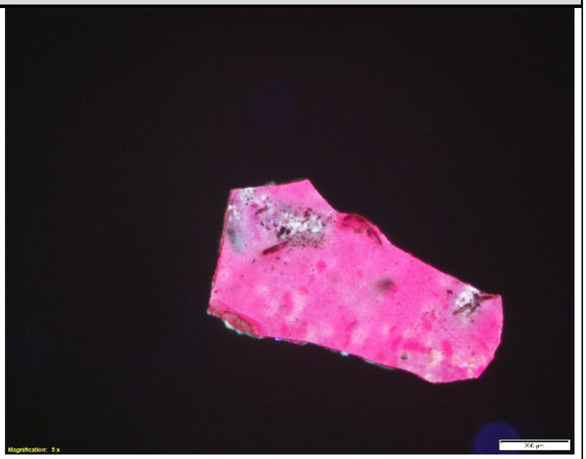
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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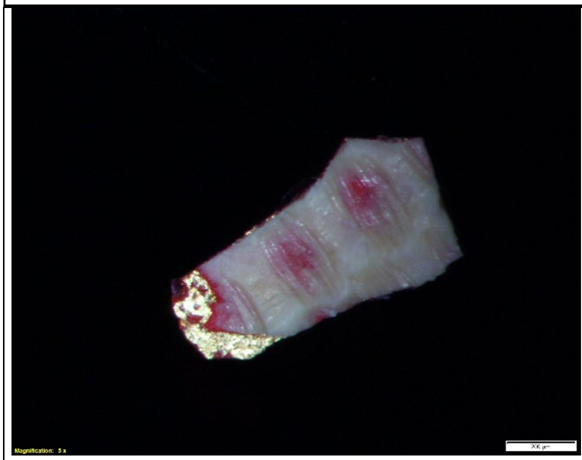
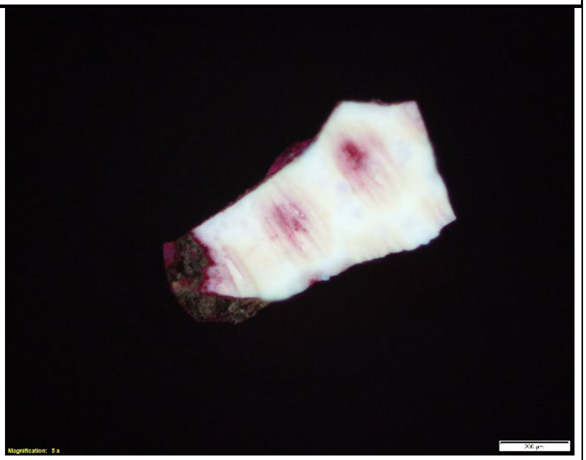
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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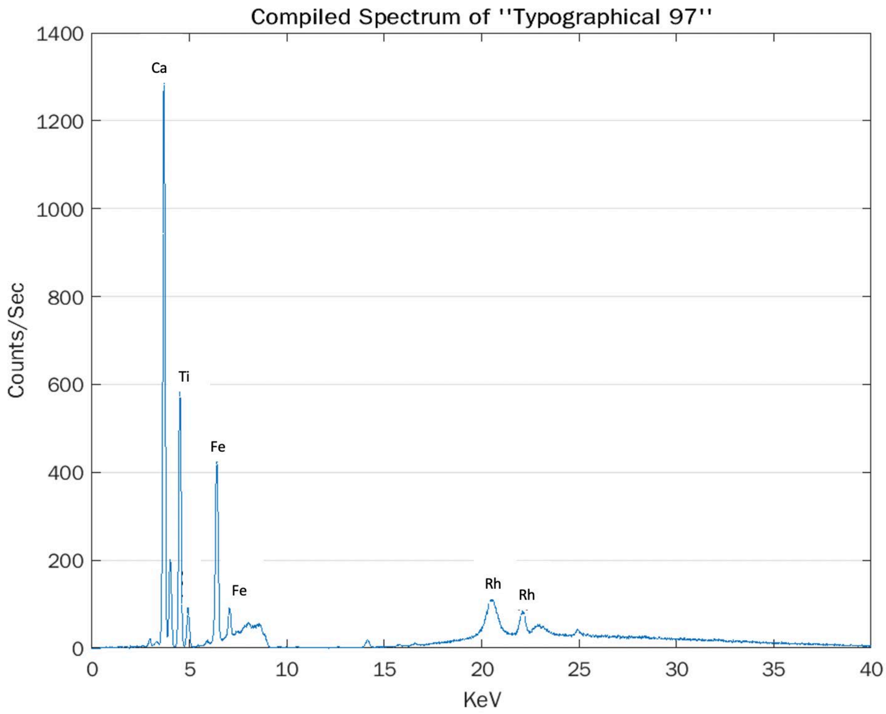
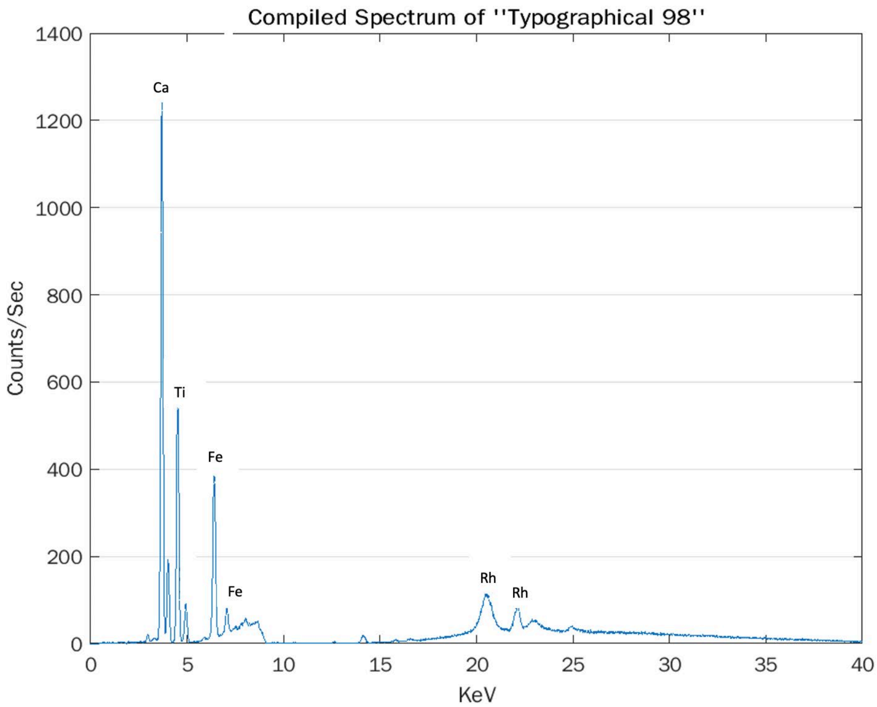
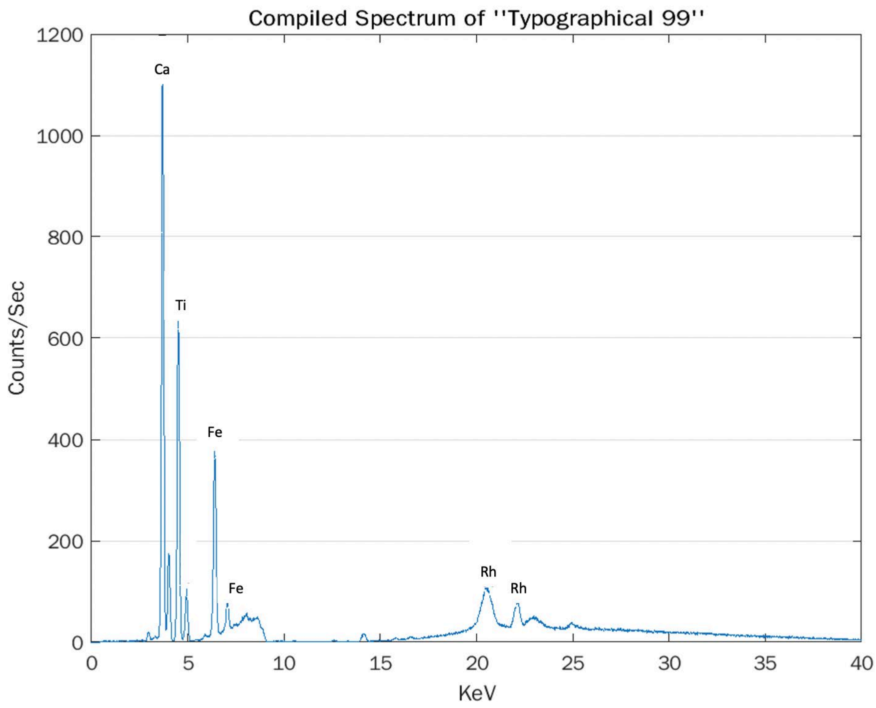
9.3.2 III.2 Portable XRF

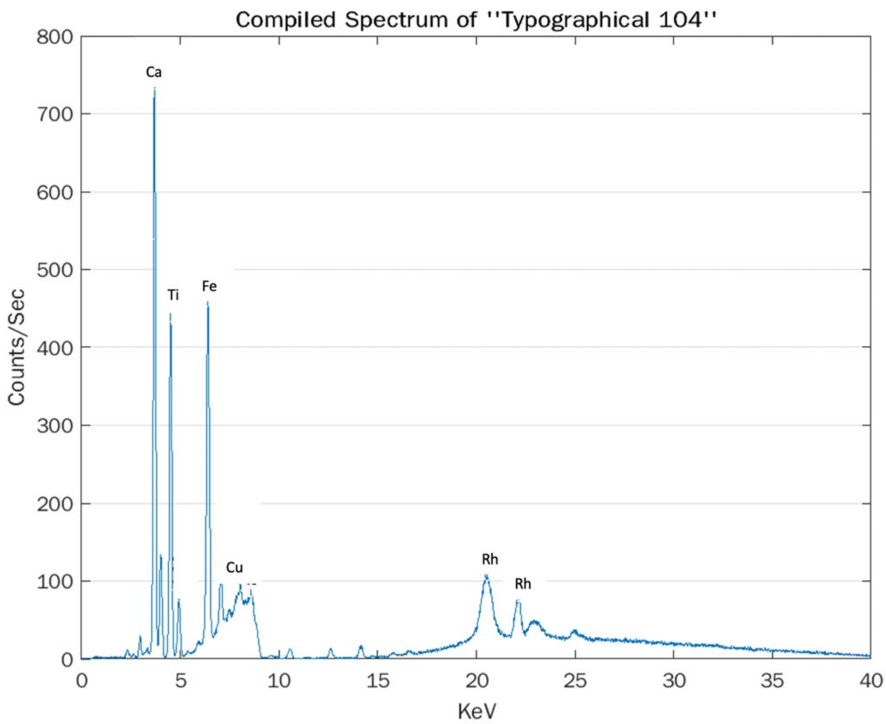
9.3.2.1 III.2.1 Sampling table spectra



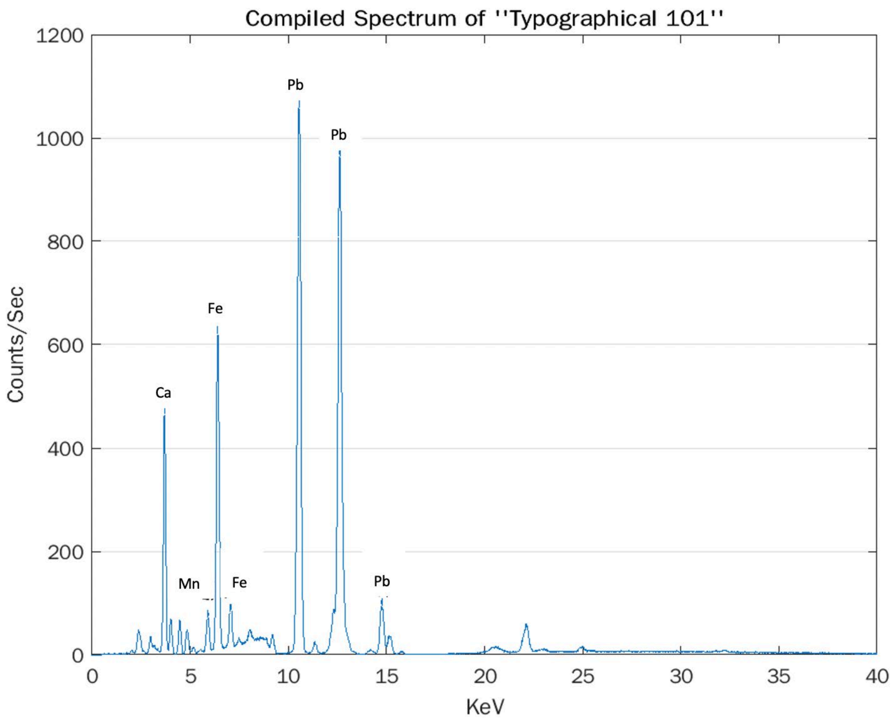


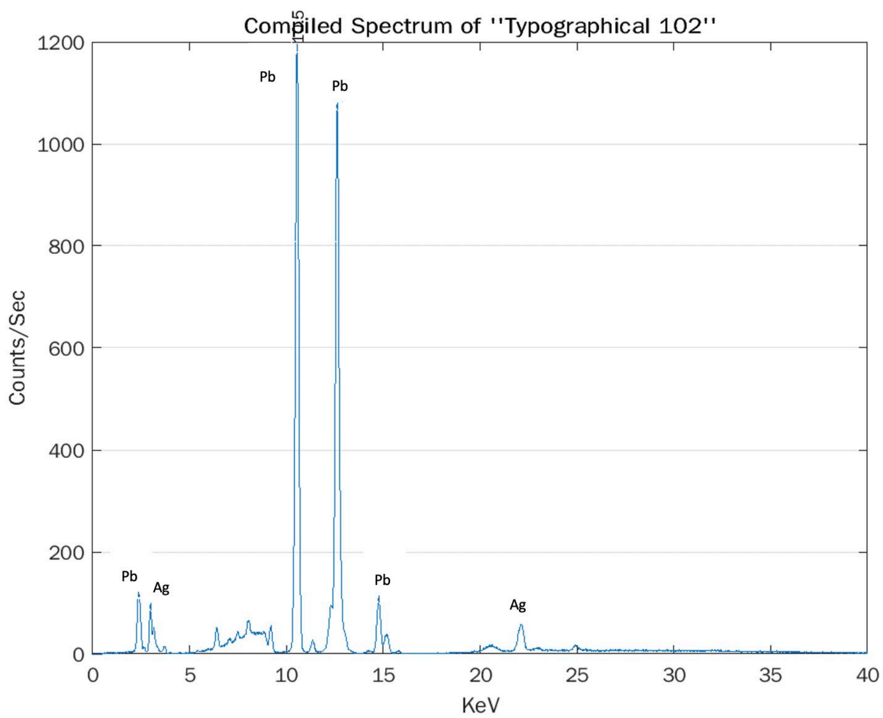


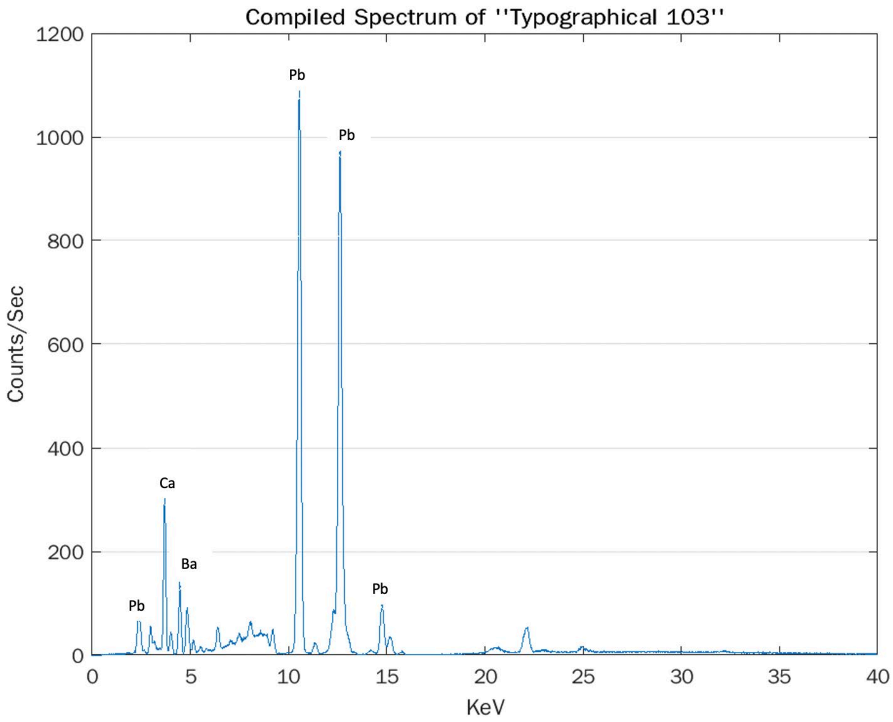
9.3.2.2 III.2.1 The Glasgow Typographical Society banner, textile spectra



9.3.2.3 III.2.1 The Glasgow Typographical Society banner, scroll spectra



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Counts/Sec
KeV
Pb
Pb
Ca
Ba
Pb
Pb
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400
600
800
1000
1200
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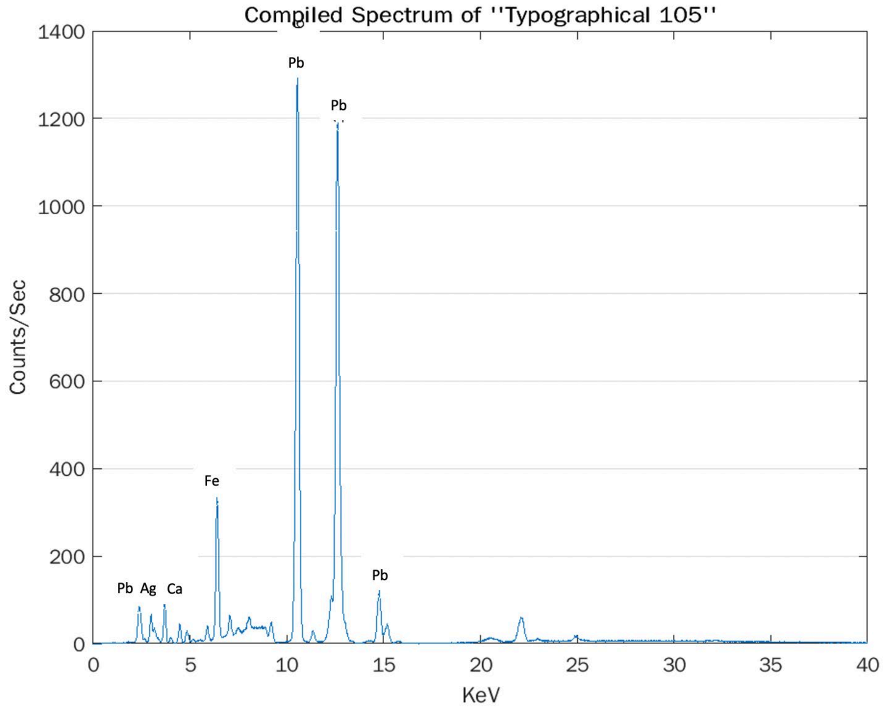
5
10
15
20
25
30
35
40


Compiled Spectrum of ''Typographical 105''
Counts/Sec
KeV
Pb
Pb
Fe
Pb Ag Ca
Pb
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400
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1000
1200
1400
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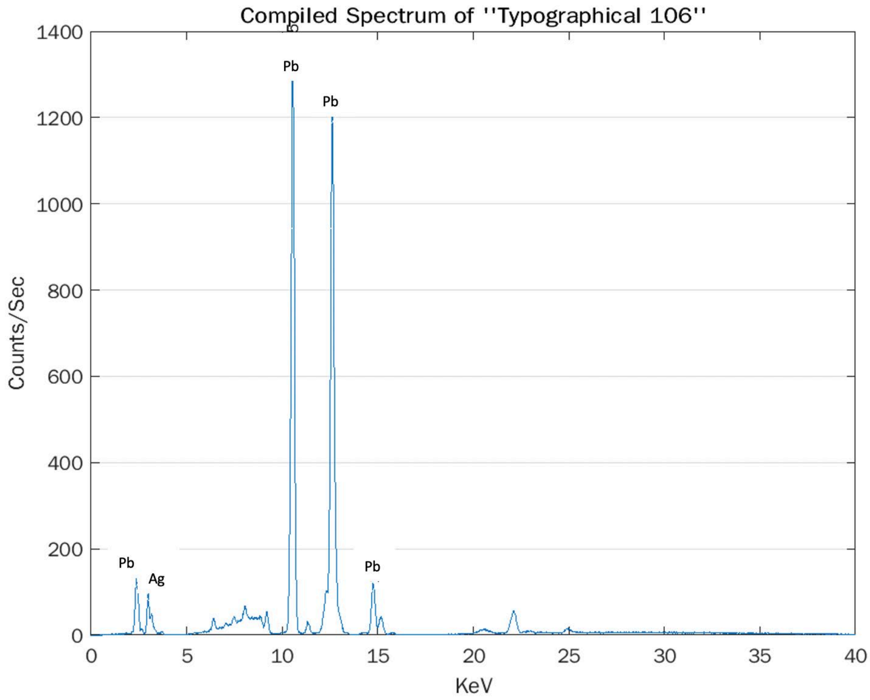
20
25
30
35
40



Compiled Spectrum of ''Typographical 106''
Counts/Sec
KeV
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200
400
600
800
1000
1200
1400
0
5
10
15
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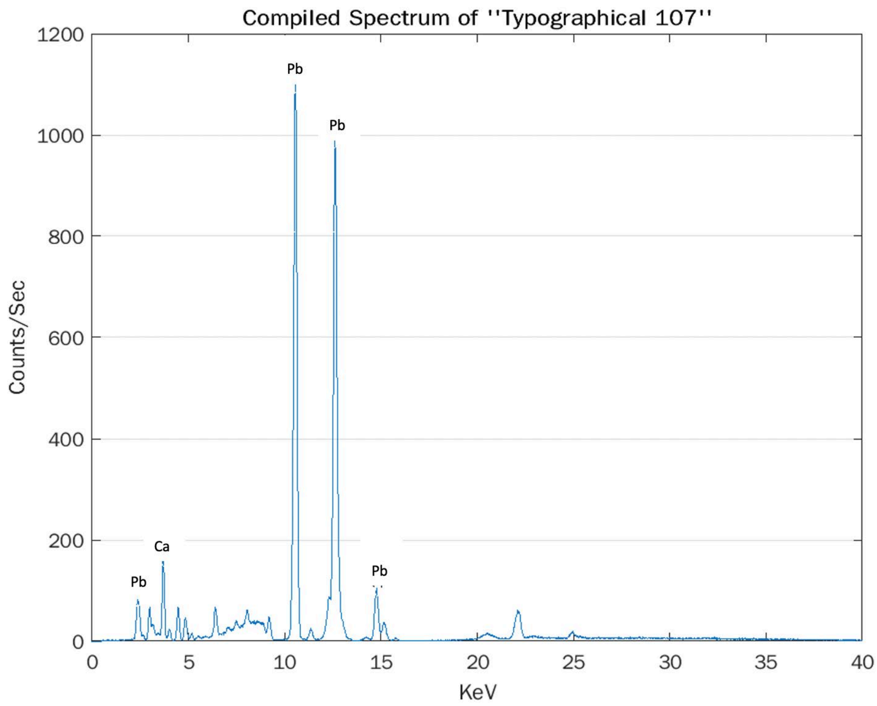
Pb
Pb
Pb
Ag
Pb



Compiled Spectrum of ''Typographical 107''
Counts/Sec
KeV
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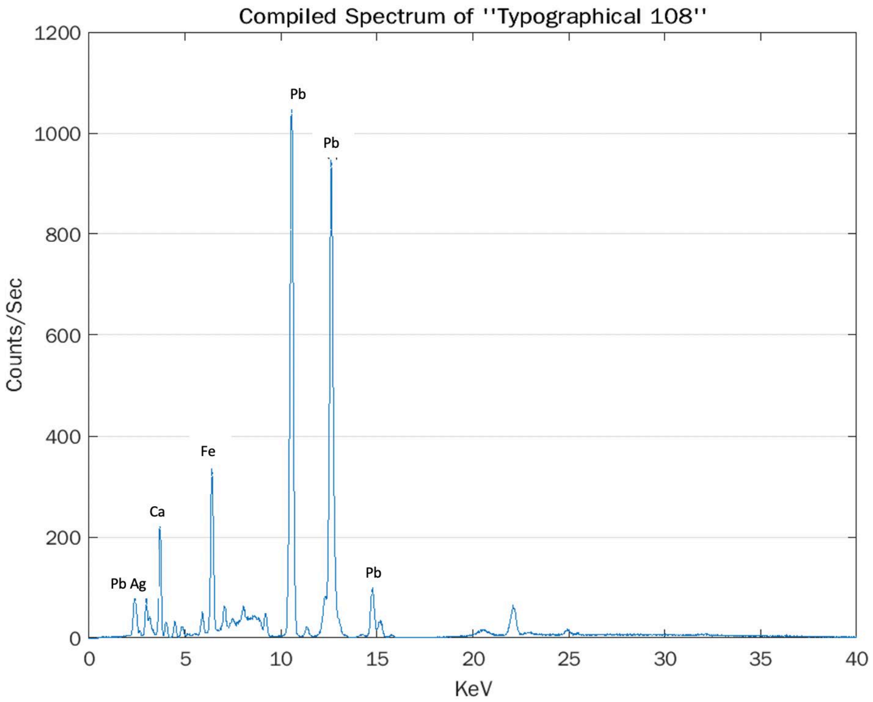
600
800
1000
1200
0
5
10
15
20
25
30
35
40
Pb
Pb
Ca
Pb
Pb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Counts/Sec
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Pb
Fe
Ca
Pb Ag
Pb
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800
1000
1200
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5
10
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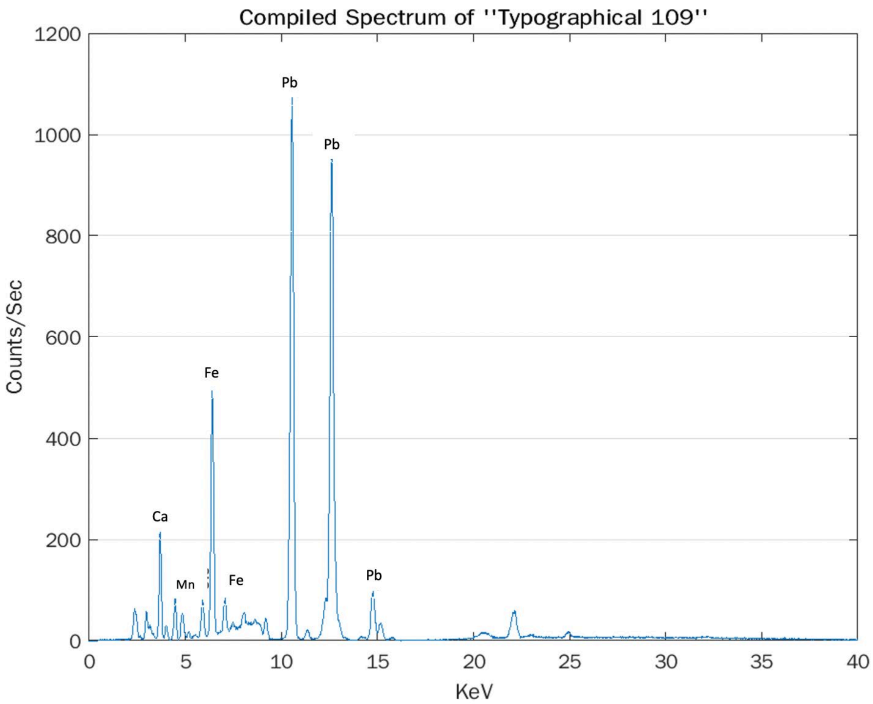
20
25
30
35
40


Compiled Spectrum of ''Typographical 109''
Counts/Sec
KeV
Pb
Pb
Fe
Ca
Mn
Fe
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600
800
1000
1200
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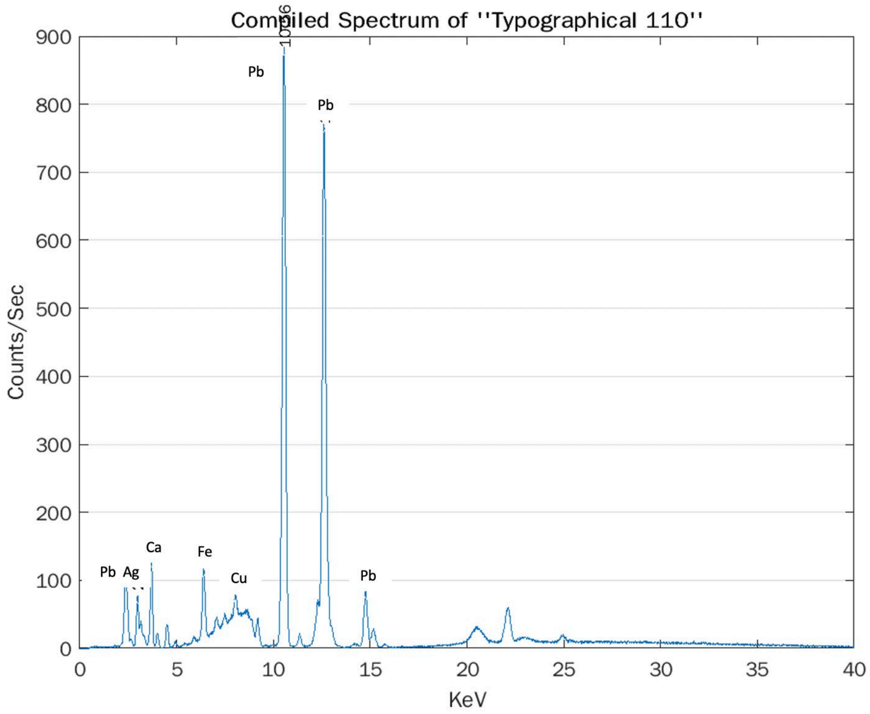
10
15
20
25
30
35
40



Compiled Spectrum of ''Typographical 110''
Counts/Sec
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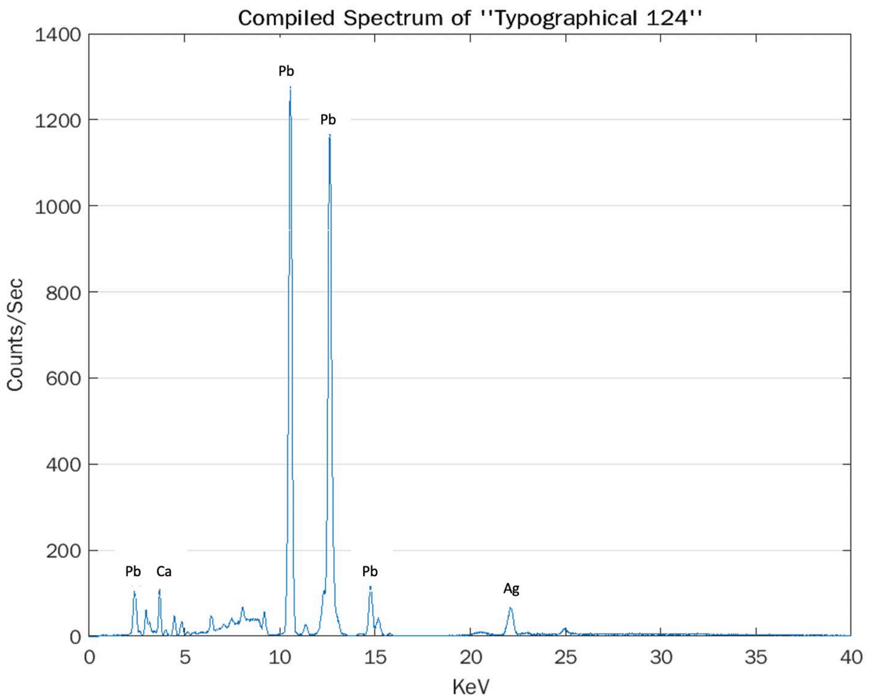
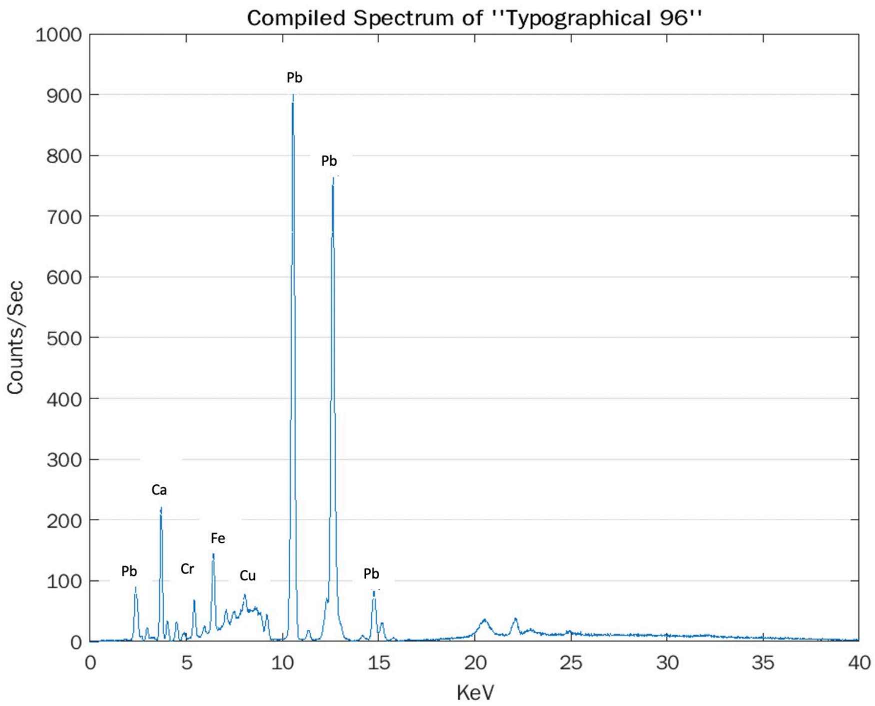
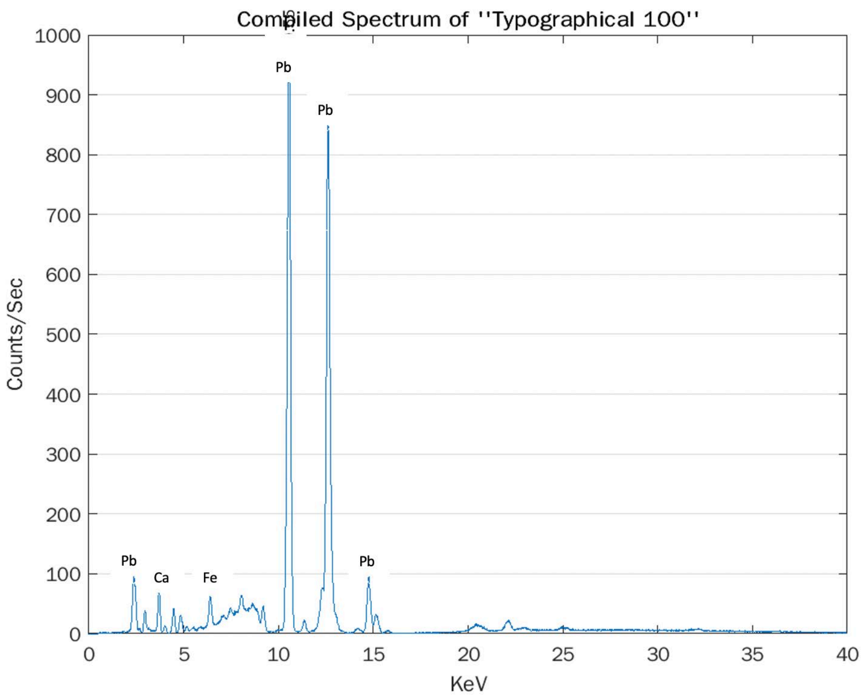
Pb
Pb
Ag
Ca
Fe
Cu
Pb

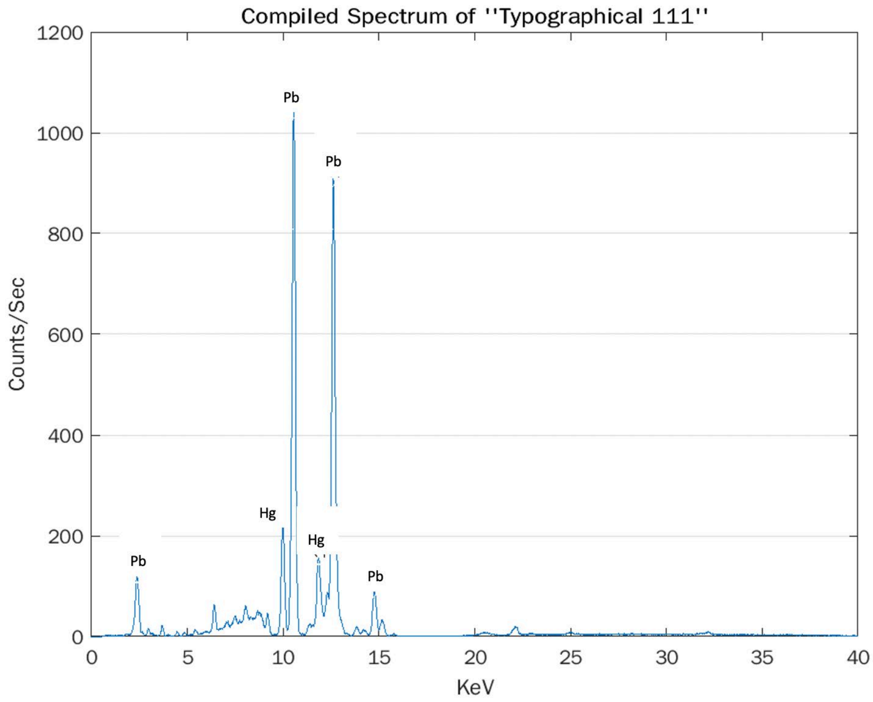


Compiled Spectrum of ''Typographical 124''
Counts/Sec
KeV
Pb
Pb
Pb
Ca
Pb
Ag

9.3.2.4 III.2.1 The Glasgow Typographical Society banner, paint spectra



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Counts/Sec
KeV
Pb
Pb
Hg
Hg
Pb
Pb
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800
1000
1200
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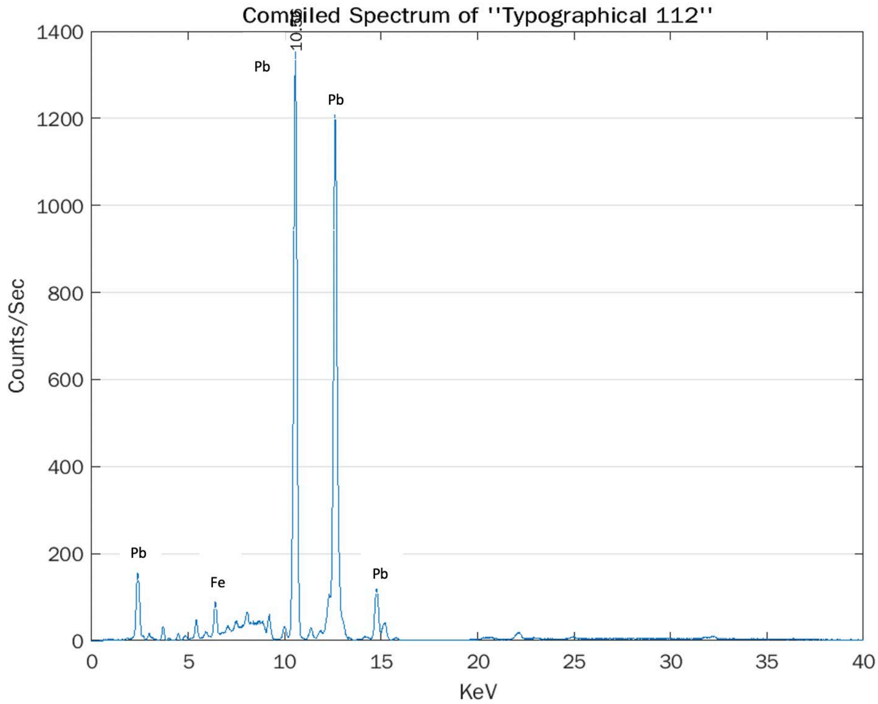
5
10
15
20
25
30
35
40


Compiled Spectrum of ''Typographical 112''
Counts/Sec
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Pb
Fe
Pb
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600
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1000
1200
1400
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10
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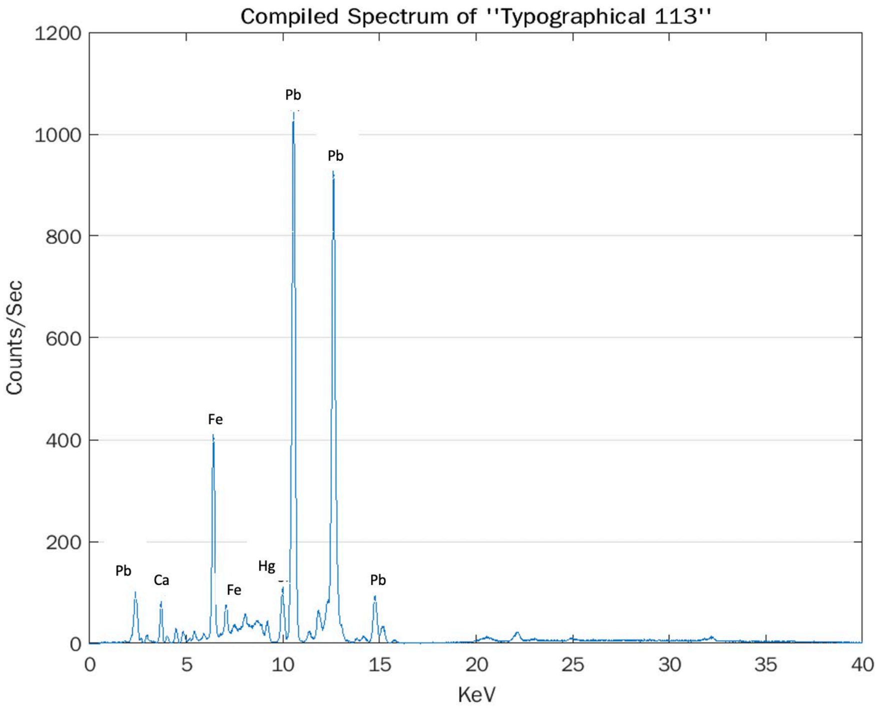
20
25
30
35
40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Counts/Sec
KeV
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Fe
Pb
Ca
Fe
Hg
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30
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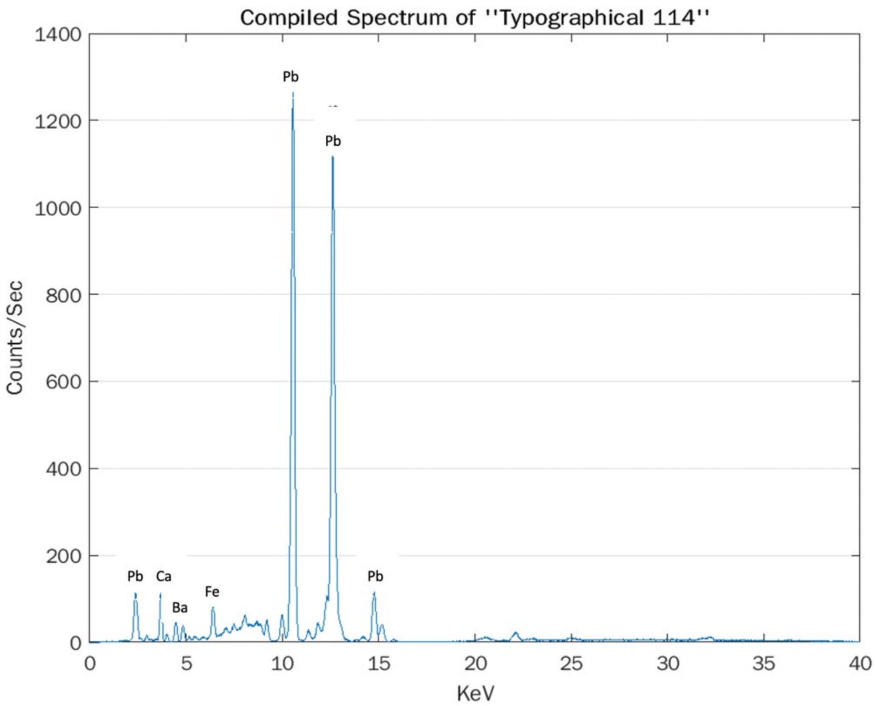
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Counts/Sec
KeV
Pb
Pb
Pb
Ca
Ba
Fe
Pb
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1200
1400
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10
15
20
25
30
35
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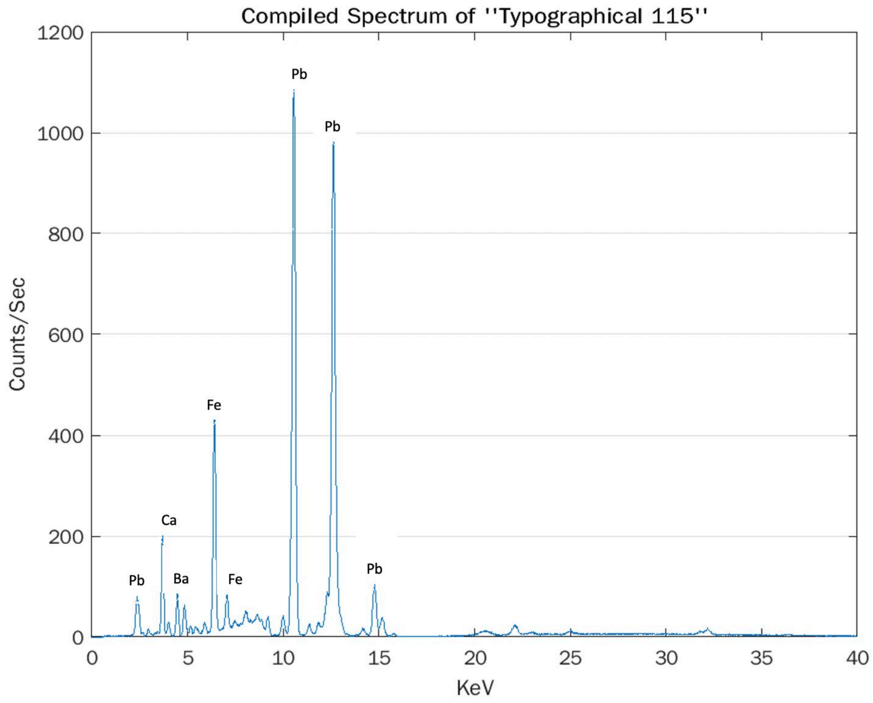
Compiled Spectrum of ''Typographical 115''
Counts/Sec
KeV
Pb
Pb
Fe
Ca
Pb
Ba
Fe
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600
800
1000
1200
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15
20
25
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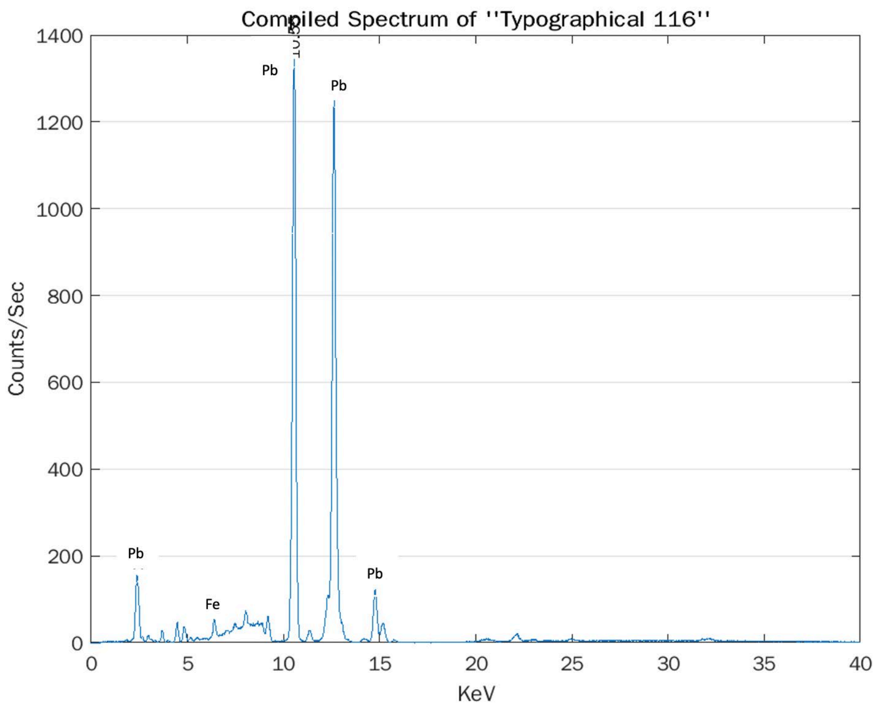
35
40


Compiled Spectrum of ''Typographical 116''
Counts/Sec
KeV
Pb
Pb
Pb
Fe
Pb
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600
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1000
1200
1400
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5
10
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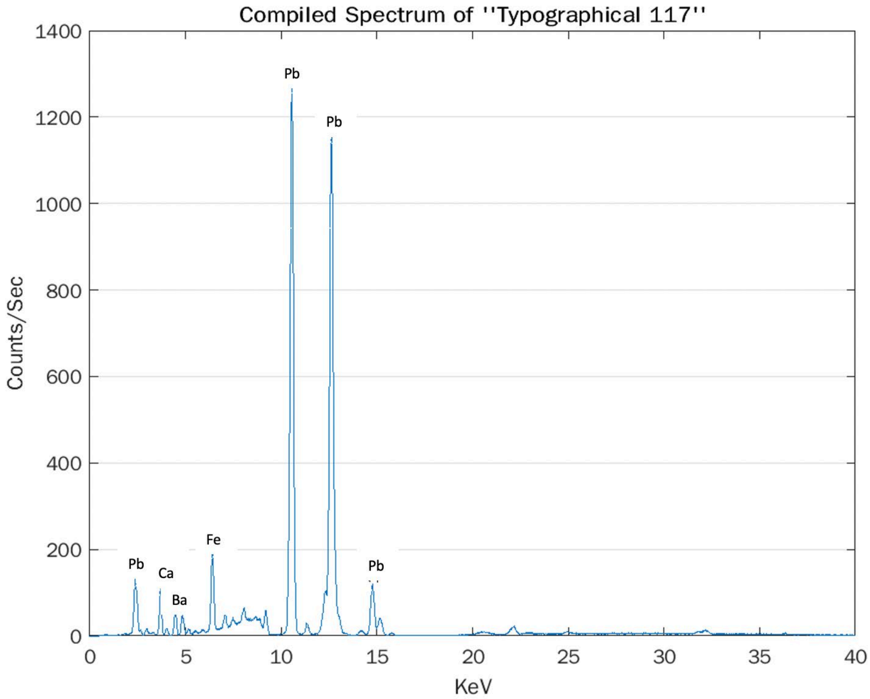
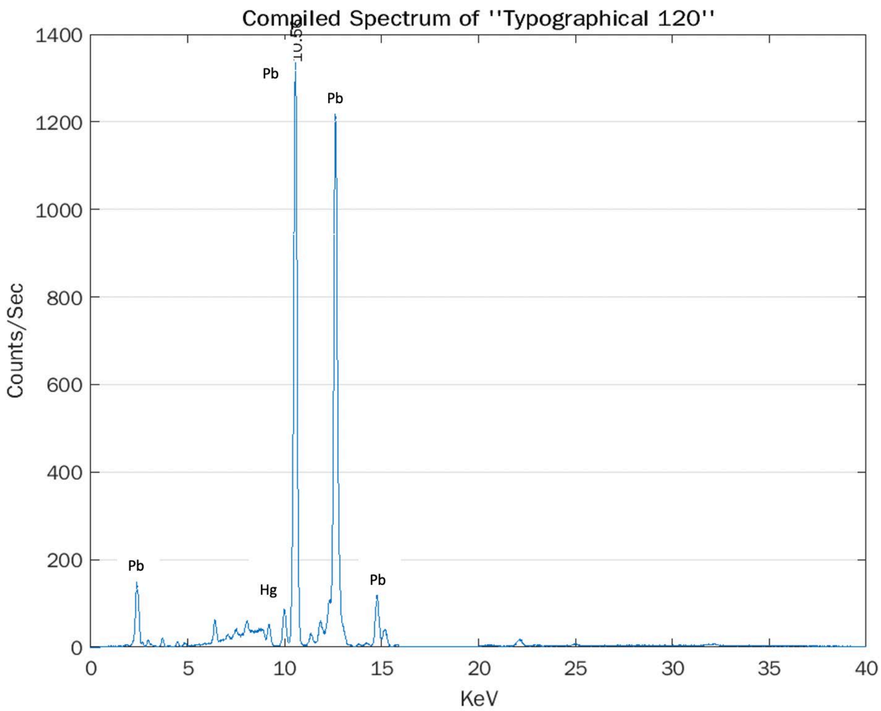
20
25
30
35
40


Compiled Spectrum of ''Typographical 117''
Counts/Sec
KeV
Pb
Pb
Pb
Ca
Ba
Fe
Pb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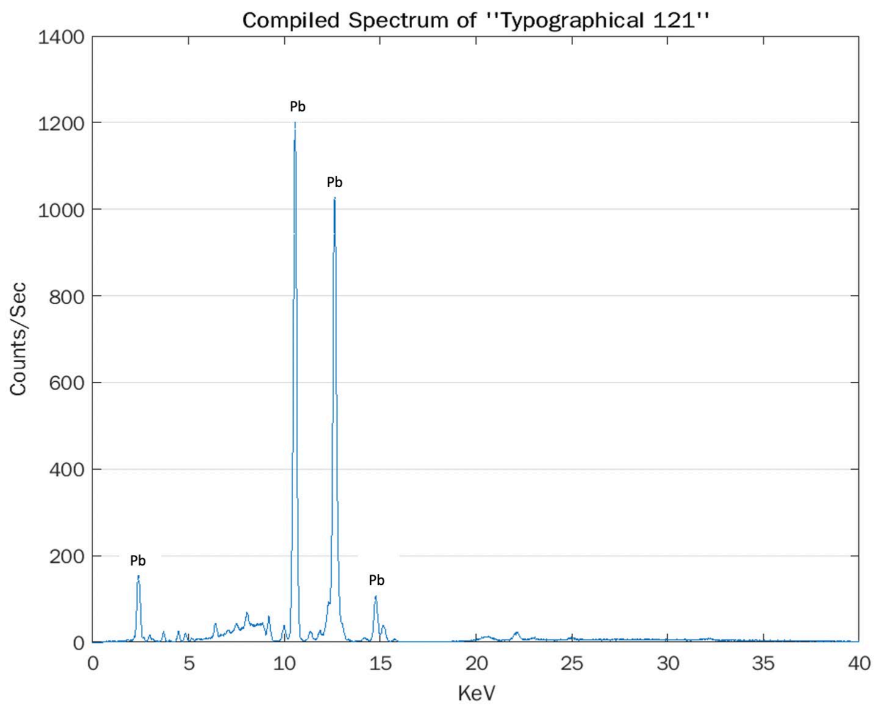
Counts/Sec
KeV
Pb
Pb
Pb
Hg
Pb


Compiled Spectrum of ''Typographical 121''
Counts/Sec
KeV
Pb
Pb
Pb
Pb
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800
1000
1200
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5
10
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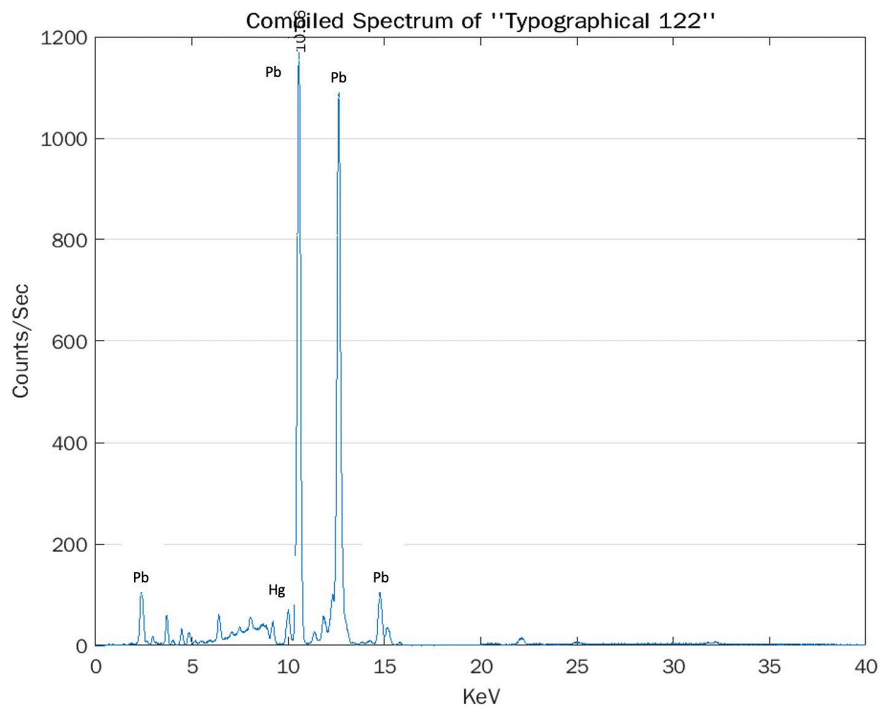
25
30
35
40


Compiled Spectrum of ''Typographical 122''
Counts/Sec
KeV
Pb
Pb
Pb
Hg
Pb
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600
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1000
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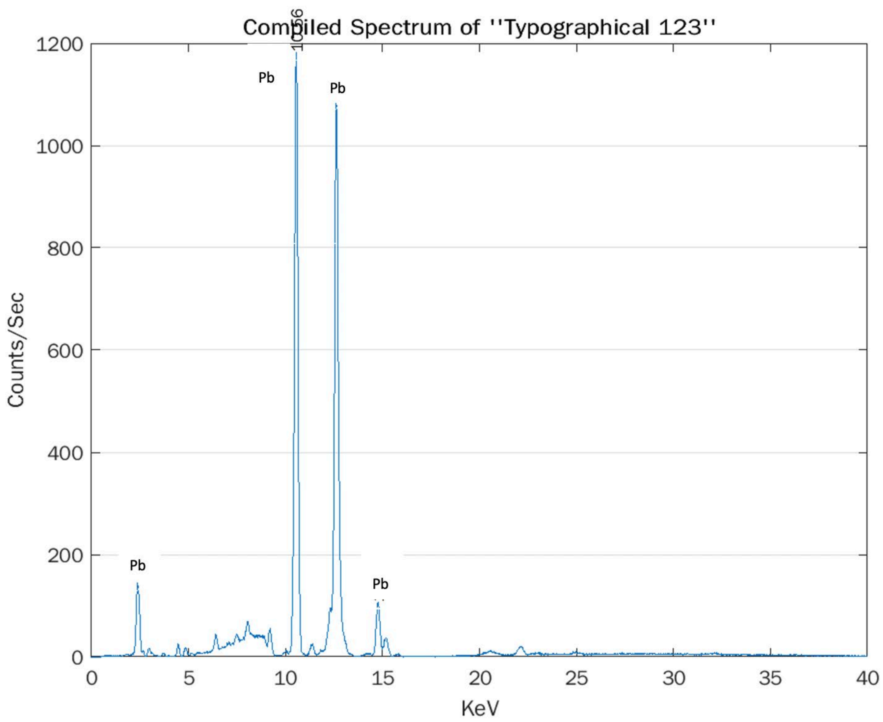
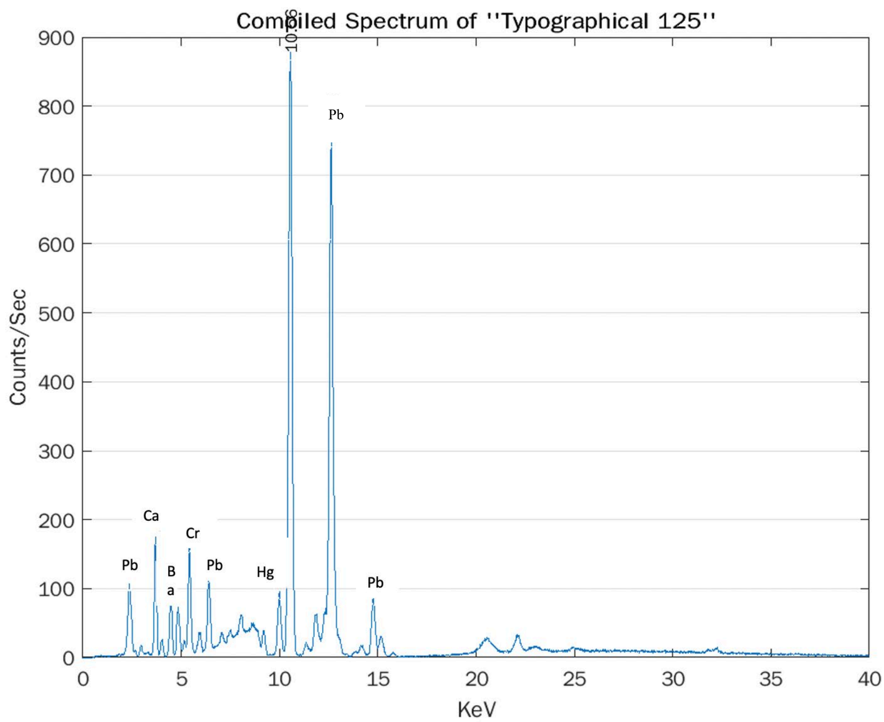
5
10
15
20
25
30
35
40


Compiled Spectrum of ''Typographical 123''
Counts/Sec
KeV
Pb
Pb
Pb
Pb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Counts/Sec
KeV
Pb
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Cr
Ba
Pb
Hg
Pb
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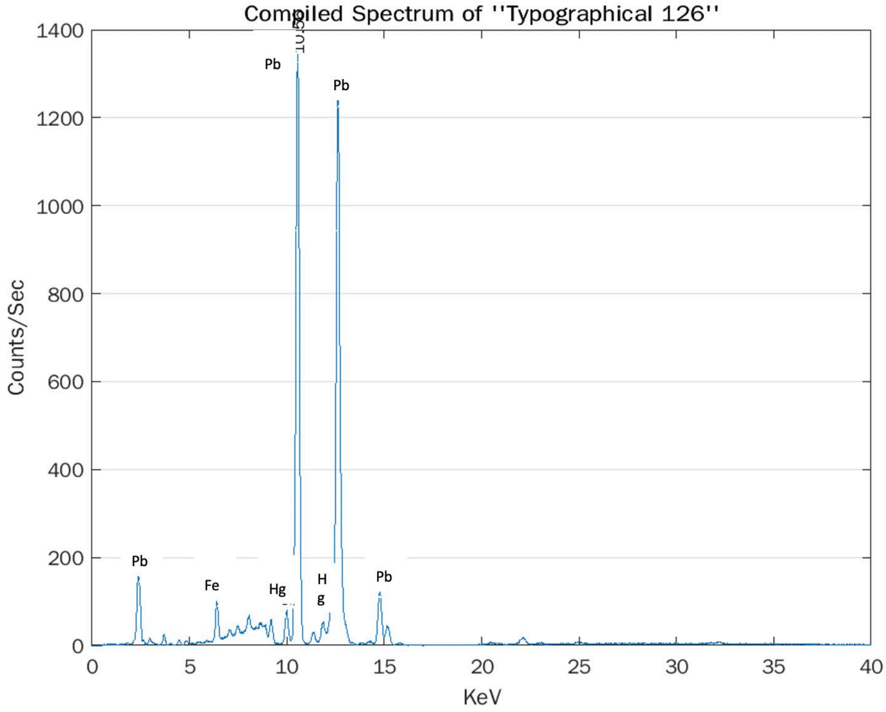
Compiled Spectrum of ''Typographical 126''
Counts/Sec
KeV
Pb
Pb
Pb
Fe
Hg
H
g
Pb
0
200
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600
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1000
1200
1400
0
5
10
15
20
25
30
35
40

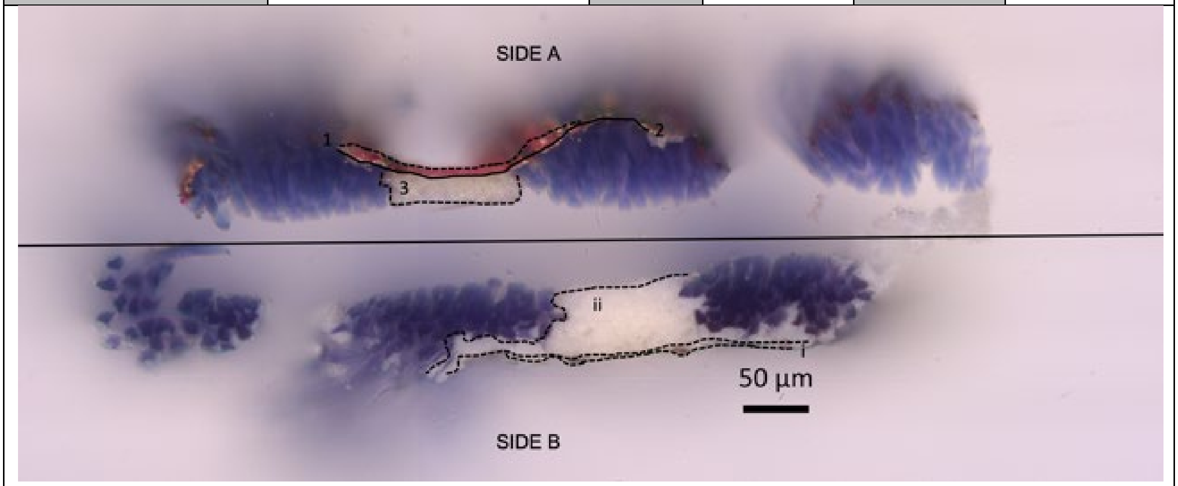
9.3.3 III. 3 SEM-EDX

Due to the considerable number of tables in this section, they were grouped per cross-section sample under the same table number. The consecutive change in numbering indicates a different group of tables of a different cross-section sample.

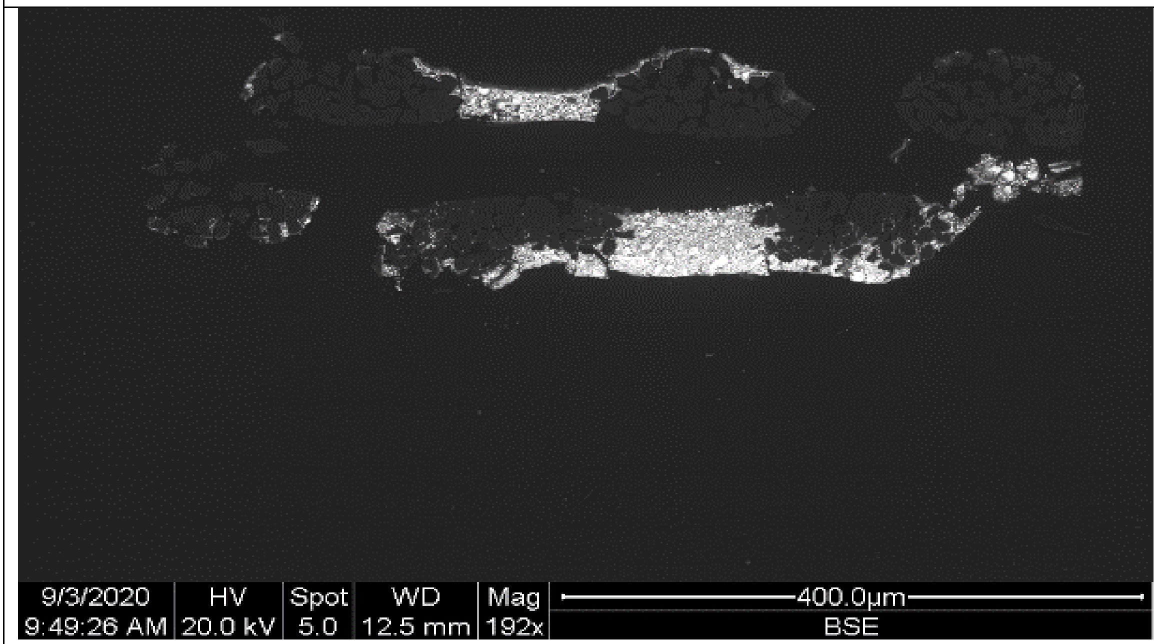
9.3.3.1 III. 3. 1 The Glasgow Typographical Society banner, scroll cross-section sample

Table III.23 SEM-EDX results of scroll cross-section sample TS08

BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08

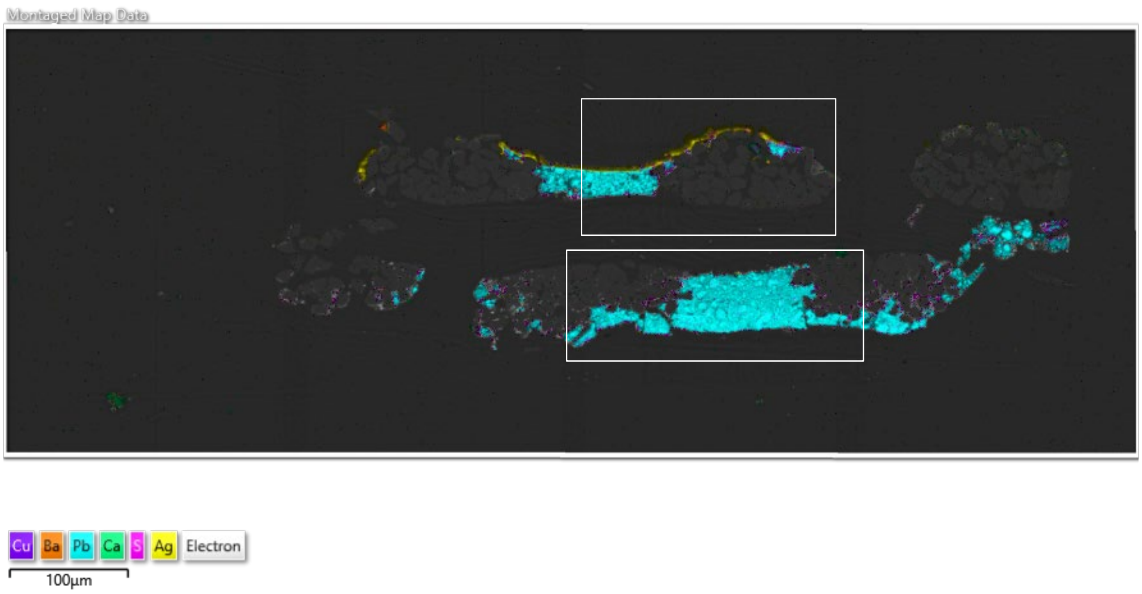


Sample TS08 annotated, incident light, bright field, Axioskop 2 Zeiss, 100×

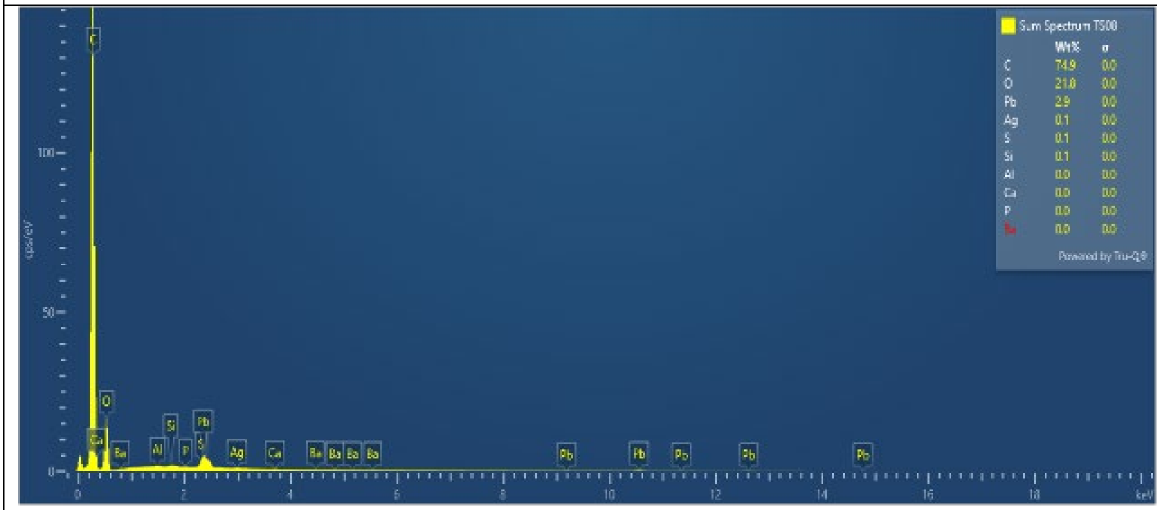


Sample TS08 backscattered electron image, Carl Zeiss Sigma SEM, 192×

Table III.23 (continued) SEM-EDX results of scroll cross-section sample TS08					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08



Sample TS08 selected areas, composite element map, Carl Zeiss Sigma SEM, 192×



Sample TS08 EDX sum spectrum, AZtec software

Table III.23 (continued) SEM-EDX results of scroll cross-section sample TS08						
BANNER	The Glasgow Typographical Society					
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08	

INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
1	2	C, O, Ag, Pb, Fe, Ba, S, Sn, Al, Ca, Si, P, Na, Mg	Red lake pigment (tin/alum based), calcium phosphate (bone-ash), red iron oxide with associated silico-aluminates (clay), barium sulphate, calcium carbonate, lead oxide (drier), magnesium carbonate (extender), salt-associated sodium and silver sulphurs
2	46	C, Pb, Ag, O	Silver leaf and lead carbonate
3	170	O, Pb, C	Lead carbonate

INTERPRETATION SIDE B OF THE BANNER			
Layer	Spectrum number	Elements	Materials
i	Elements were too light for analysis	n/a	Protein-based isolation layer (positively stained with SYPRO Ruby)
ii	93	Pb, C, O	Lead carbonate
	3	Pb, C, O	Lead carbonate particle

Table III.23 (continued) SEM-EDX results of scroll cross-section sample TS08

BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08

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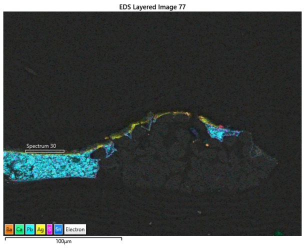
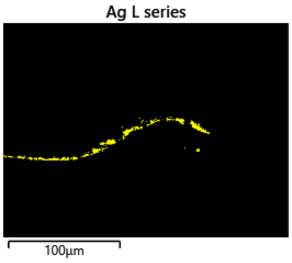
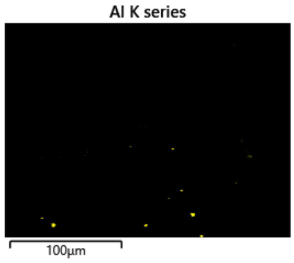
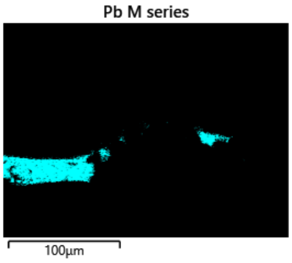
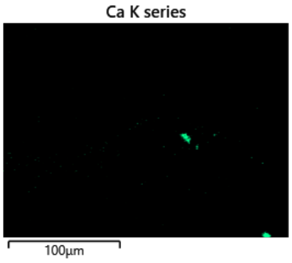
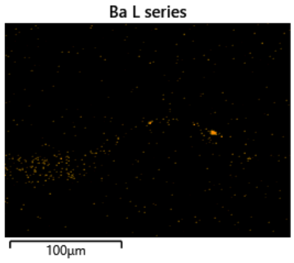
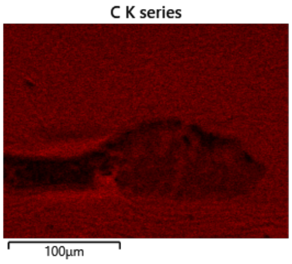
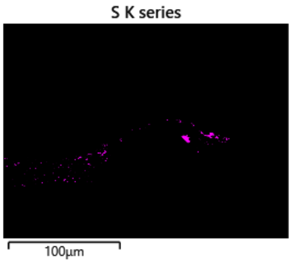
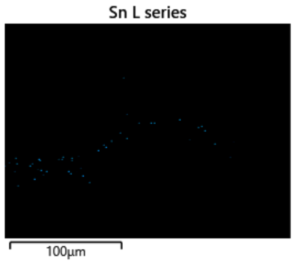
<tr><td rowspan="2">
Sample TS08 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×</td><td colspan="2">SINGLE ELEMENT MAPS SIDE A OF THE BANNER</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
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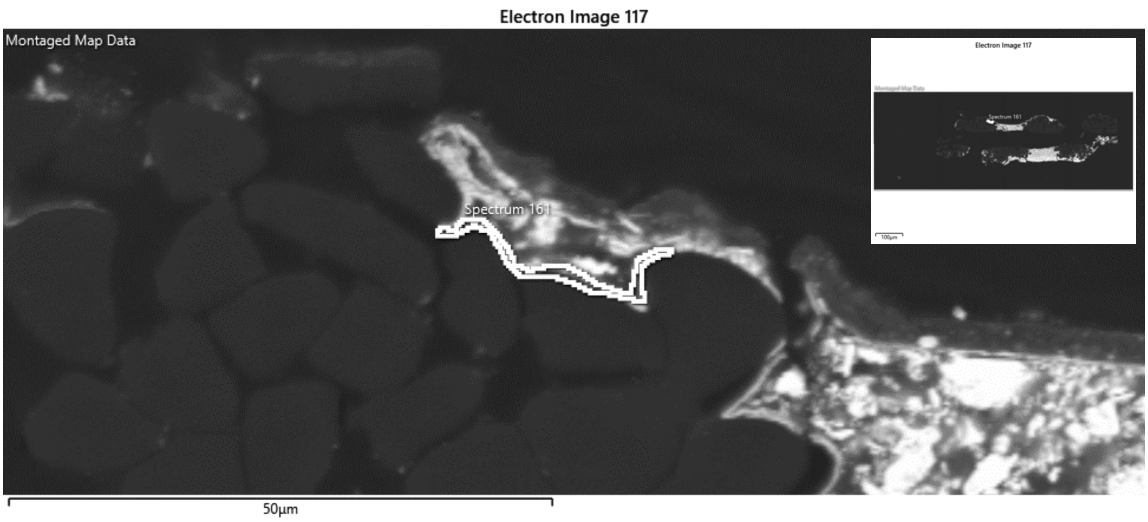


Figure III.1 Back-scattered electron image of lead-containing size in sample TS08 side A with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 1200×

Table III.23 (continued) SEM-EDX results of scroll cross-section sample TS08

BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08

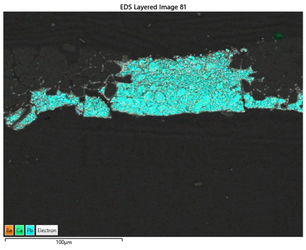
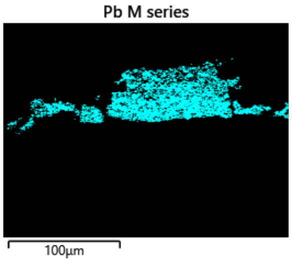
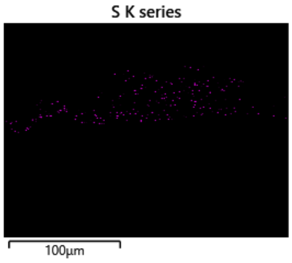
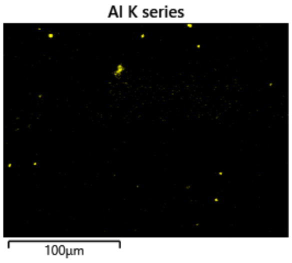
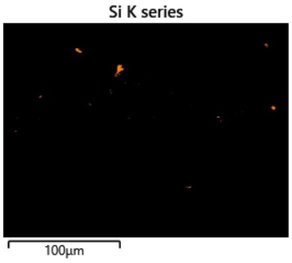
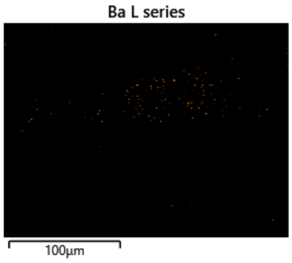
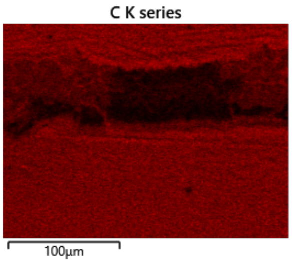
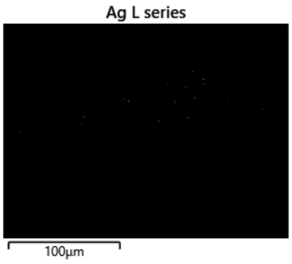
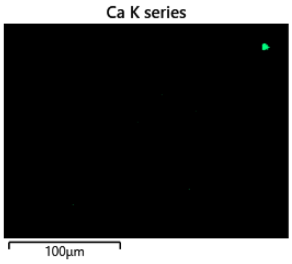
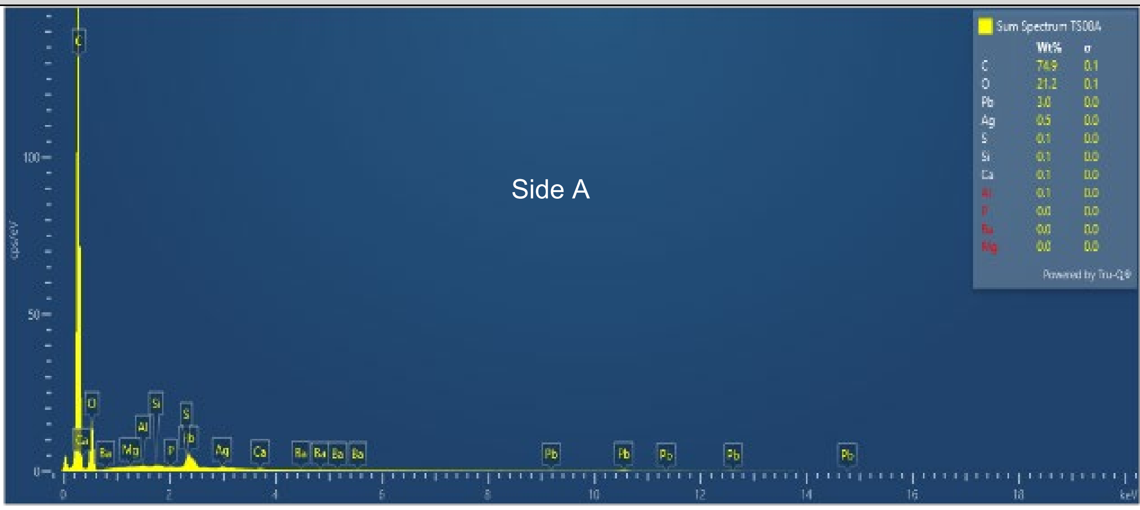
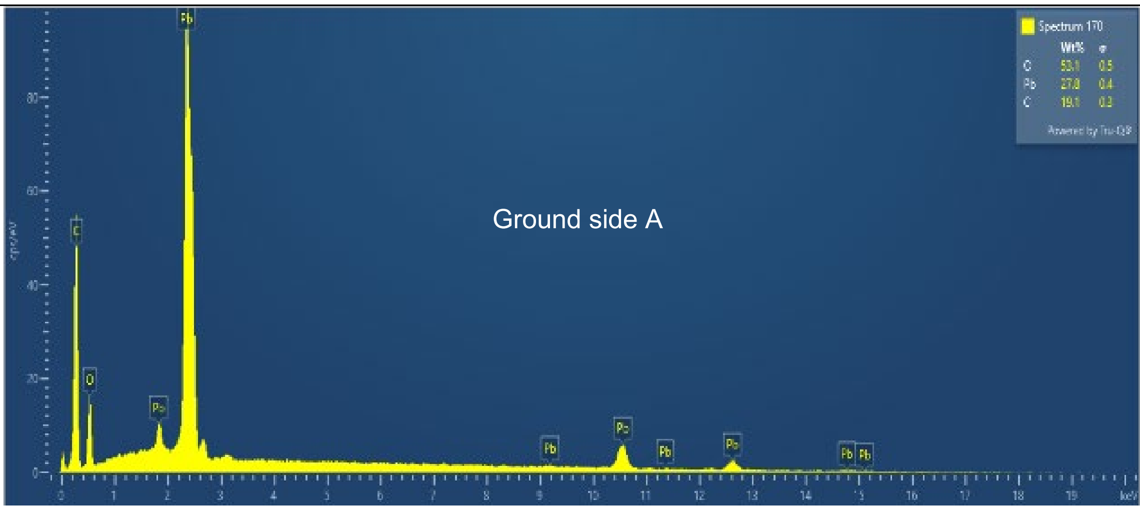
	SINGLE ELEMENT MAPS SIDE B OF THE BANNER	
 Sample TS08 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×		
		
		

Table III.23 (continued) SEM-EDX results of scroll cross-section sample TS08					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08
SELECTED EDX SPECTRA SIDE A OF THE BANNER					





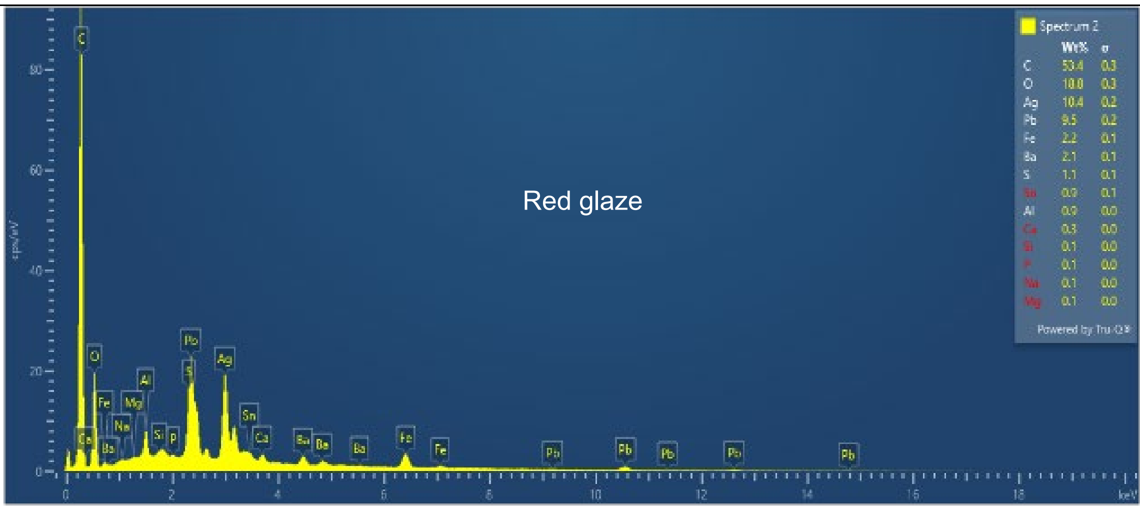


Table III.23 (continued) SEM-EDX results of scroll cross-section sample TS08					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08
SELECTED EDX SPECTRA SIDE A OF THE BANNER					

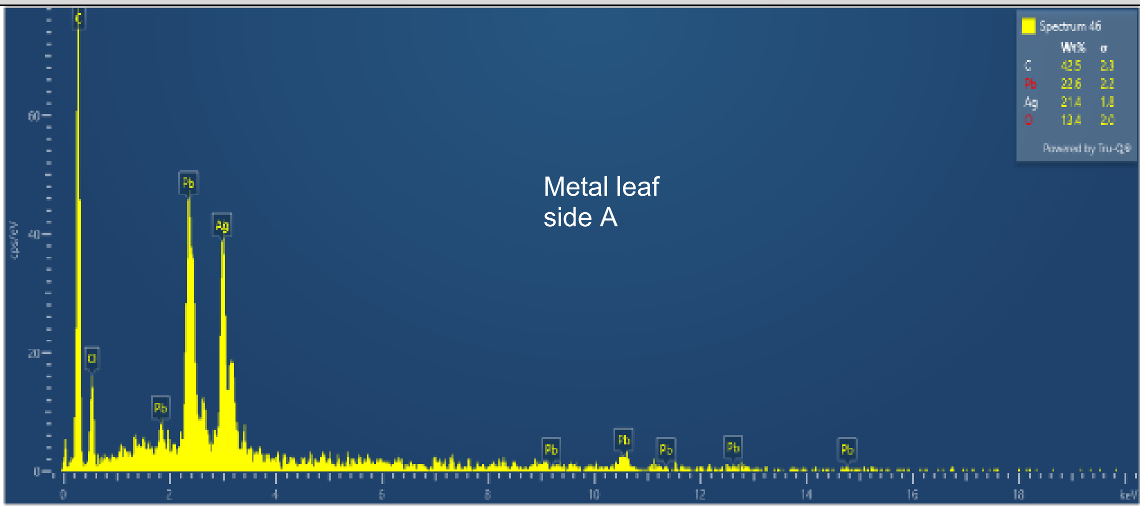


Table III.23 (continued) SEM-EDX results of scroll cross-section sample TS08					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

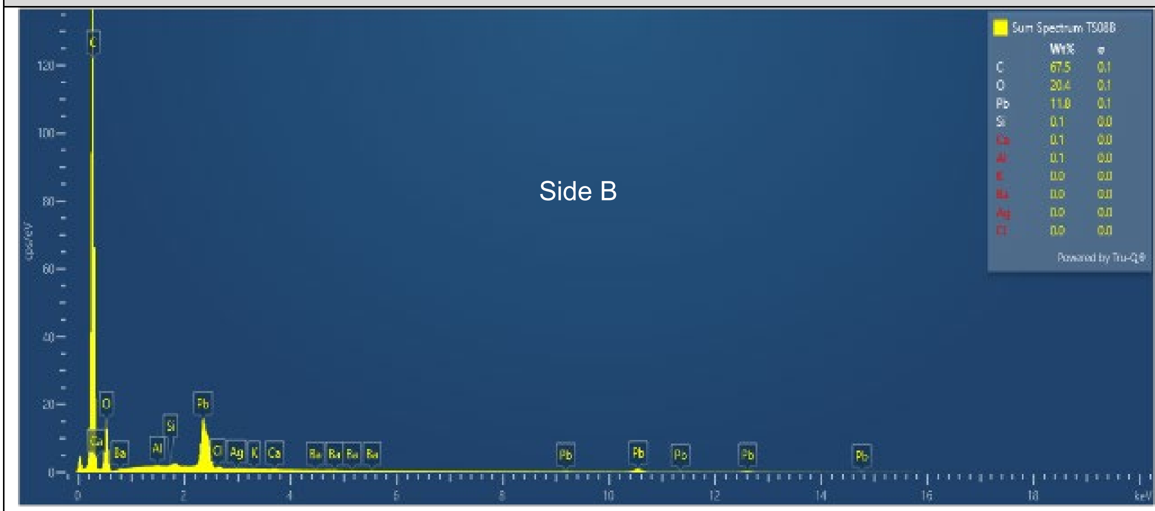
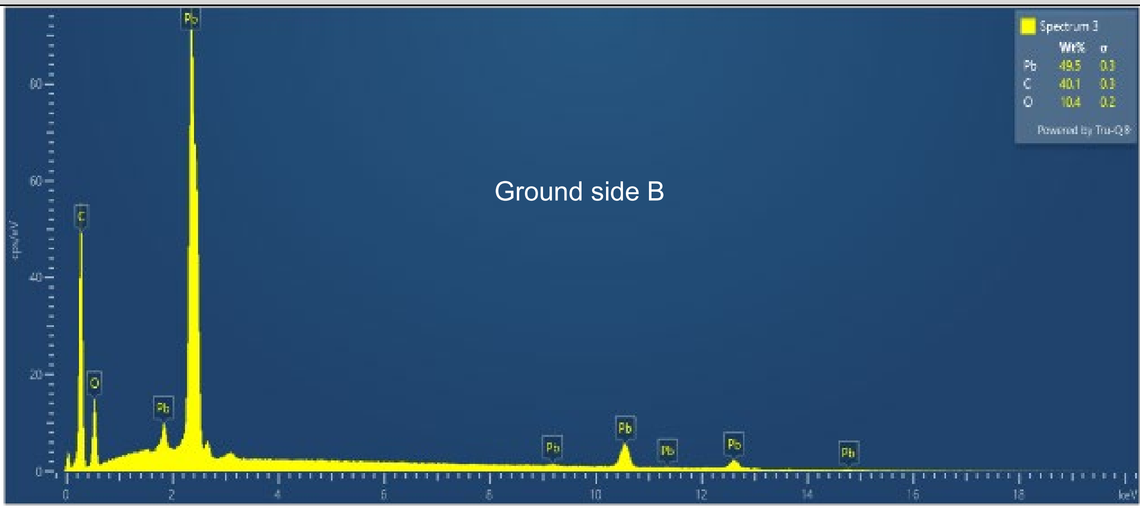
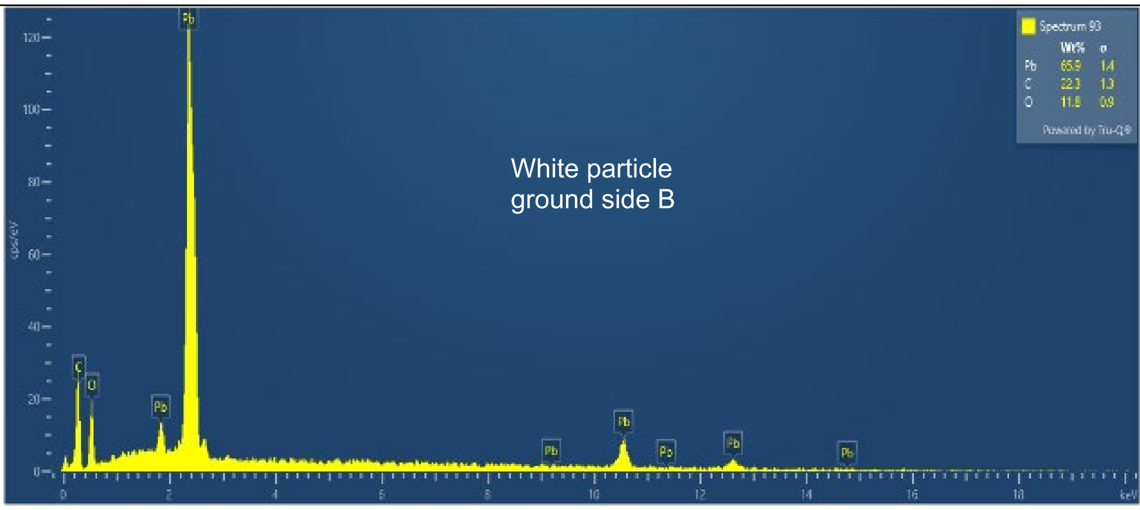
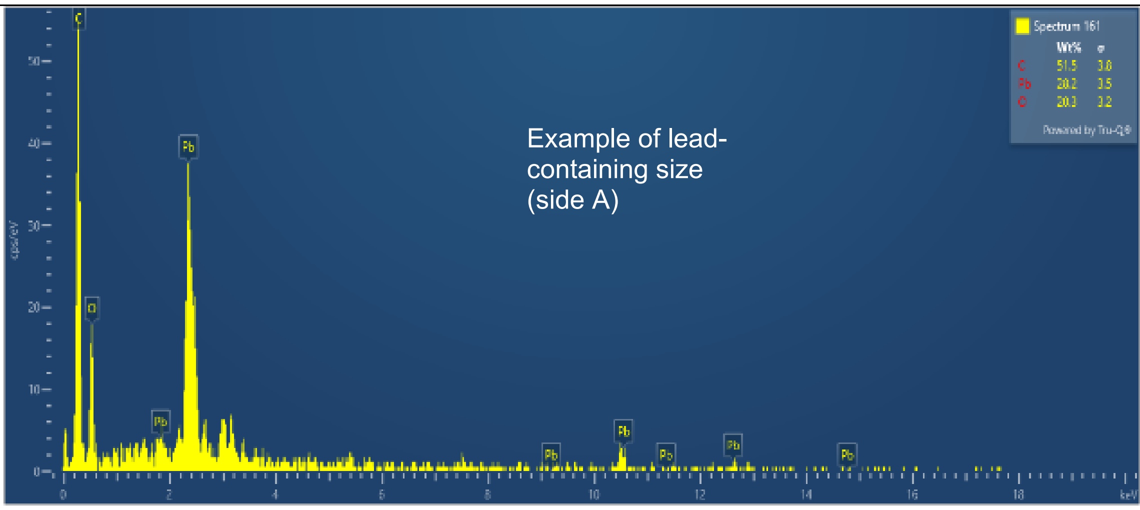


Table III.23 (continued) SEM-EDX results of scroll cross-section sample TS08					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS08
SELECTED EDX SPECTRA SIDE B OF THE BANNER					



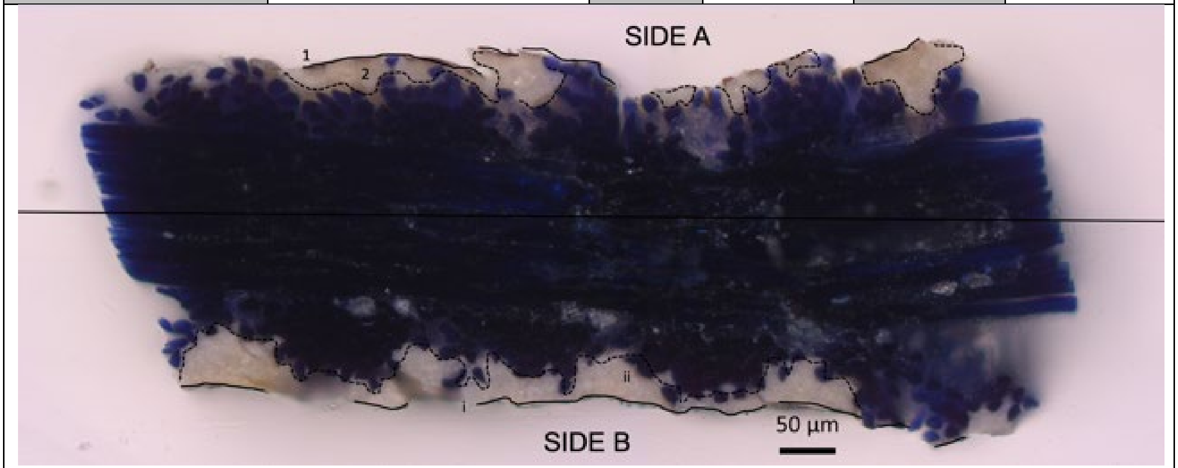




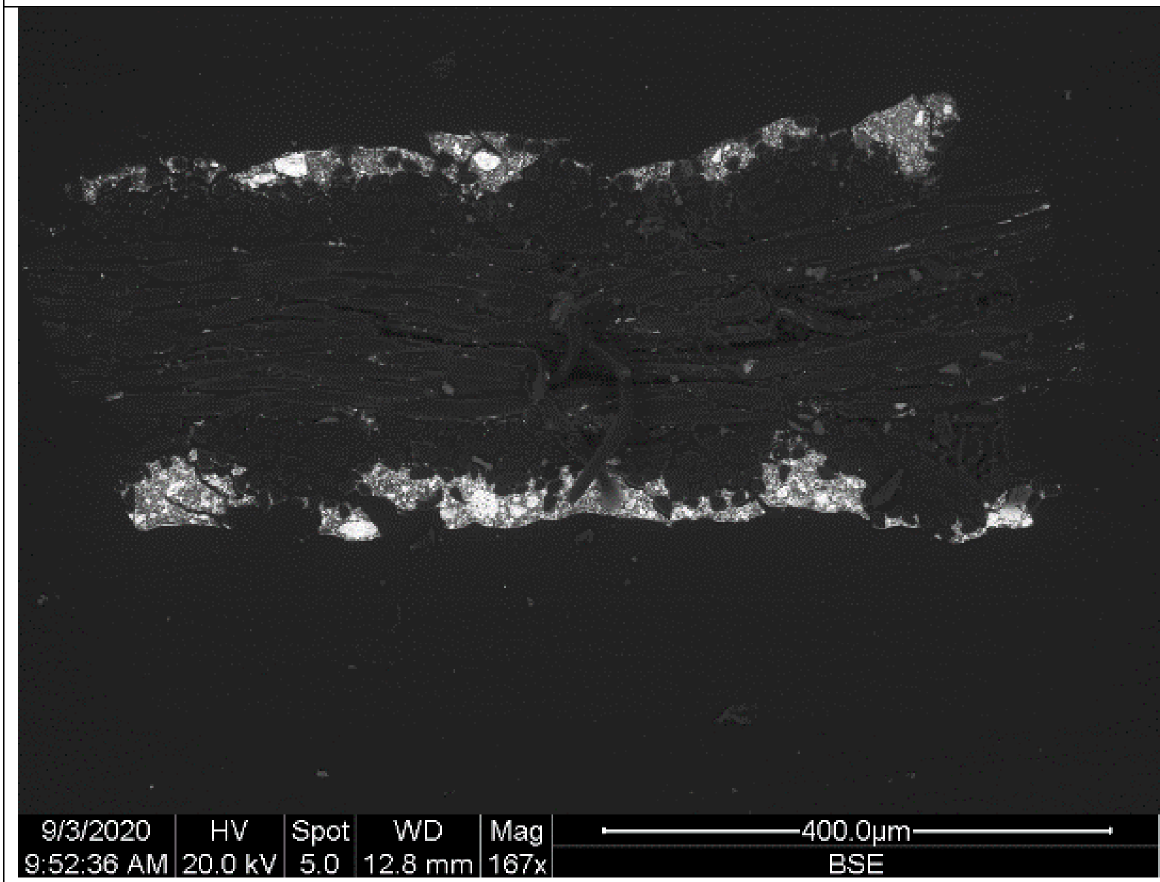
9.3.3.2 III.3.2 The Glasgow Upholsterers Society banner, scroll cross-section sample

Table III.24 SEM-EDX results of scroll cross-section sample GU08

BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU08

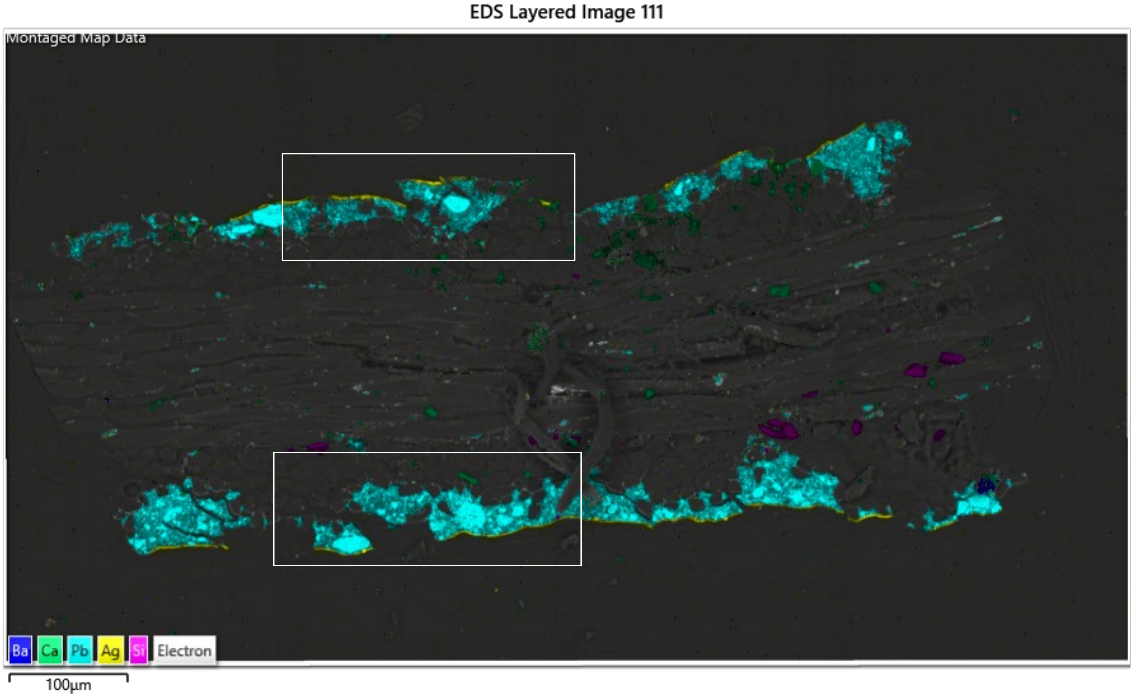


Sample GU08 annotated, incident light, bright field, Axioskop 2 Zeiss, 100×

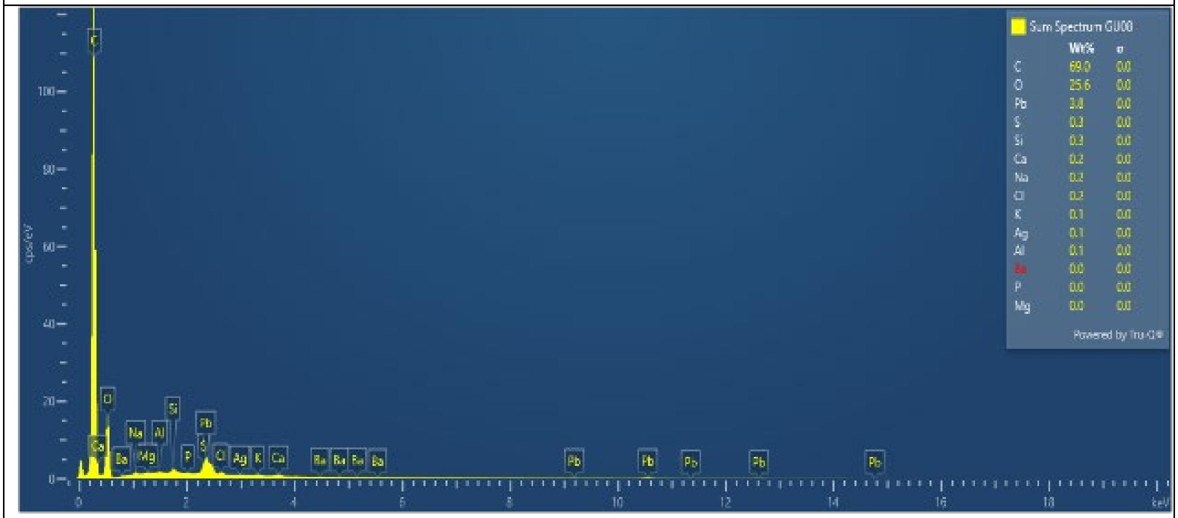


Sample GU08 backscattered electron image, Carl Zeiss Sigma SEM, 167×

Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU08



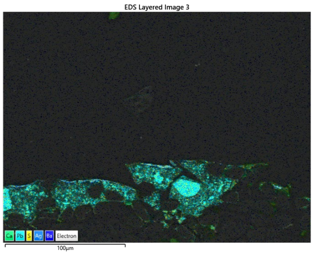
Sample GU08 selected areas, composite element map, Carl Zeiss Sigma SEM, 167×



Sample GU08 EDX sum spectrum, AZtec software

Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08						
BANNER		The Glasgow Upholsterers Society				
MANUFACTURER		George Kenning	YEAR	1884	SAMPLE	GU08
INTERPRETATION SIDE A OF THE BANNER						
Layer	Spectrum number	Elements		Materials		
1	43	C, Ag, O, Pb, S		Silver leaf (sulphured) and lead carbonate		
2	114	C, Pb, O		Lead carbonate		
	94	O, C, Ca, Pb, S		Calcium sulphate particle (with lead carbonate)		
INTERPRETATION SIDE B OF THE BANNER						
Layer	Spectrum number	Elements		Materials		
i	98	C Ag, O, Pb, S		Silver leaf (sulphured) and lead carbonate		
ii	150	C, Pb, O, Ca, Ba, S		Lead carbonate with barium sulphate and calcium carbonate		
	9	C Pb O		Lead carbonate particle		

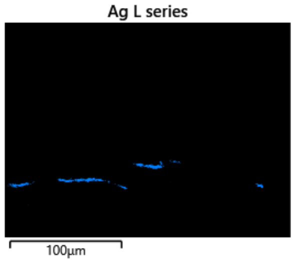
Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU08



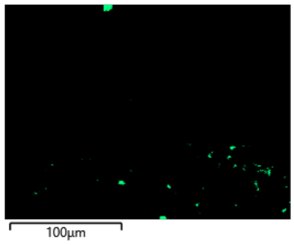
Sample GU08 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×

SINGLE ELEMENT MAPS SIDE A OF THE BANNER

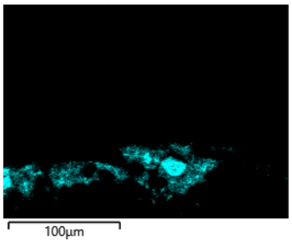
Ag L series



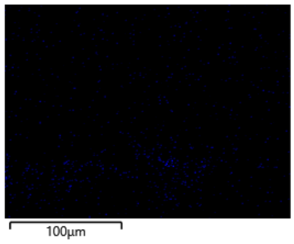
Ca K series



Pb M series



Ba L series



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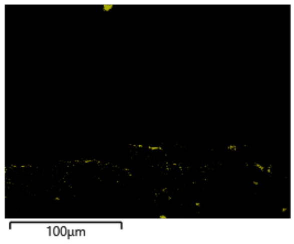
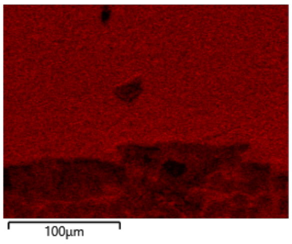
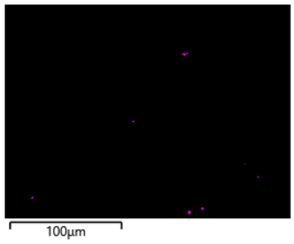


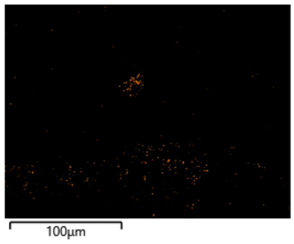
C K series

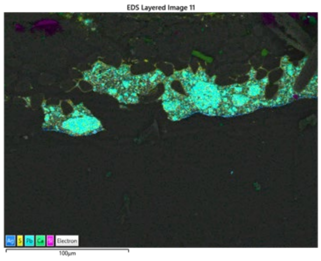


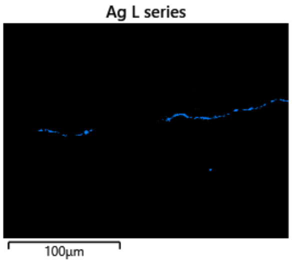
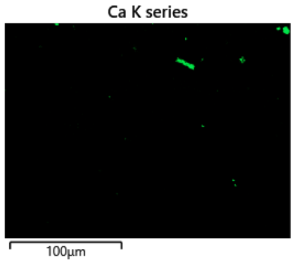
Si K series



Cl K series



<table>
<tr><td colspan="6">Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08</td></tr>
<tr><td>BANNER</td><td colspan="5">The Glasgow Upholsterers Society</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning</td><td>YEAR</td><td>1884</td><td>SAMPLE</td><td>GU08</td></tr>
<tr><td rowspan="2">

Sample GU08 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×</td><td colspan="5">SINGLE ELEMENT MAPS SIDE B OF THE BANNER</td></tr>
<tr><td colspan="2">
</td><td colspan="3">
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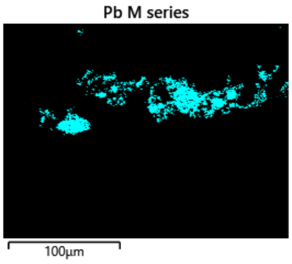
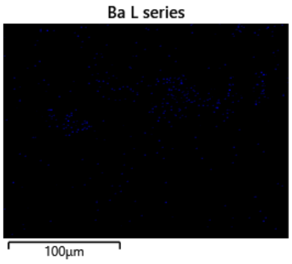
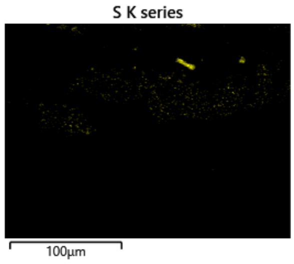
<tr><td>
</td><td colspan="2">
</td><td colspan="3">
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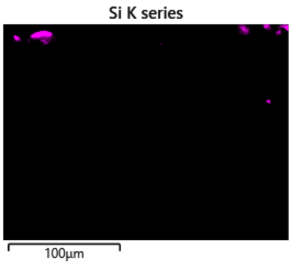
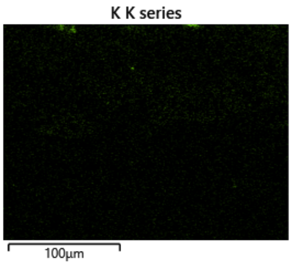
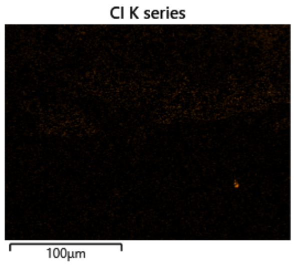
<tr><td>
</td><td colspan="2">
</td><td colspan="3">
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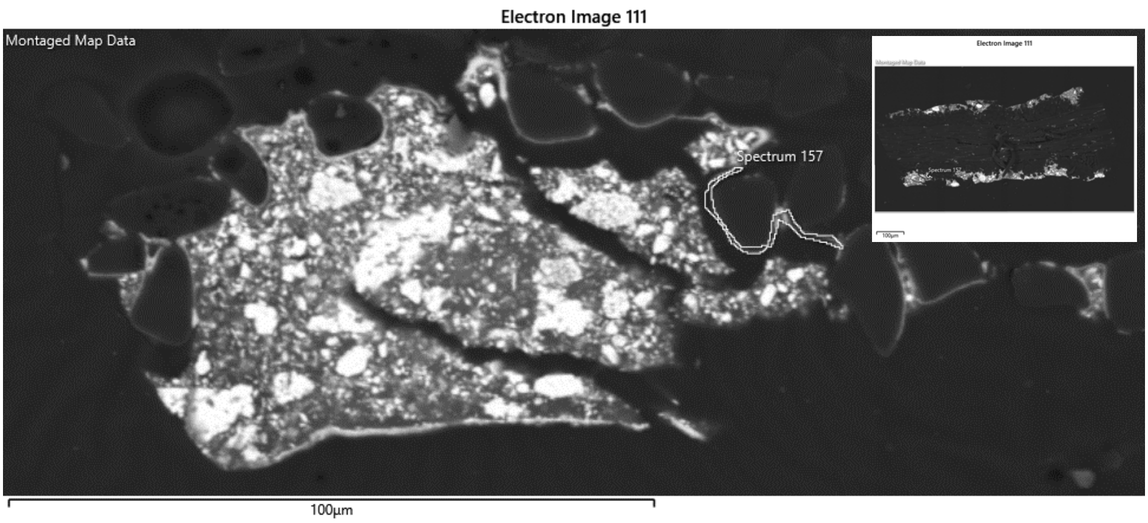
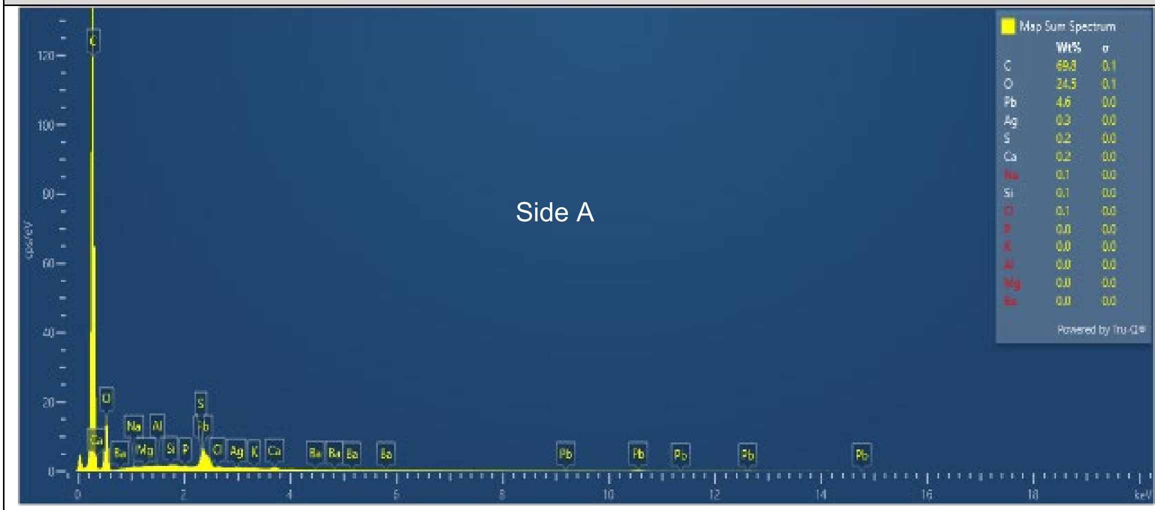
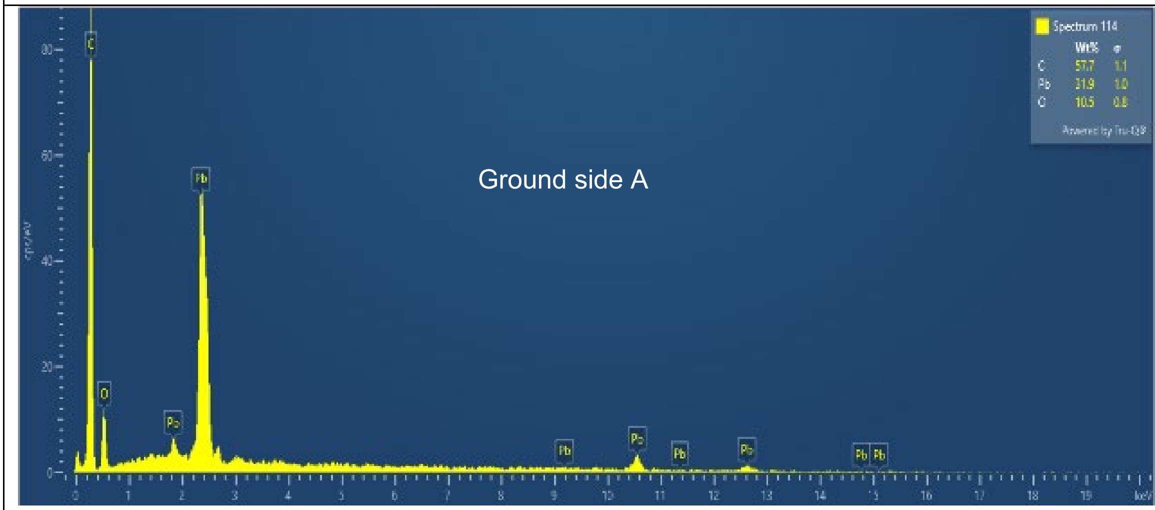


Figure III.2 Back-scattered electron image of lead-containing size in sample GU08 side B with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 1200×

Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU08
SELECTED EDX SPECTRA SIDE A OF THE BANNER					





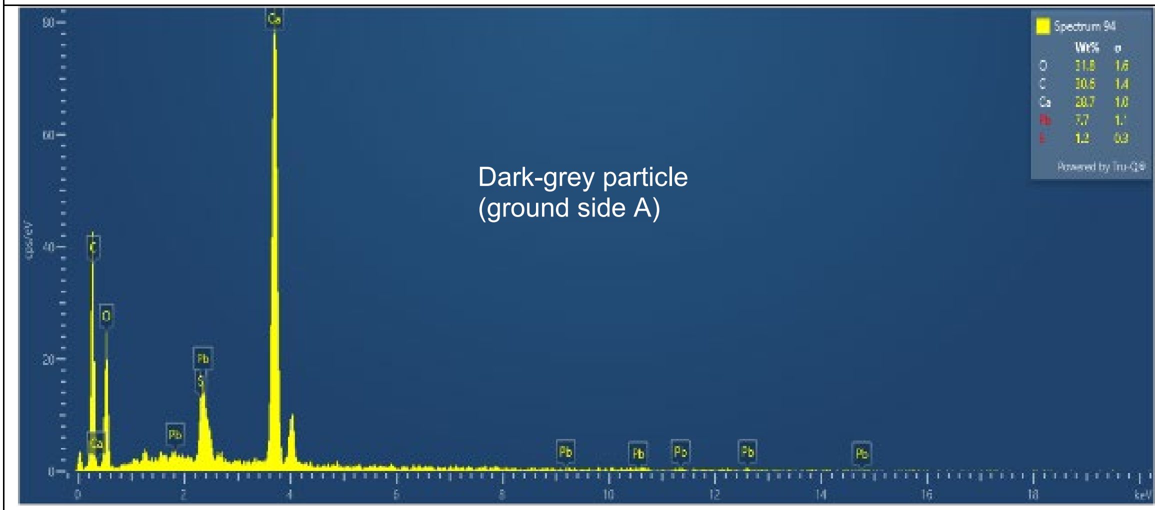


Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU08
SELECTED EDX SPECTRA SIDE A OF THE BANNER					

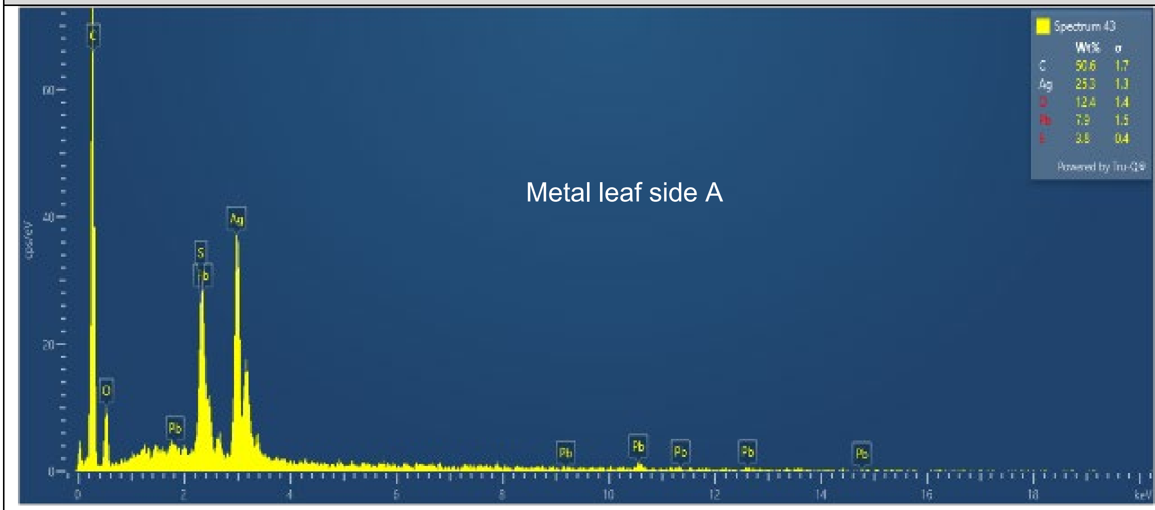


Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU08
SELECTED EDX SPECTRA SIDE A OF THE BANNER					

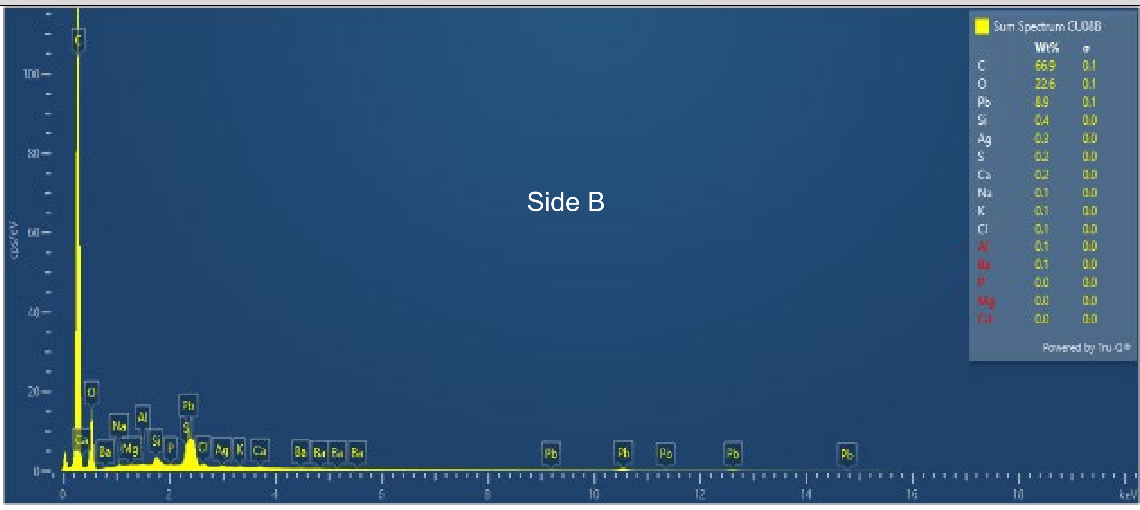
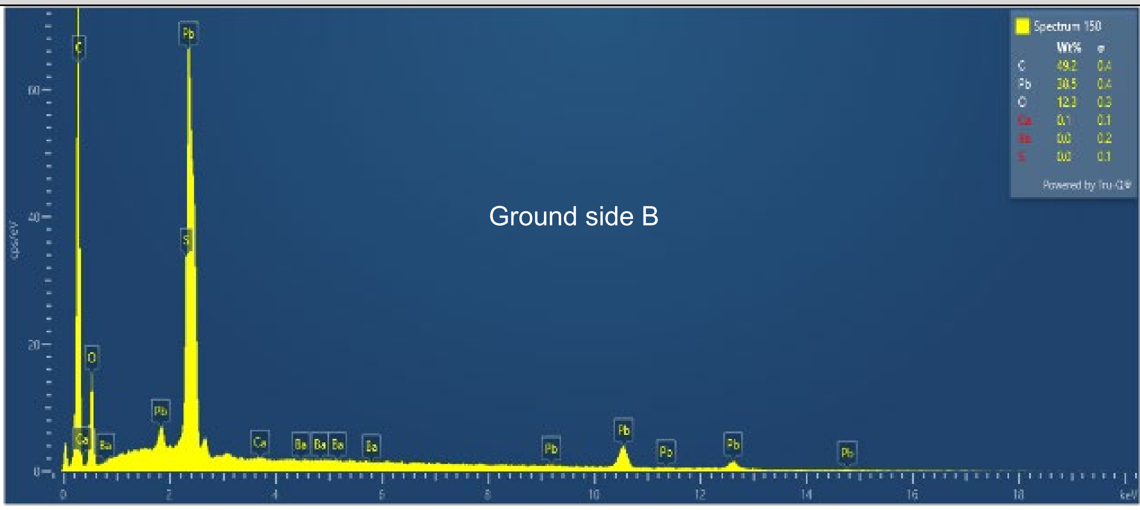
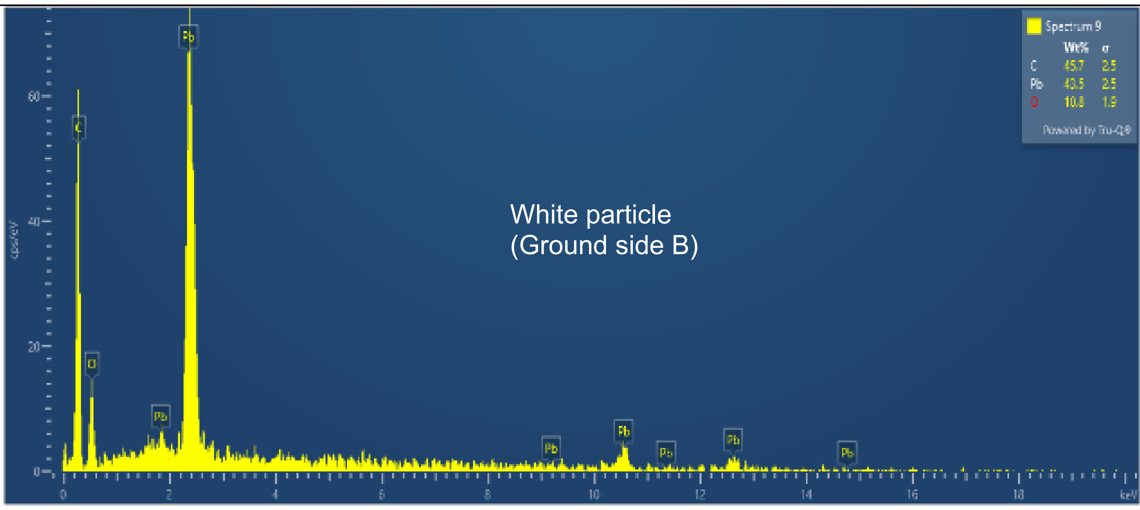


Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU08
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





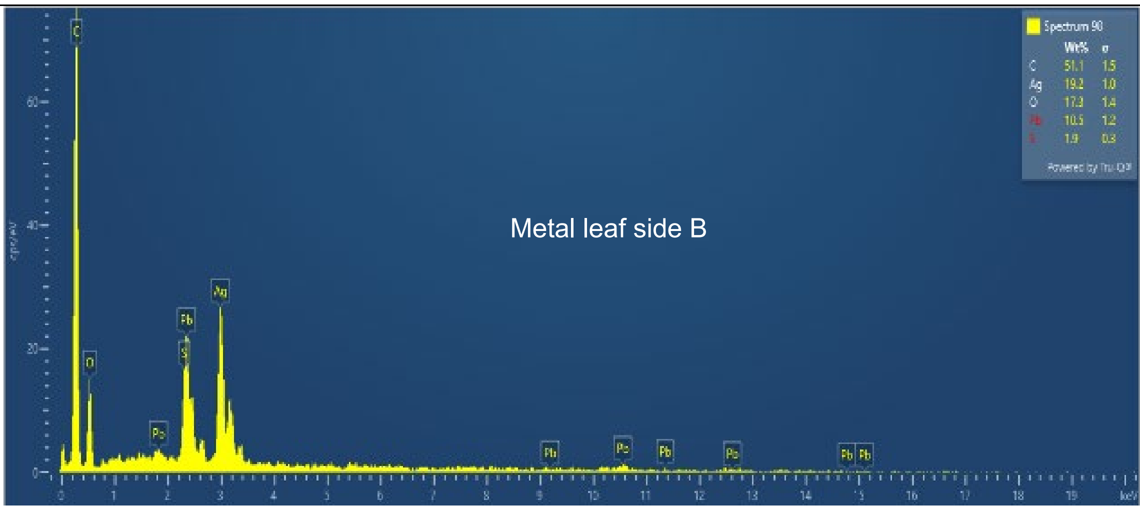
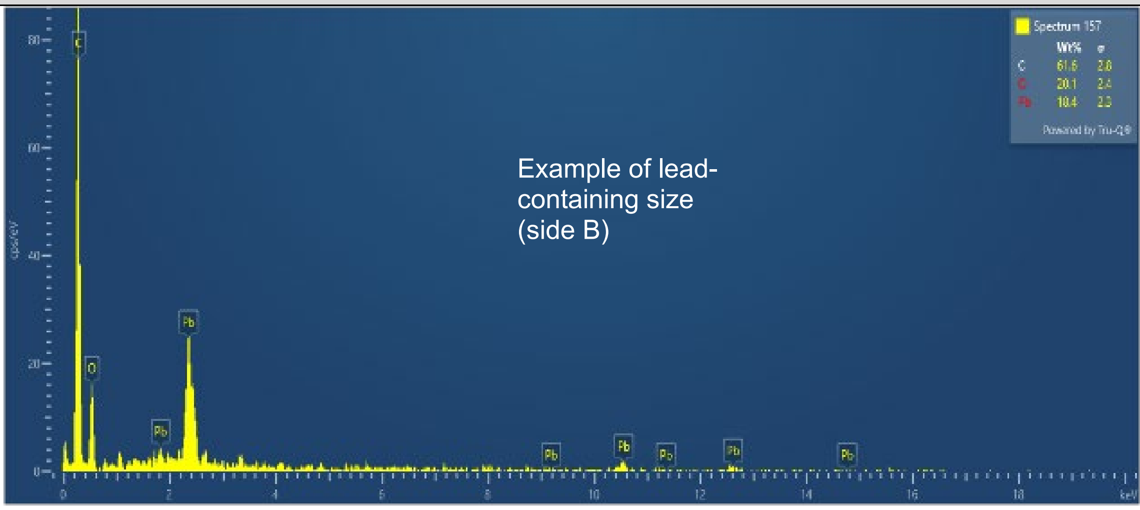


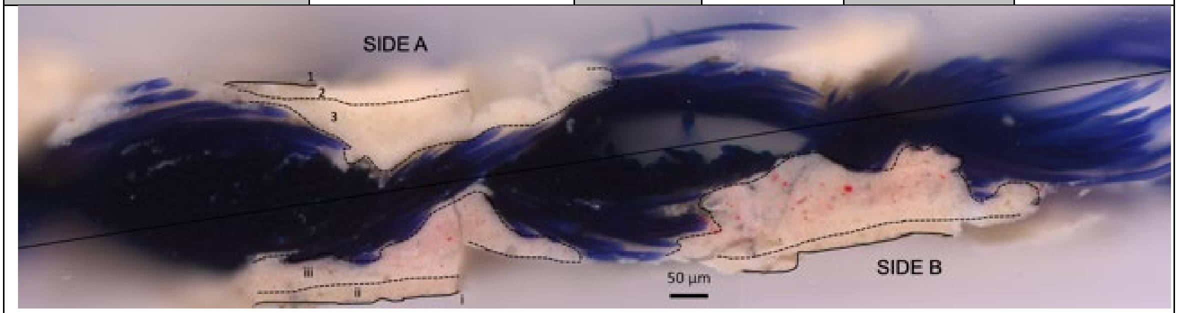
Table III.24 (continued) SEM-EDX results of scroll cross-section sample GU08					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU08
SELECTED EDX SPECTRA SIDE B OF THE BANNER					



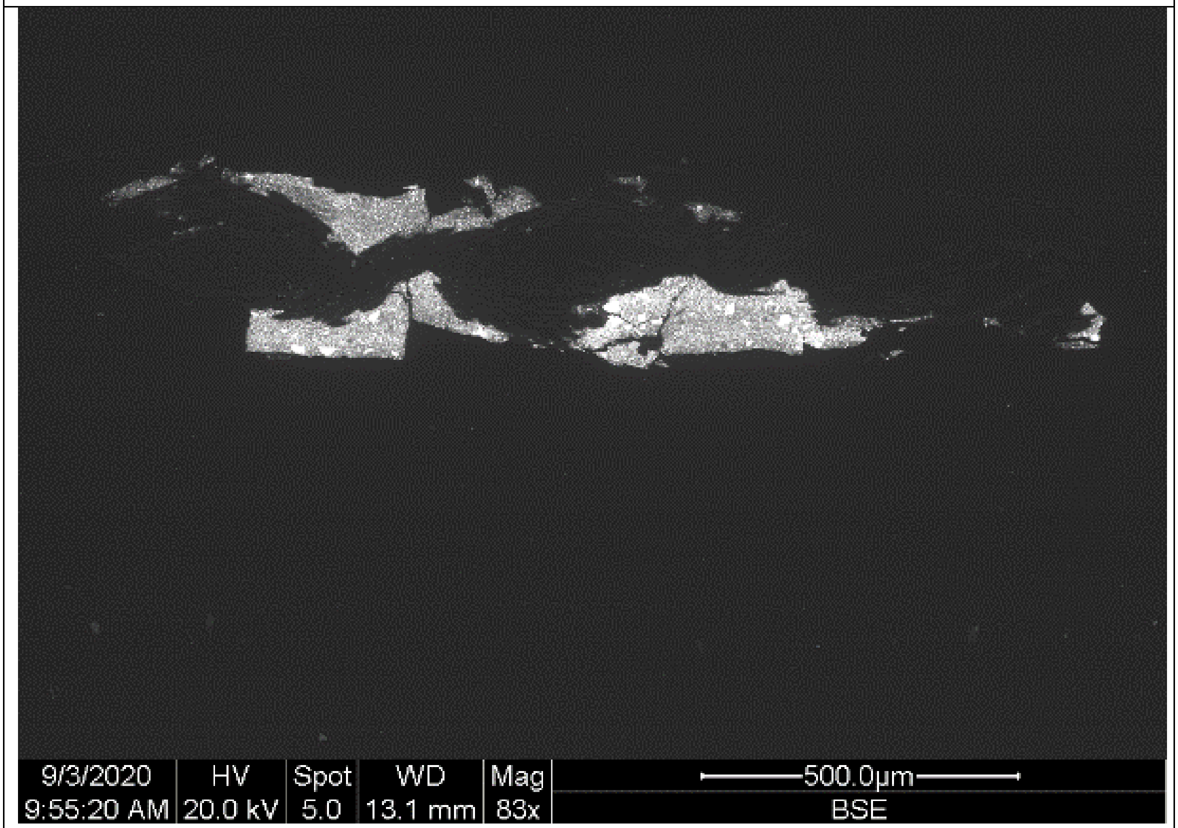
9.3.3.3 III.3.3 The Grain Millers of Glasgow banner, scroll cross-section sample

Table III.25 SEM-EDX results of scroll cross-section sample MG26

BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26

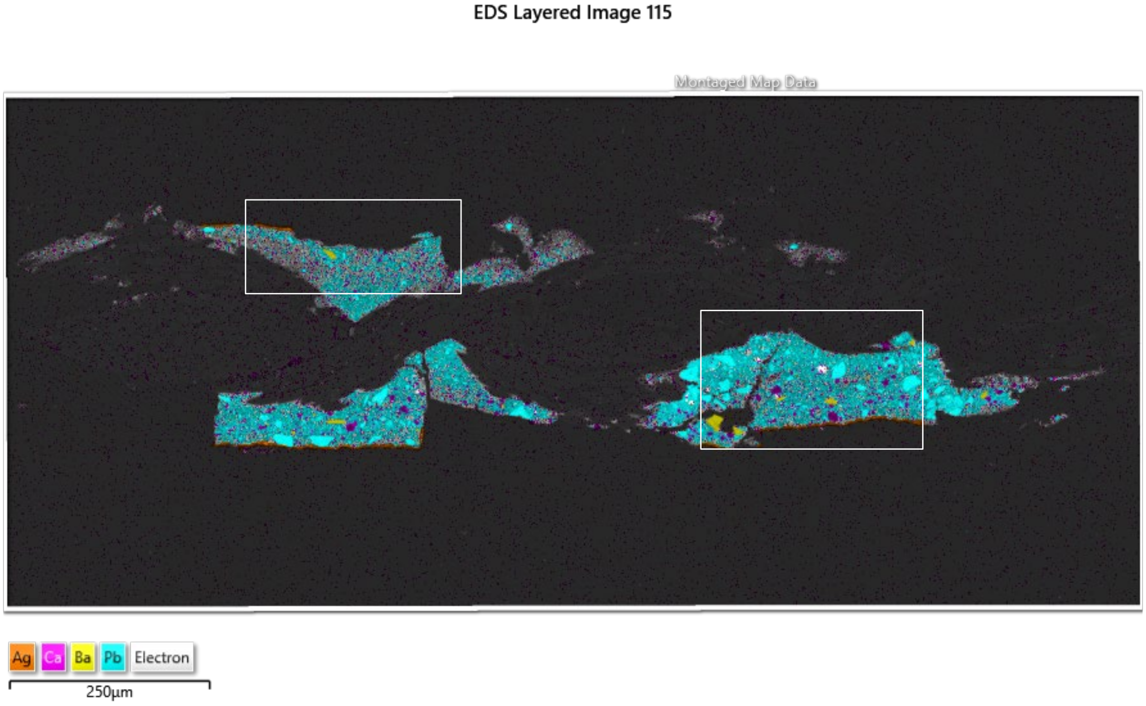


Sample MG26 annotated, incident light, bright field, Axioskop 2 Zeiss, 100×

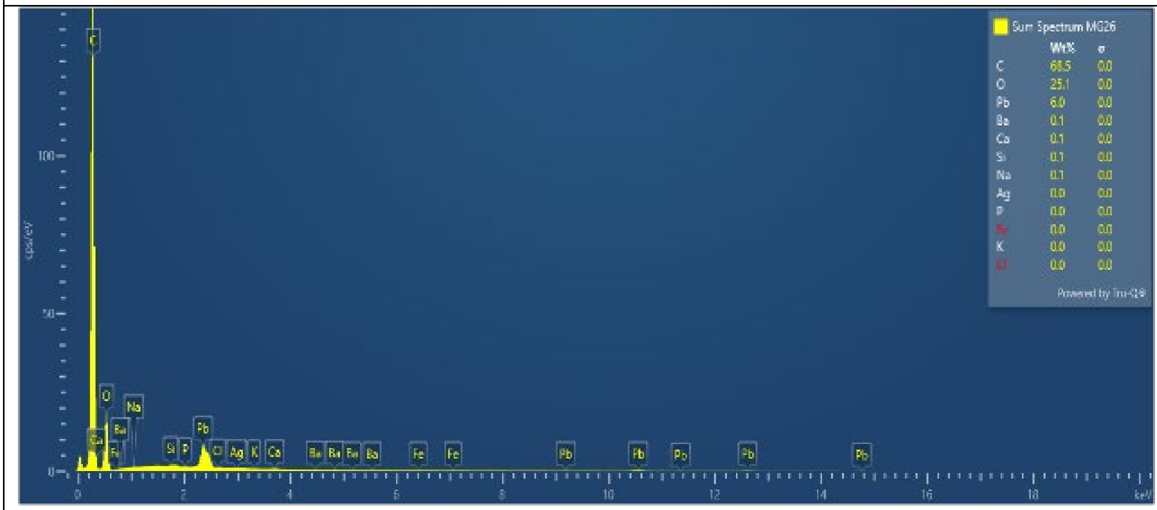


Sample MG26 backscattered electron image, Carl Zeiss Sigma SEM, 83×

Table III.25 (continued) SEM-EDX results of scroll cross-section sample MG26					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26



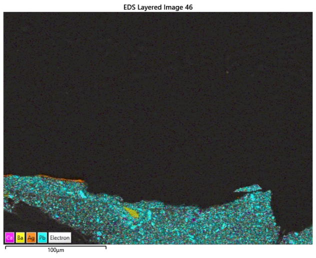
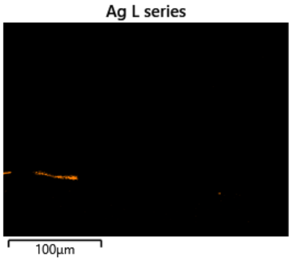
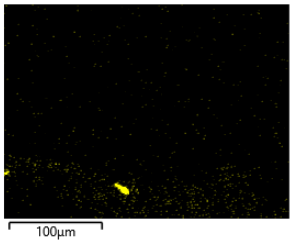
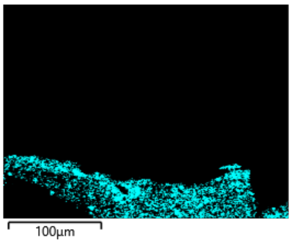
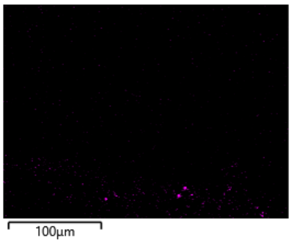
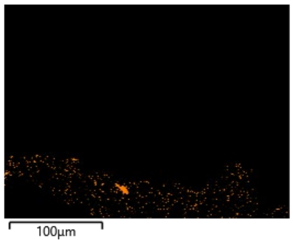
Sample MG26 selected areas, composite element map, Carl Zeiss Sigma SEM, 83×



Sample MG26 EDX sum spectrum, Aztec software

Table III.25 (continued) SEM-EDX results of scroll cross-section sample MG26					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26

INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
1	92	C, Ag, O, Pb, S	Silver leaf (sulphured) and lead carbonate
2	181	O, C, Pb	Lead carbonate
3	151	C, Pb, O, Ca, Ba S	Lead carbonate, barium sulphate and calcium carbonate
	91	Ba, C, O, Pb, S	Barium sulphate particle (with lead carbonate)
INTERPRETATION SIDE B OF THE BANNER			
Layer	Spectrum number	Elements	Materials
i	44	C, O, Ag, Pb, S	Silver leaf (sulphured) and lead carbonate
ii	182	O, C, Pb, Ca	Lead carbonate and calcium carbonate
iii	184	O, Pb, C Fe, S, Ba	Lead carbonate, barium sulphate and red iron oxides
	90	Hg, C, S, O	Mercury sulphide (vermillion pigment)
	88	Pb, C, O	Red lead oxide particle

Table III.25 (continued) SEM-EDX results of scroll cross-section sample MG26					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26
 Sample MG26 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 800×	SINGLE ELEMENT MAPS SIDE A OF THE BANNER				
	Ag L series 		Ba L series 		
Pb M series 	Ca K series 		S K series 		

Electron Image 115

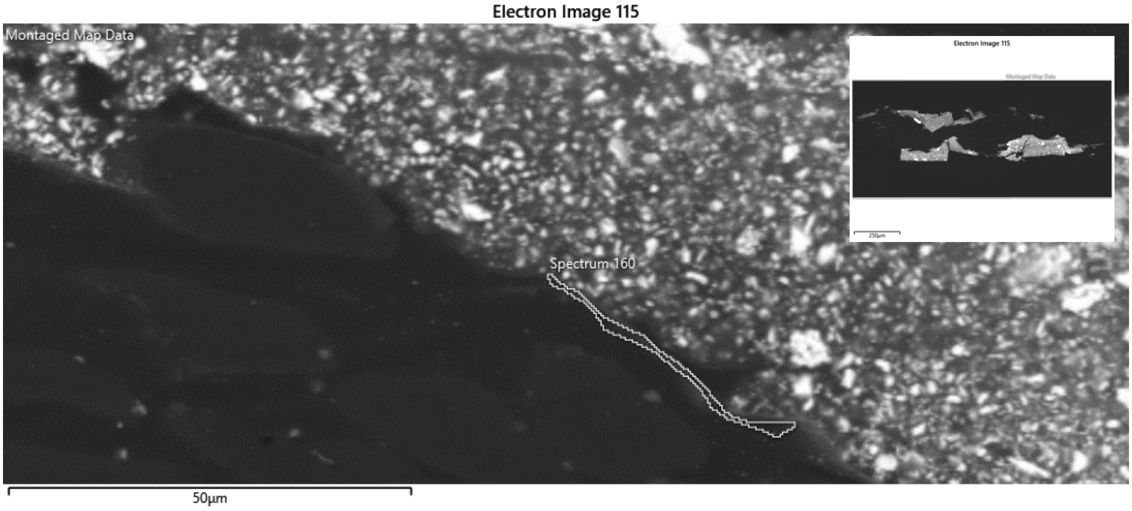


Figure III.3 Back-scattered electron image of lead-containing size in sample MG26 side A with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 800×

Table III.25 (continued) SEM-EDX results of scroll cross-section sample MG26					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26

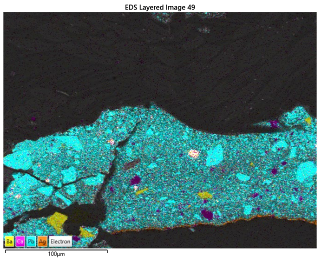
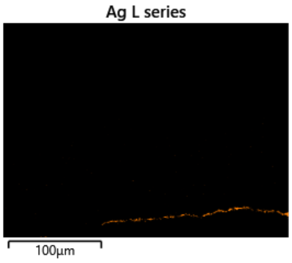
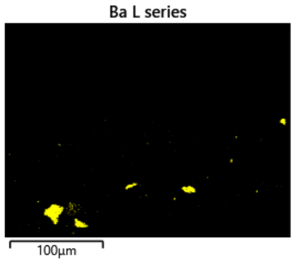
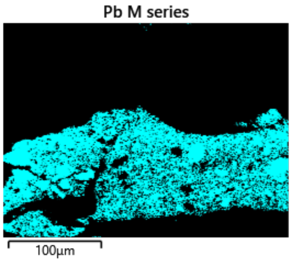
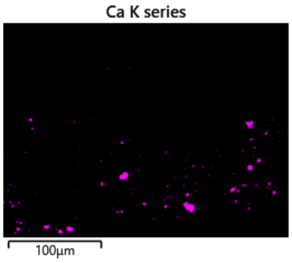
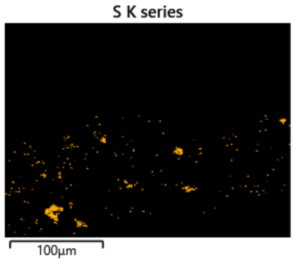
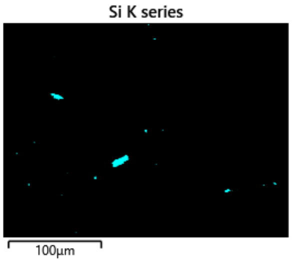
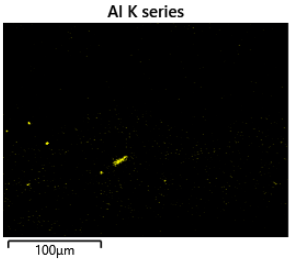
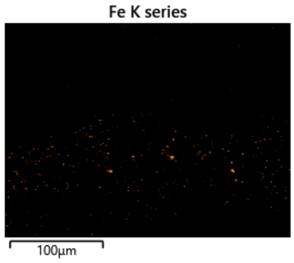
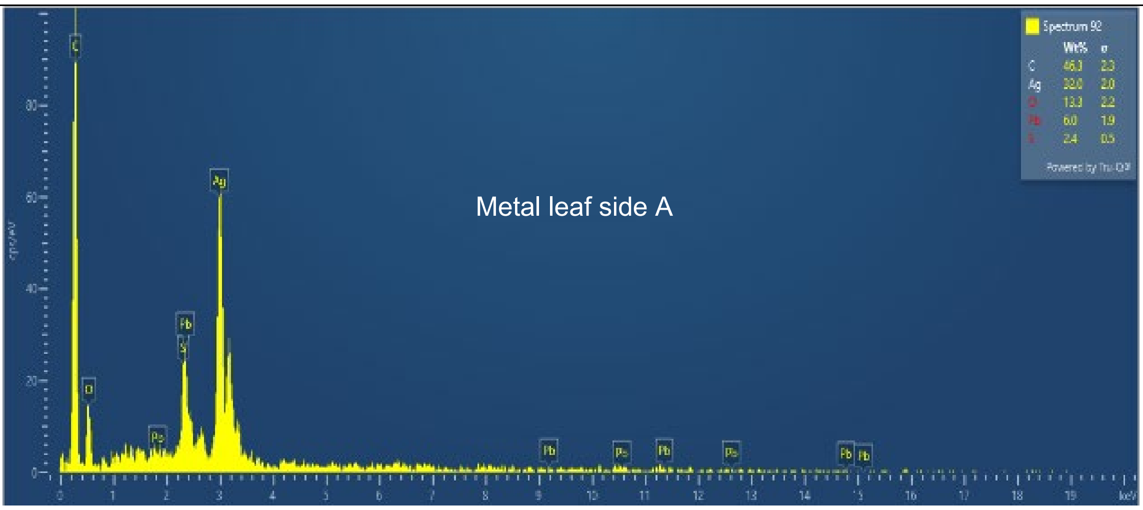
	SINGLE ELEMENT MAPS SIDE B OF THE BANNER	
 Sample MG26 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 800×		
		
		

Table III.25 (continued) SEM-EDX results of scroll cross-section sample MG26					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26
SELECTED EDX SPECTRA SIDE A OF THE BANNER					



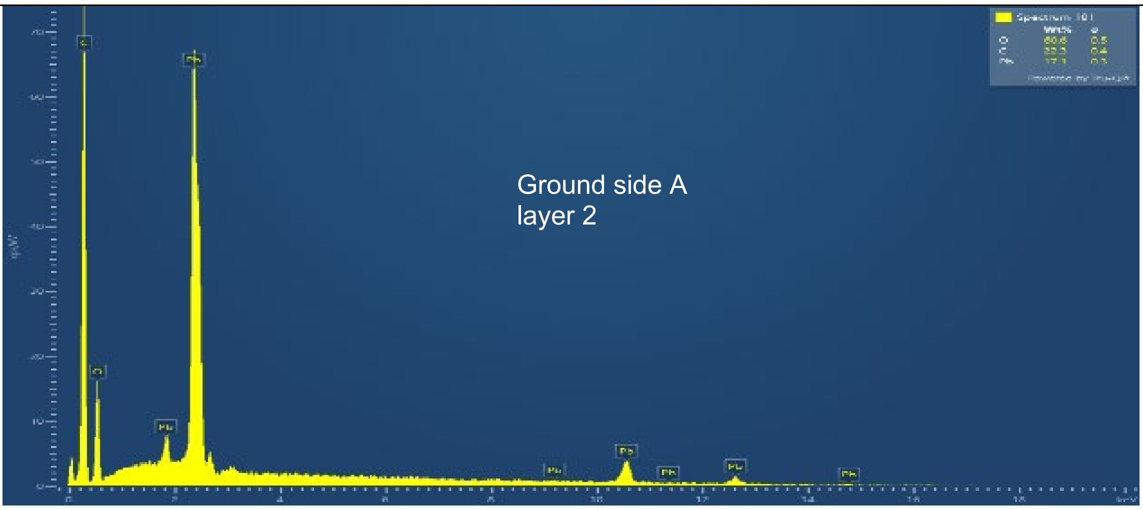
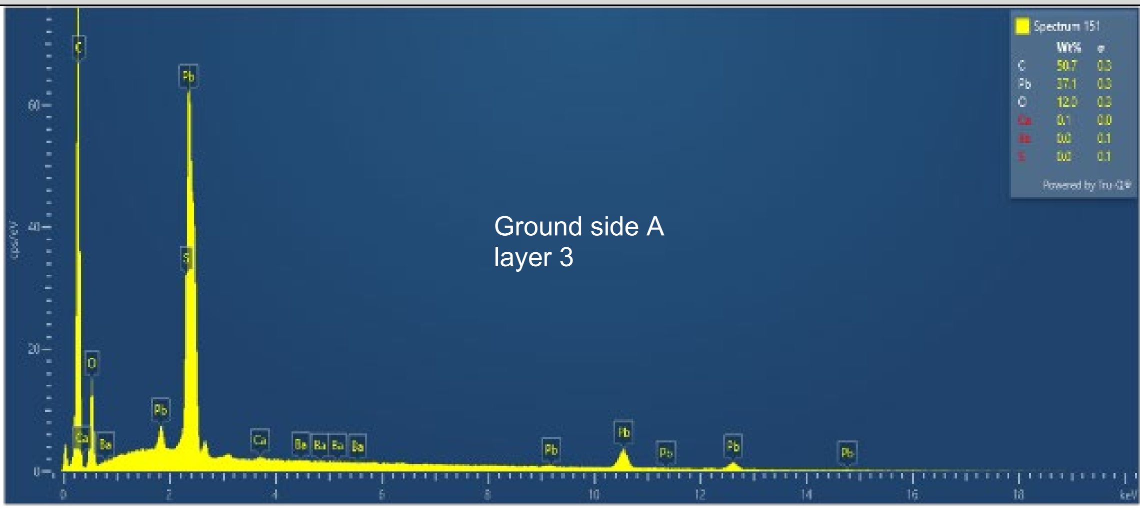
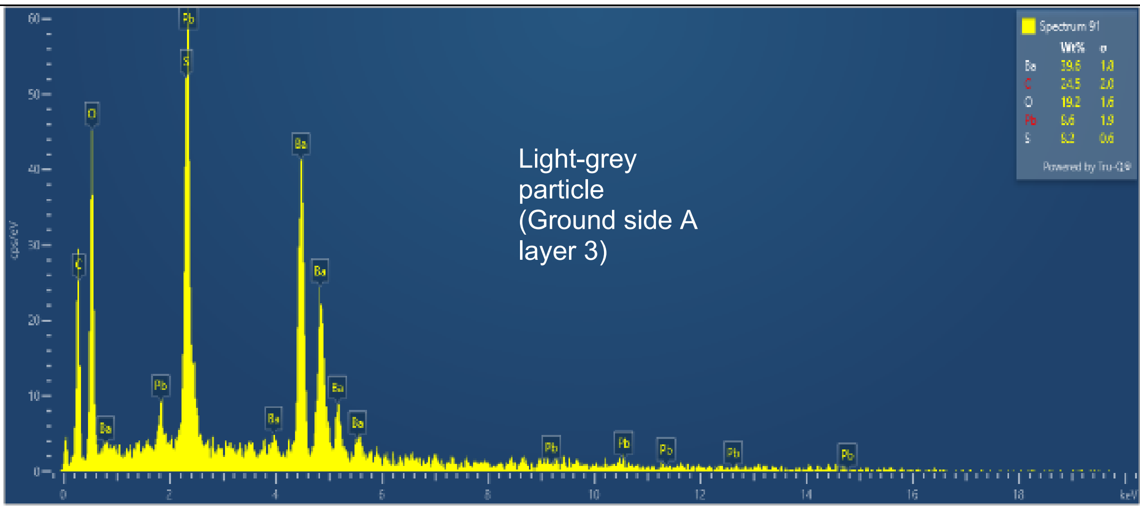


Table III.25 (continued) SEM-EDX results of scroll cross-section sample MG26					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26
SELECTED EDX SPECTRA SIDE A OF THE BANNER					





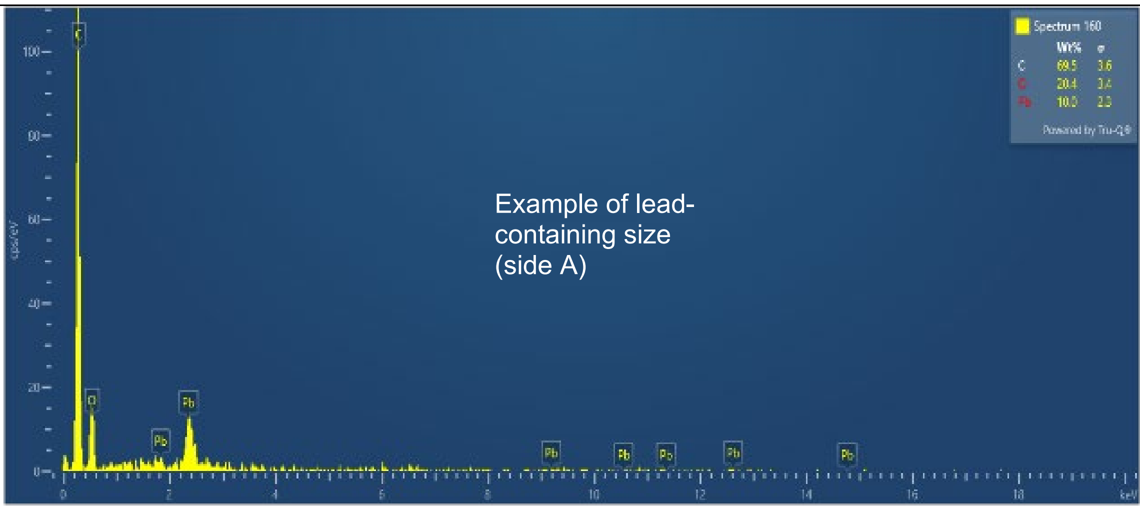
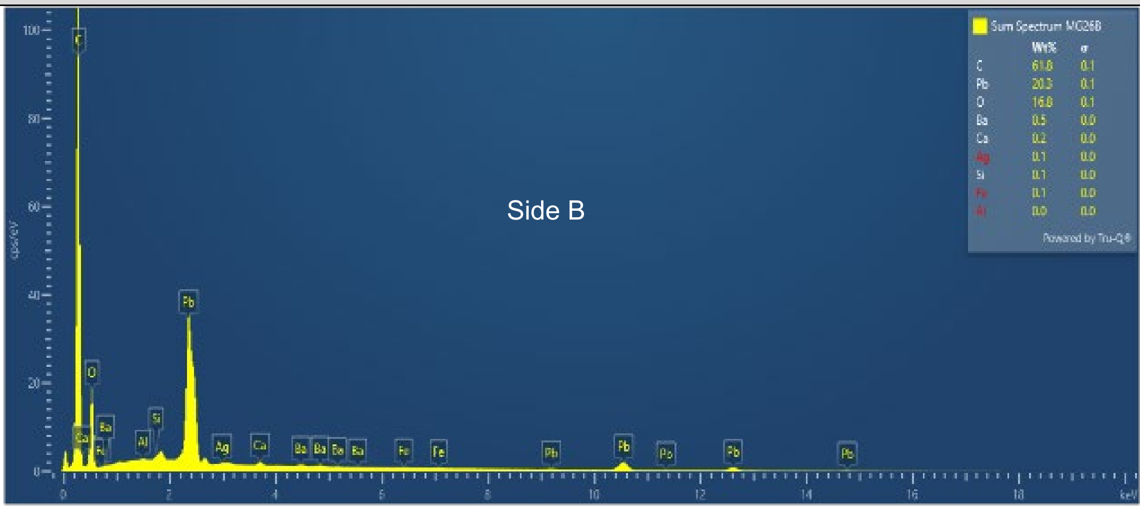
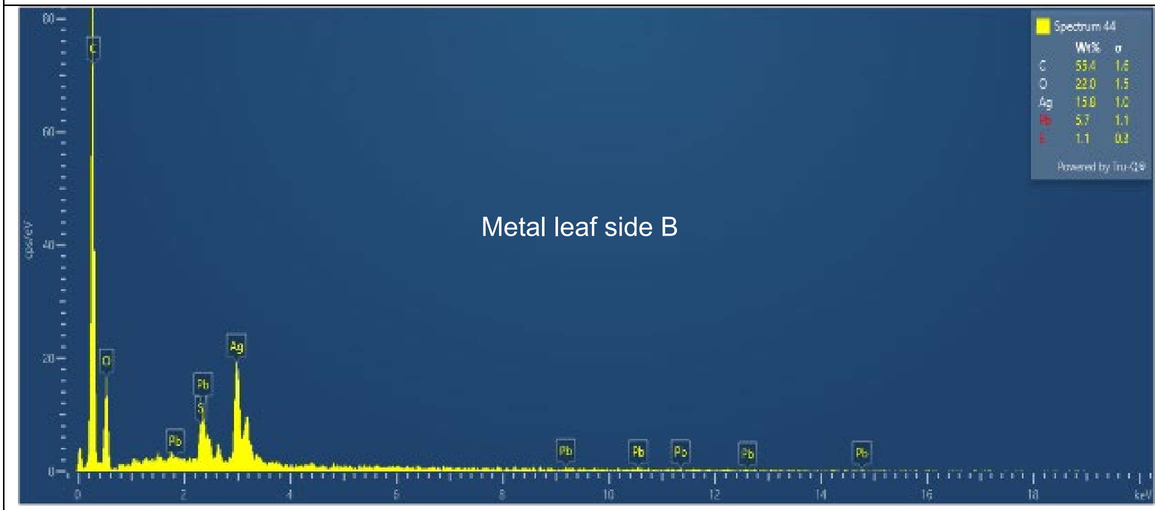


Table III.25 (continued) SEM-EDX results of scroll cross-section sample MG26					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





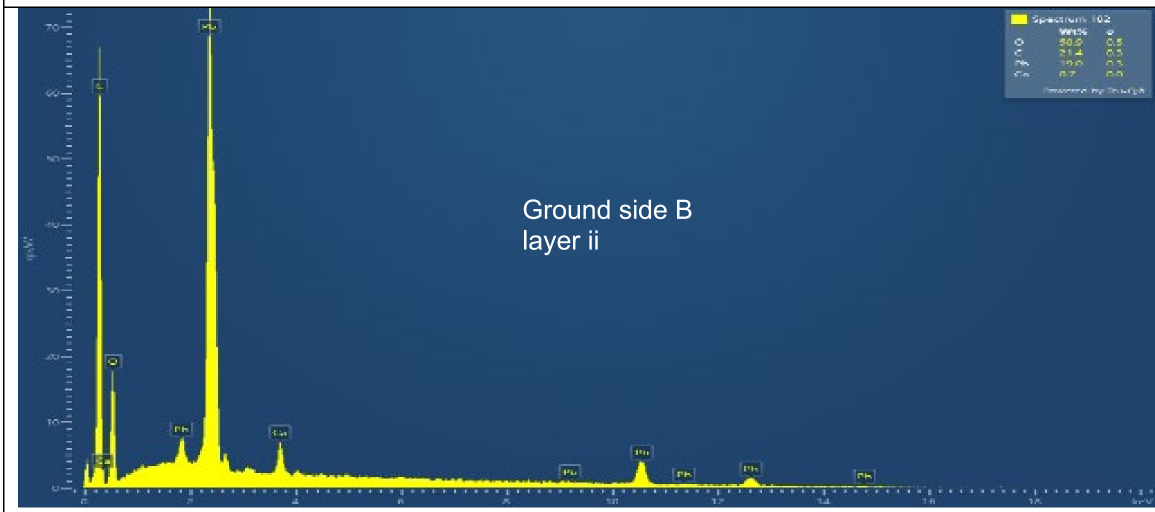
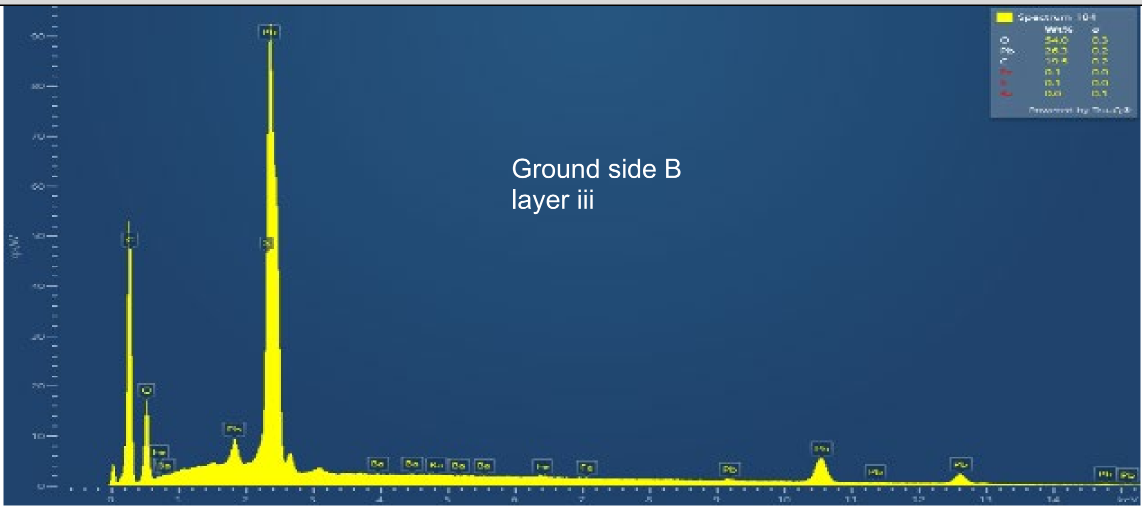
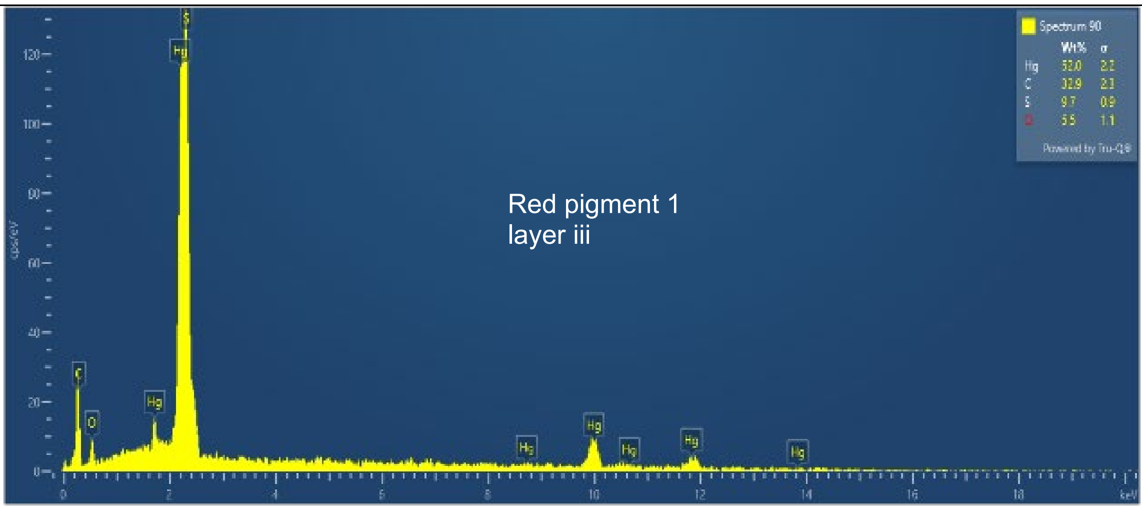
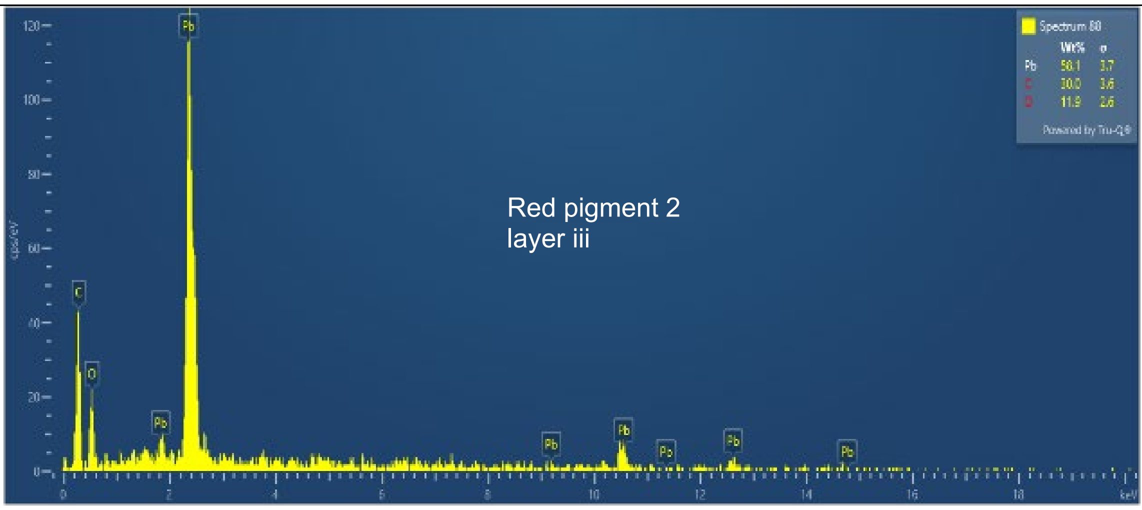


Table III.25 (continued) SEM-EDX results of scroll cross-section sample MG26

BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG26
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

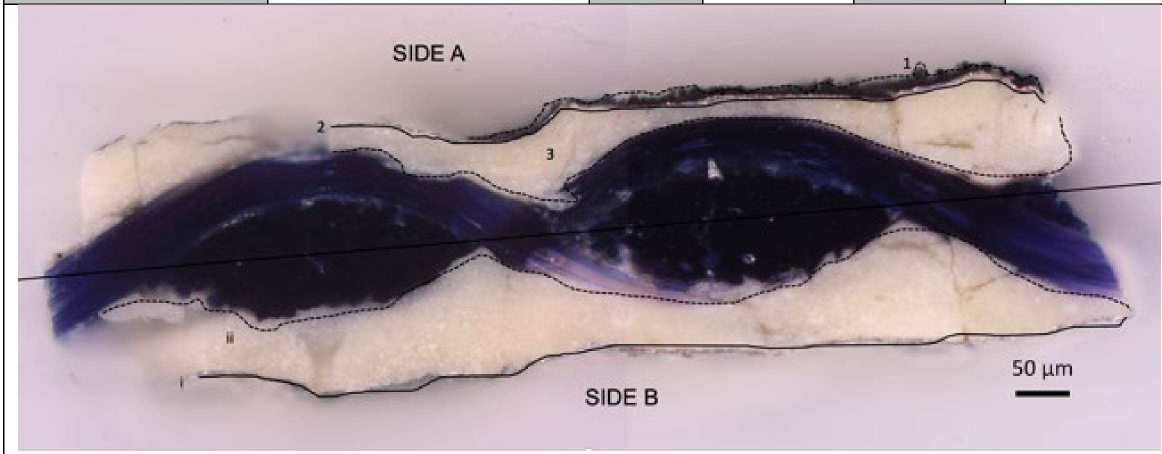




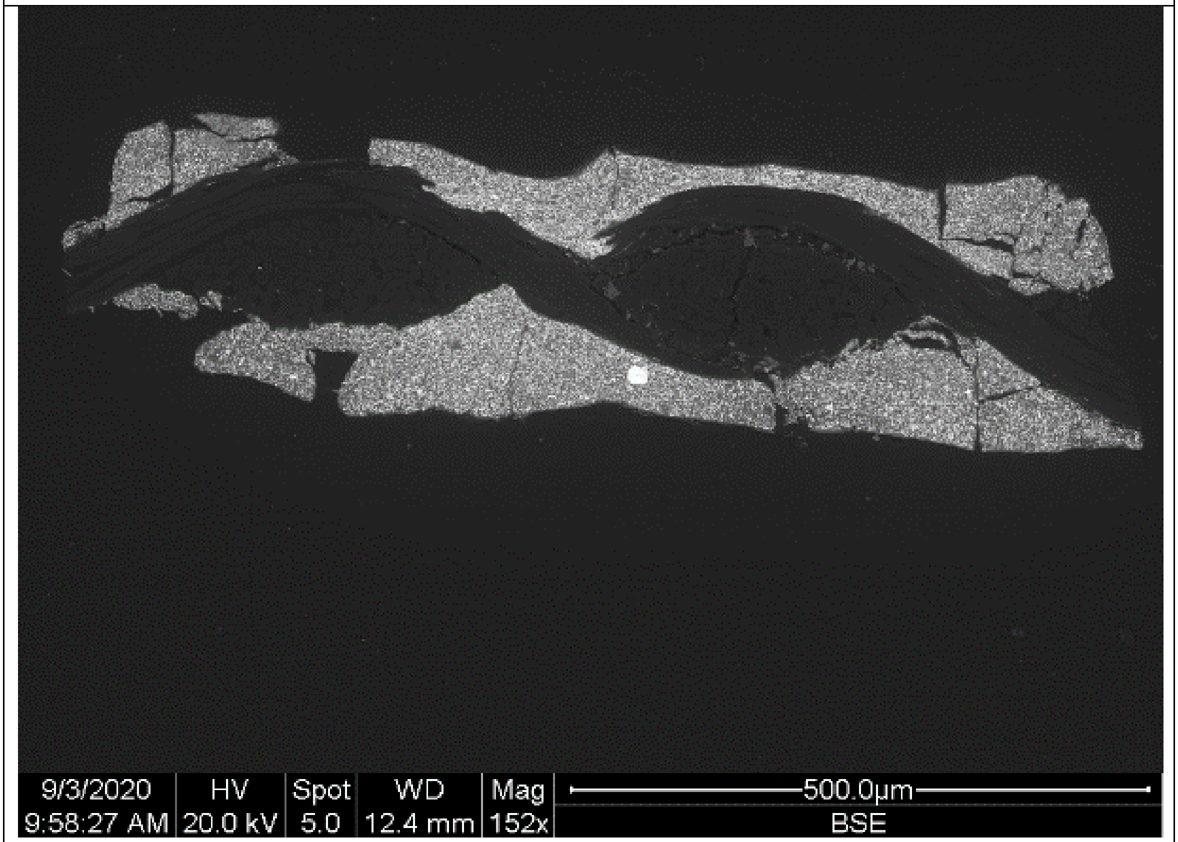


9.3.3.4 III.3.4 The National Union of Vehicle Builders, Glasgow Branch banner, scroll cross-section sample

Table III.26 SEM-EDX results of scroll cross-section sample VB11					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB11

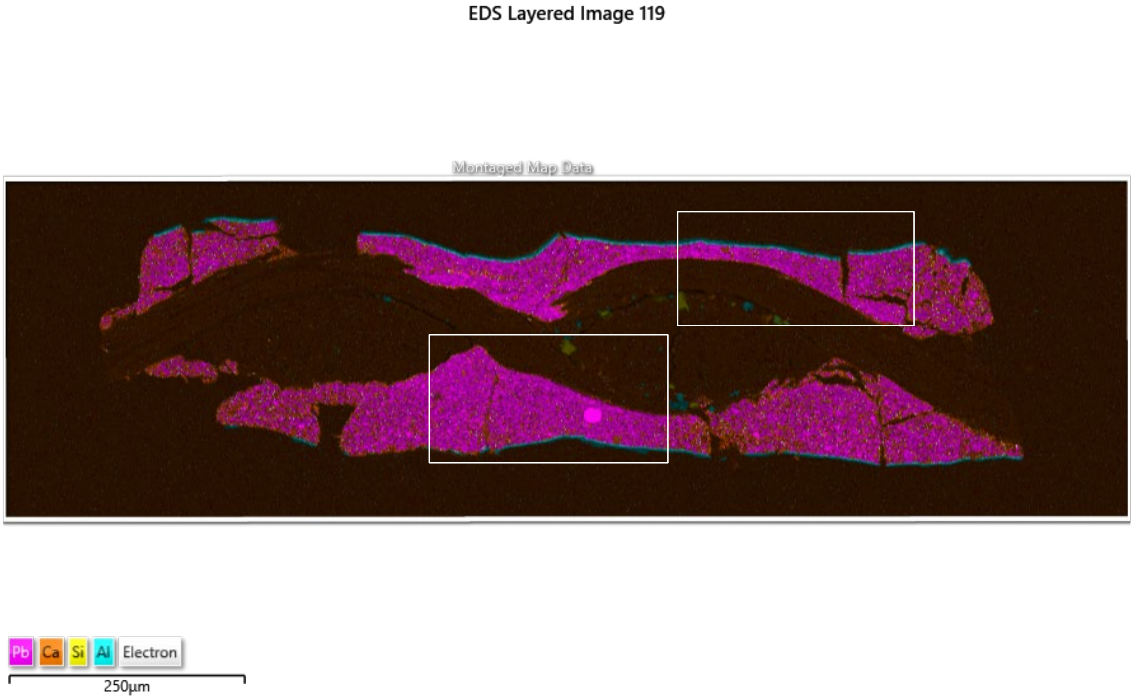


Sample VB11 annotated, incident light, bright field, Axioskop 2 Zeiss, 100×

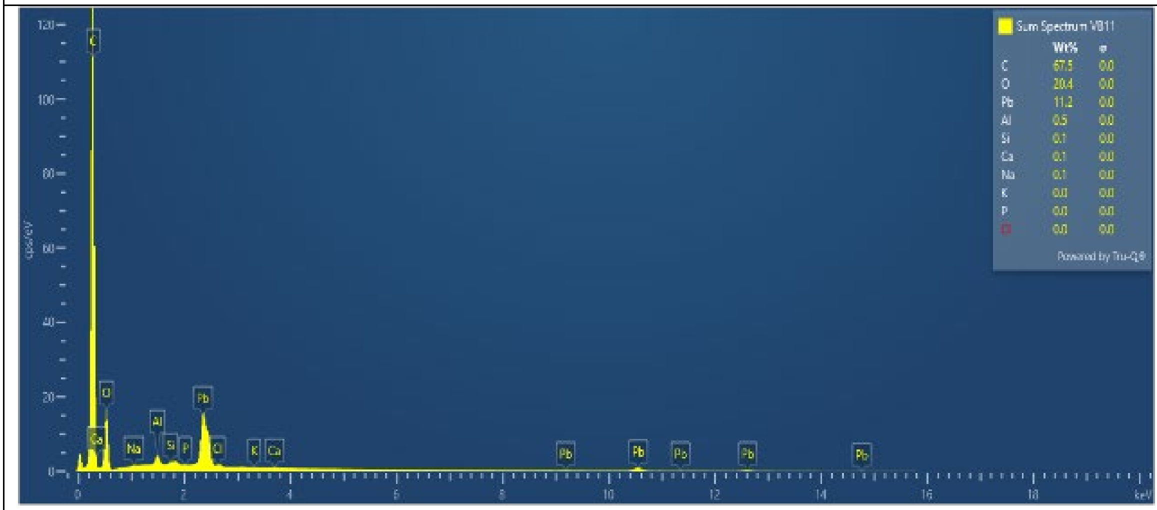


Sample VB11 backscattered electron image, Carl Zeiss Sigma SEM, 152×

Table III.26 (continued) SEM-EDX results of scroll cross-section sample VB11					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB11



Sample VB11 selected areas, composite element map, Carl Zeiss Sigma SEM,152×



Sample VB11 EDX sum spectrum, AZtec software

Table III.26 (continued) SEM-EDX results of scroll cross-section sample VB11						
BANNER	The National Union of Vehicle Builders, Glasgow Branch					
MANUFACTURER	George Kenning & Son		YEAR	1914	SAMPLE	VB11

INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
1	35	C, O, S, Ca, Al, P	Calcinated bone particle (calcium phosphate, collagen-associated sulphur), aluminium from the leaf
2	48	C, Al, Pb, O	Aluminium leaf and lead carbonate
3	125	Pb, C, O	Lead carbonate
	99	Pb, C	Lead carbonate particle
INTERPRETATION SIDE B OF THE BANNER			
Layer	Spectrum number	Elements	Materials
i	172	C, Al, Pb, O	Aluminium leaf and lead carbonate
ii	109	Pb, C, O	Lead carbonate

Table III.26 (continued) SEM-EDX results of scroll cross-section sample VB11					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB11

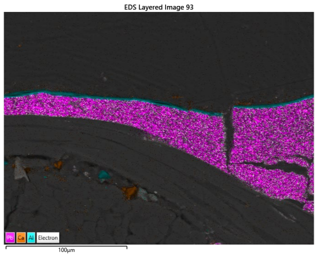
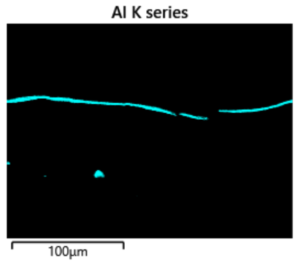
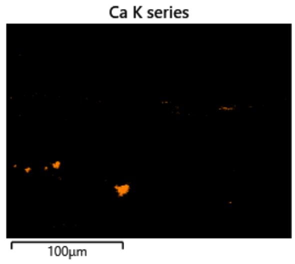
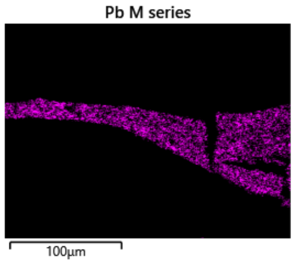
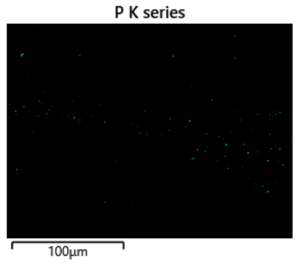
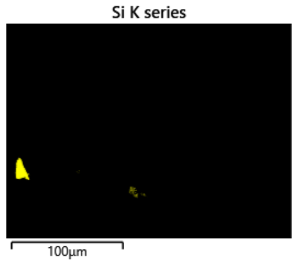
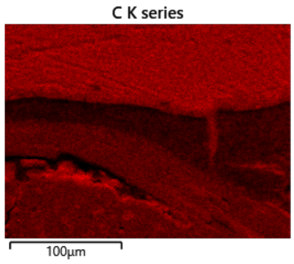
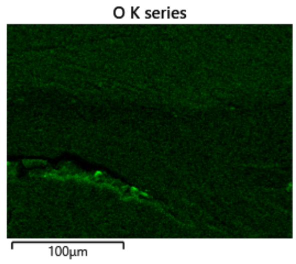
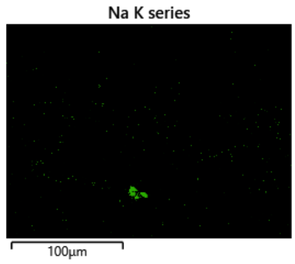
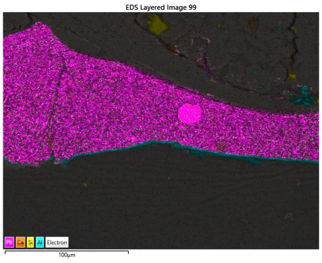
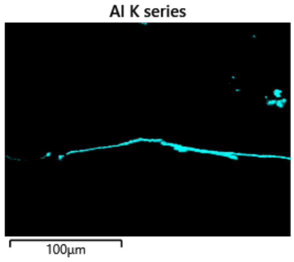
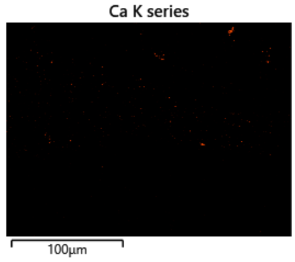
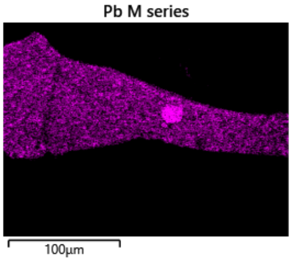
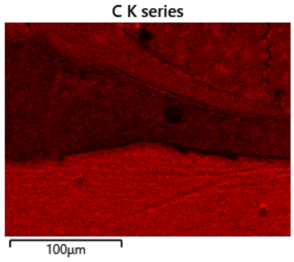
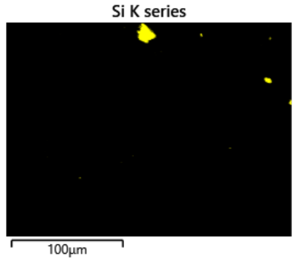
 Sample VB11 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×	SINGLE ELEMENT MAPS SIDE A OF THE BANNER 	
		
		

Table III.26 (continued) SEM-EDX results of scroll cross-section sample VB11		
BANNER	The National Union of Vehicle Builders, Glasgow Branch	
MANUFACTURER	George Kenning & Son; YEAR: 1914	SAMPLE: VB11
 Sample VB11 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×	SINGLE ELEMENT MAPS SIDE B OF THE BANNER	
		
		

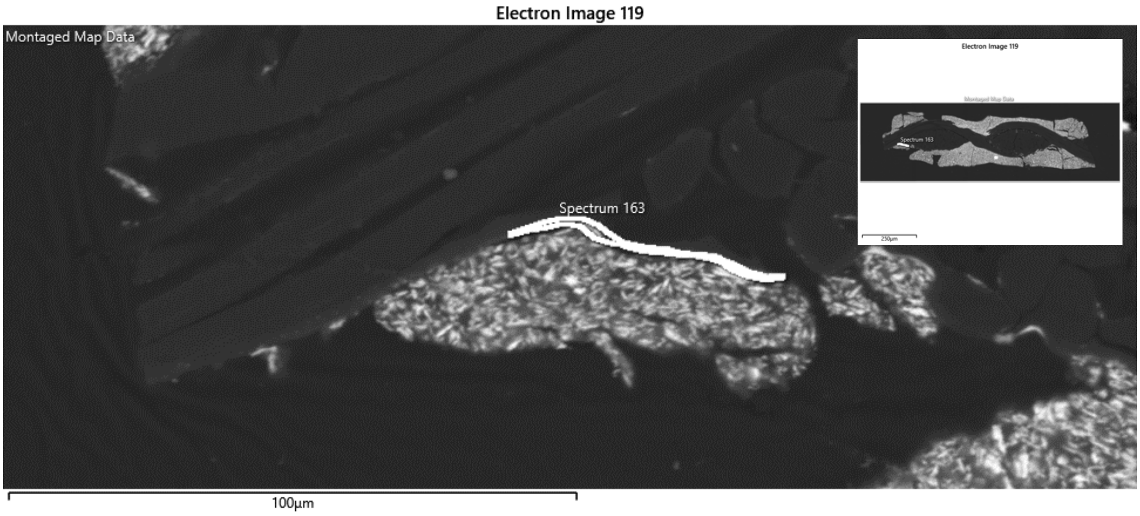
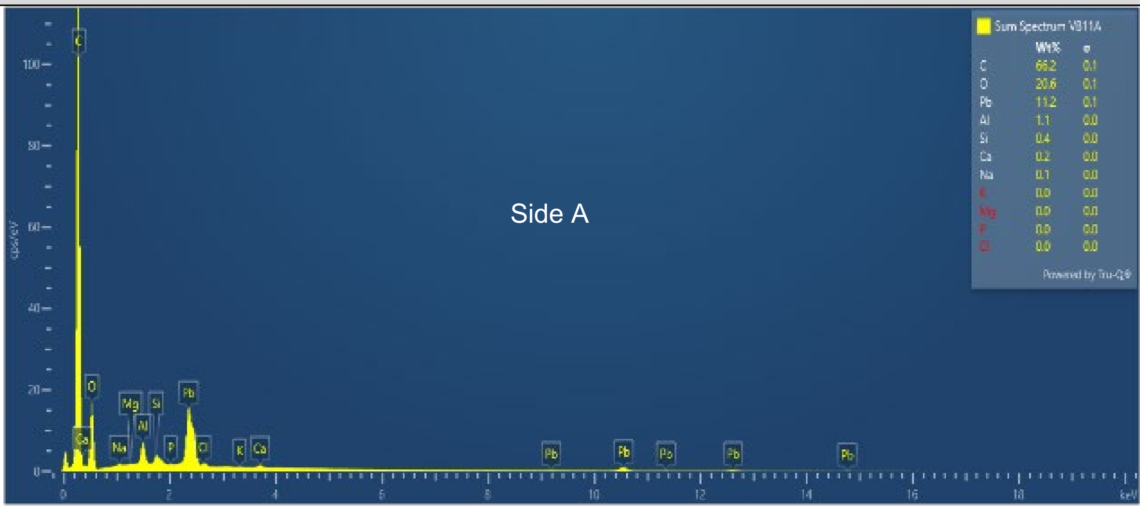


Figure III.4 Back-scattered electron image of lead-containing size in sample VB11 side B with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 1200×

Table III.26 (continued) SEM-EDX results of scroll cross-section sample VB11					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB11
SELECTED EDX SPECTRA SIDE A OF THE BANNER					



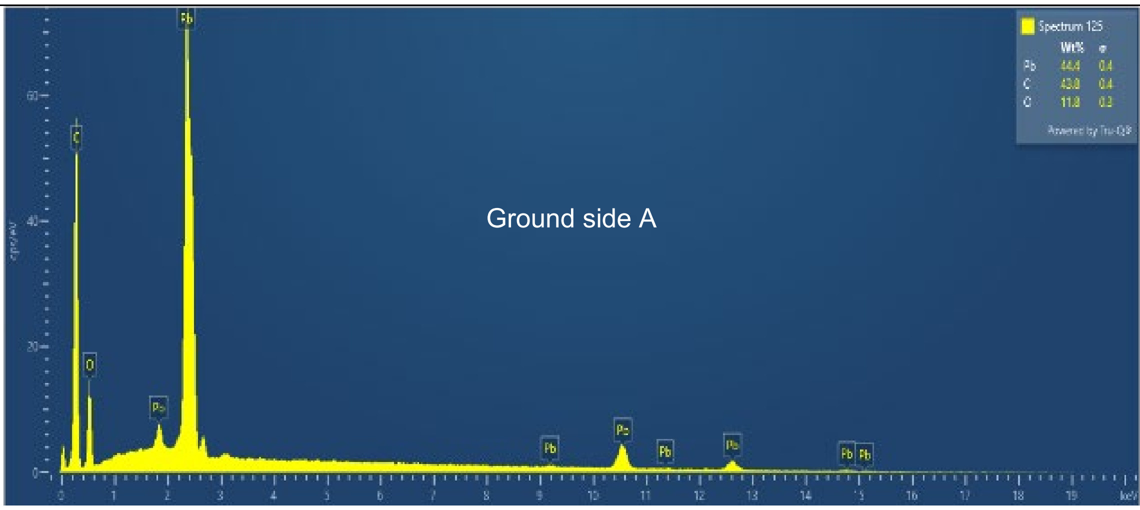
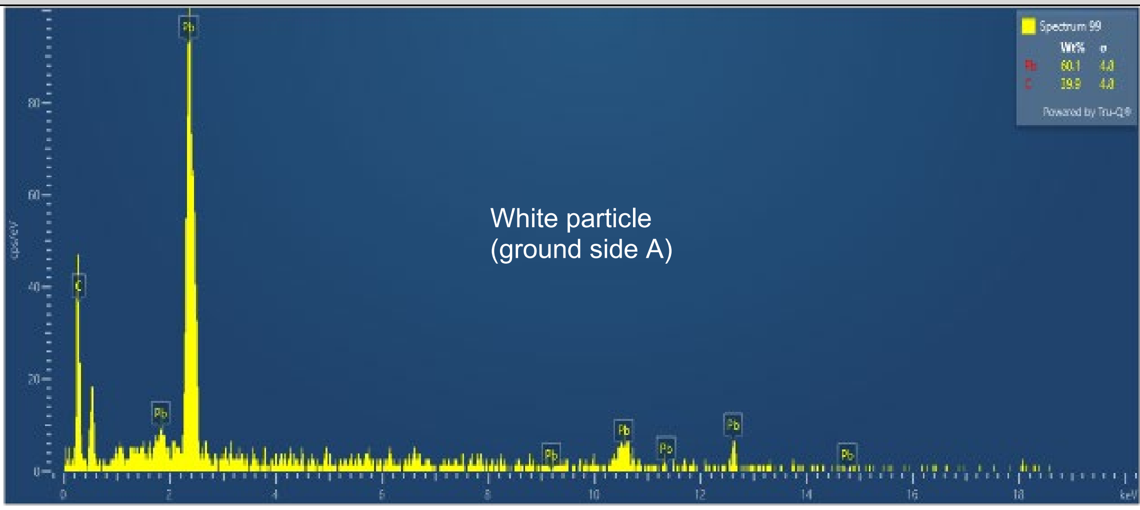


Table III.26 (continued) SEM-EDX results of scroll cross-section sample VB11					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB11
SELECTED EDX SPECTRA SIDE A OF THE BANNER					



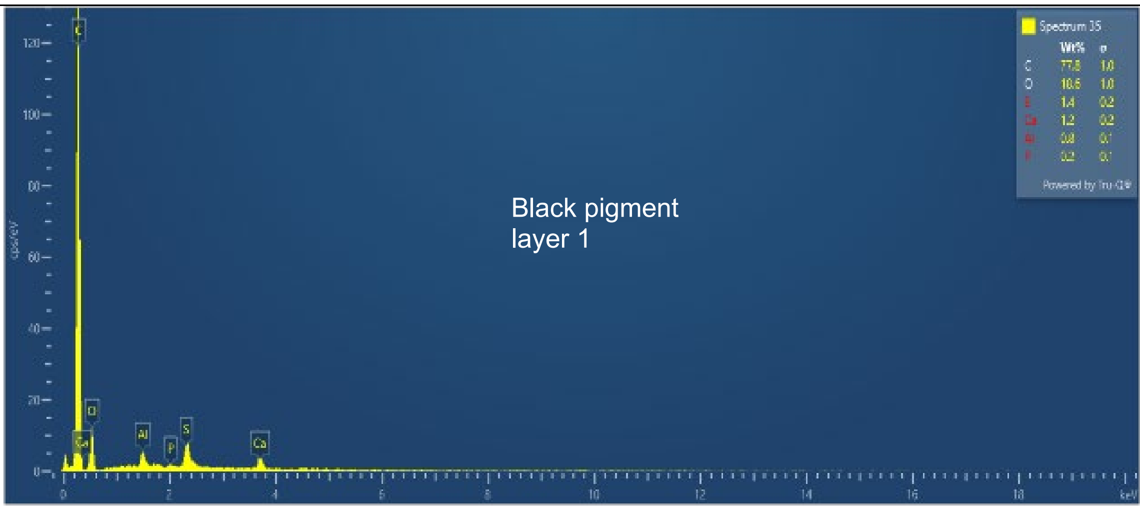
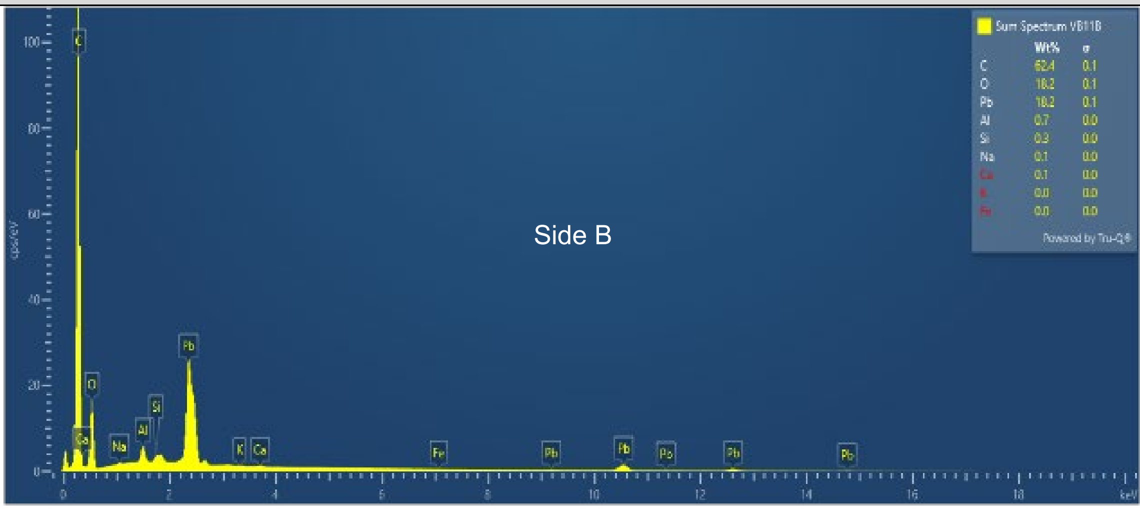
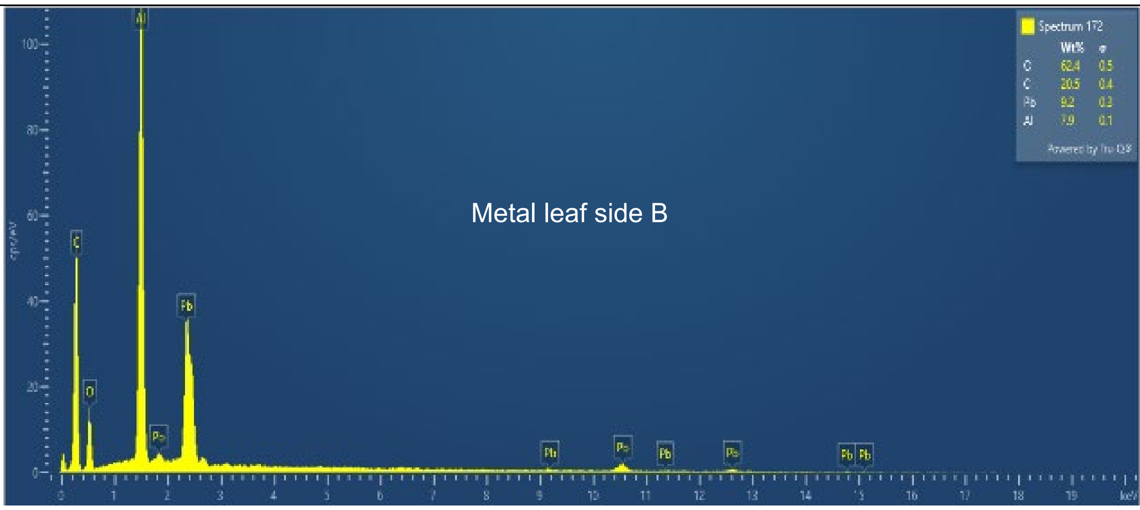


Table III.26 (continued) SEM-EDX results of scroll cross-section sample VB11					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB11
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





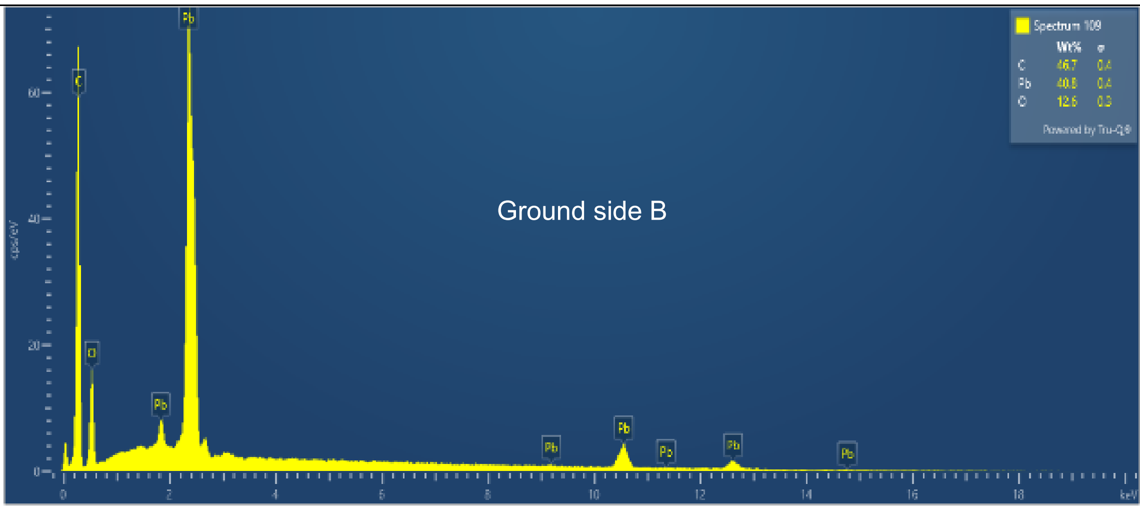
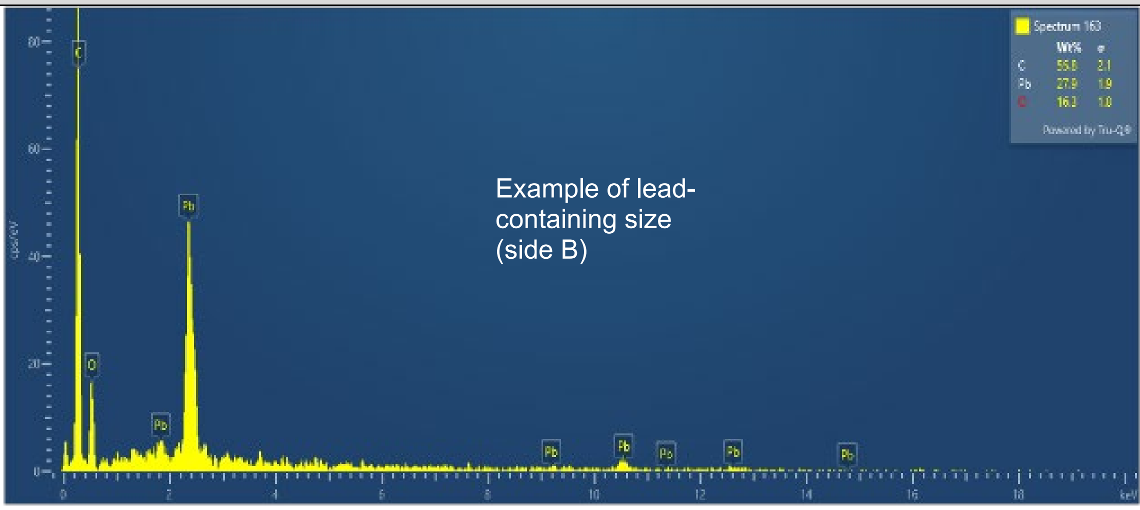
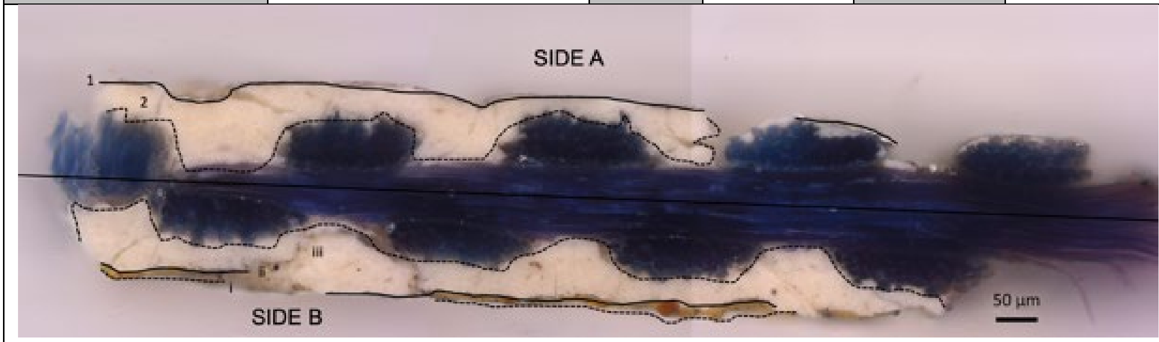


Table III.26 (continued) SEM-EDX results of scroll cross-section sample VB11					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB11
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

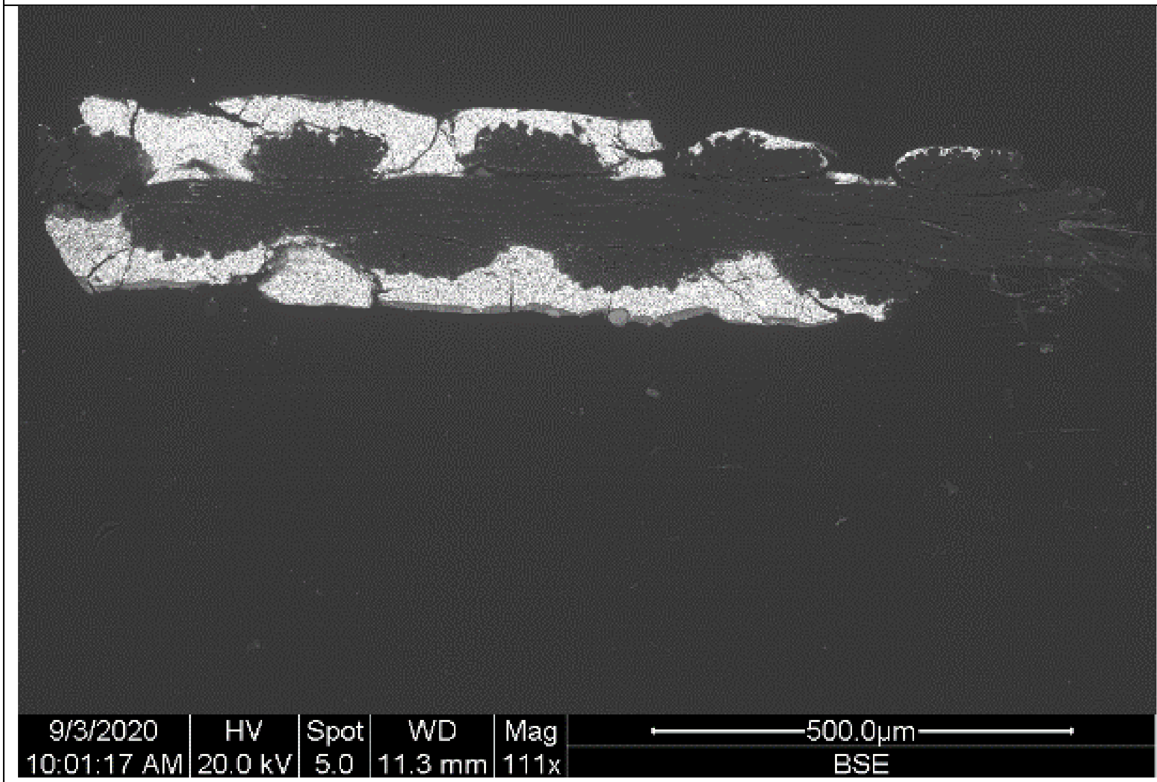


9.3.3.5 III.3.5 The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner, scroll cross-section sample

Table III.27 SEM-EDX results of scroll cross-section sample SM21					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM21



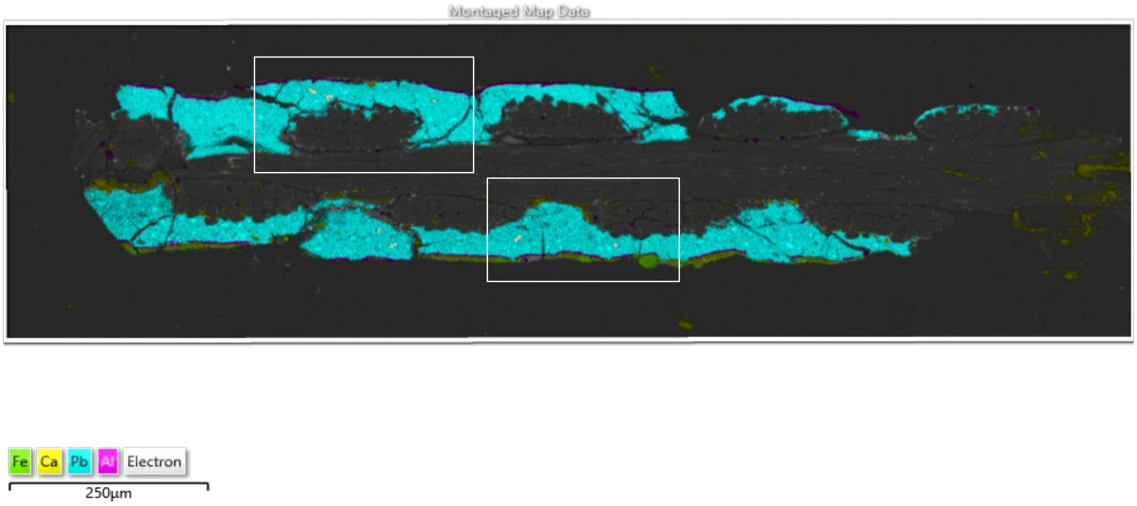
Sample SM21 annotated, incident light, bright field, Axioskop 2 Zeiss, 100×



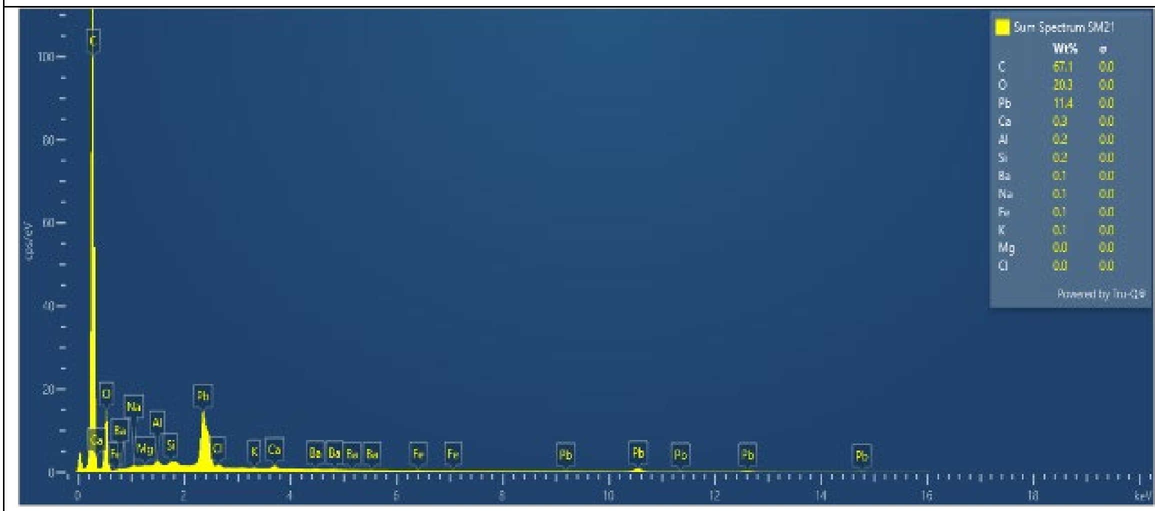
Sample SM21 backscattered electron image, Carl Zeiss Sigma SEM, 111×

Table III.27 (continued) SEM-EDX results of scroll cross-section sample SM21

BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM21



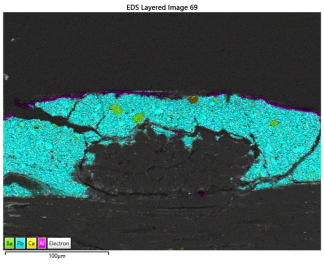
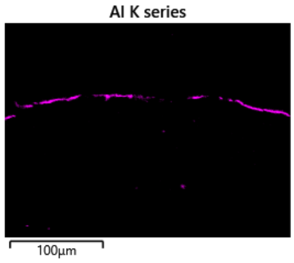
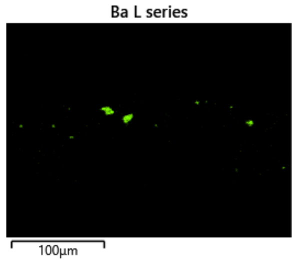
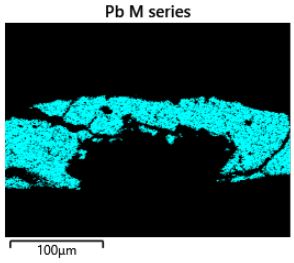
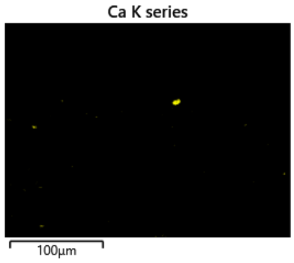
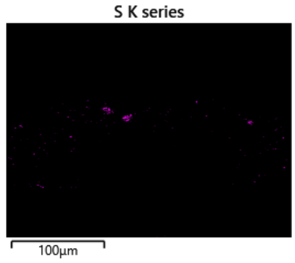
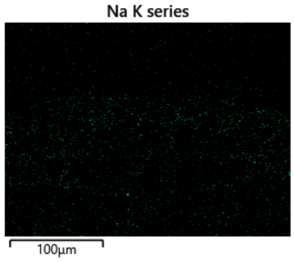
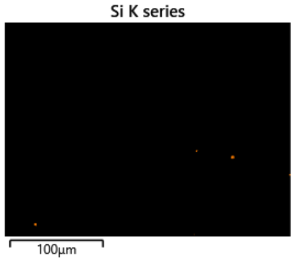
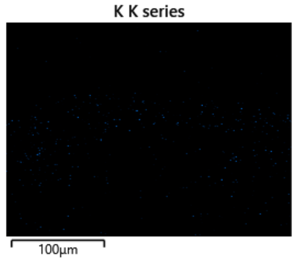
Sample SM21 selected areas, composite element map, Carl Zeiss Sigma SEM, 111×



Sample SM21 EDX sum spectrum, Aztec software

Table III.27 (continued) SEM-EDX results of scroll cross-section sample SM21						
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society					
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM21	

INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
1	Spectrum metal leaf	Al, Pb, O, Si, Ca, Fe	Aluminium leaf, lead carbonate and iron oxide particles with associated silico-aluminates (clay)
2	152	Pb, C, O, Ba, S, Ca	Lead carbonate, barium sulphate and calcium carbonate.
	126	Ba, O, C, S	Barium sulphate particle
	127	Ca, O, C, Pb	Calcium carbonate particle (with lead carbonate)
INTERPRETATION SIDE B OF THE BANNER			
Layer	Spectrum number	Elements	Materials
i	Spectrum yellow glaze	C, O, Pb, Ca, Fe, Al, Si, As, S, K, Ba, Cl	Yellow iron oxide (ochre pigment), silico-aluminates (clay), barium sulphate, arsenic sulphide (artificial orpiment pigment), calcium carbonate, potassium alum (yellow lake pigment substrate), lead oxide (drier) and salt-associated chlorine
	Spectrum yellow pigment	Fe, C, O, Pb, As, Si, Ca, S	Yellow iron oxide (ochre pigment), arsenic sulphide (artificial orpiment pigment), calcium carbonate, lead oxide (drier) and silicon (sanding cloths)
	Spectrum yellow pigment 2	Fe, C, O, Pb, Si, As, Al, Mn, Ca, Na, S, Cl	Yellow iron oxide (ochre pigment), arsenic sulphide (artificial orpiment pigment), silico-aluminates (clay), calcium carbonate, lead oxide (drier), Iron-manganese oxide (Umber) and sodium chloride (salt)
ii	173	C, Al, Pb, O	Aluminium leaf and lead carbonate

<table>
<tr><td colspan="6">Table III.27 (continued) SEM-EDX results of scroll cross-section sample SM21</td></tr>
<tr><td>BANNER</td><td colspan="5">The Scottish Tin Plate Braziers and Sheet Metal Workers' Society</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning & Son</td><td>YEAR</td><td>c.1916</td><td>SAMPLE</td><td>SM21</td></tr>
<tr><td rowspan="2">
Sample SM21 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×</td><td colspan="2">SINGLE ELEMENT MAPS SIDE A OF THE BANNER</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
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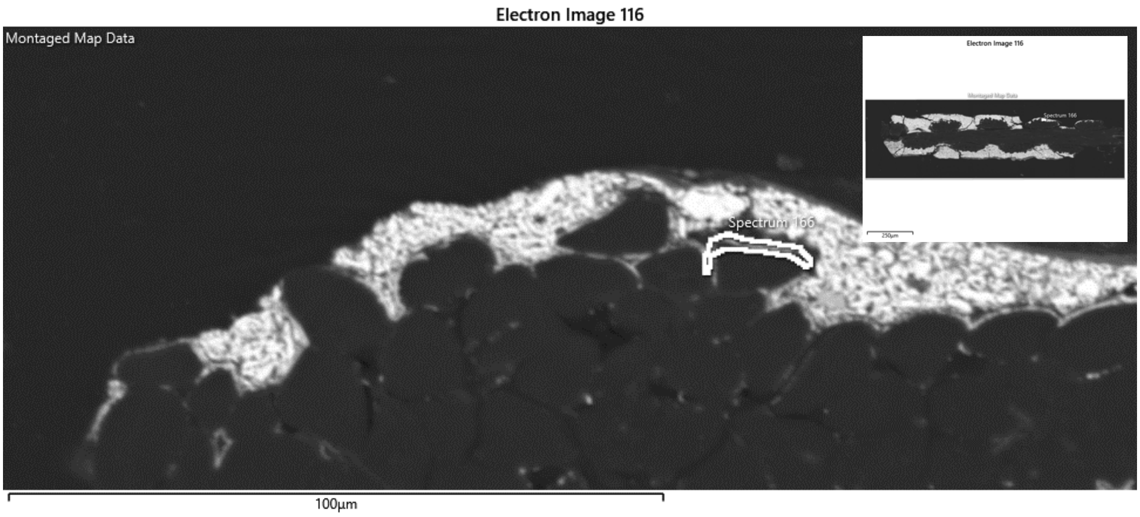
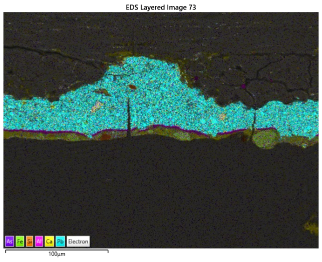
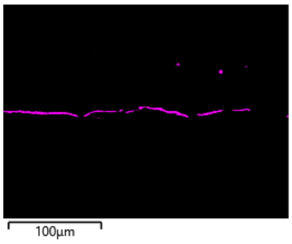
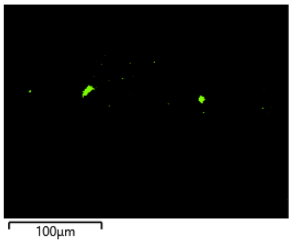
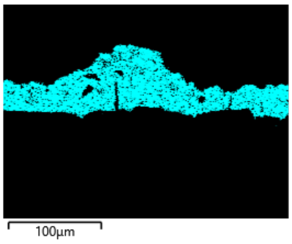
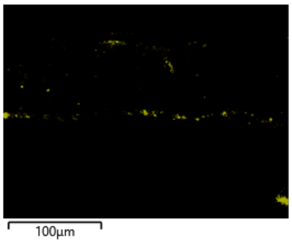
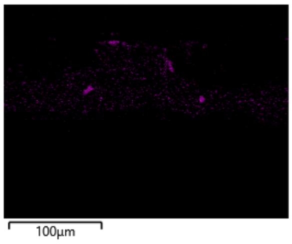
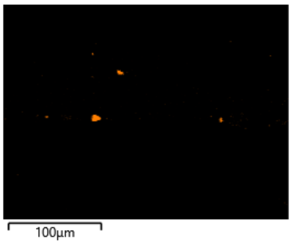
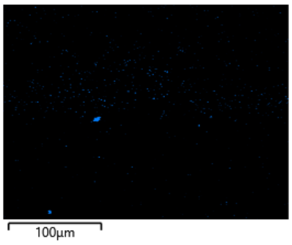
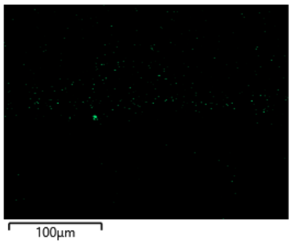
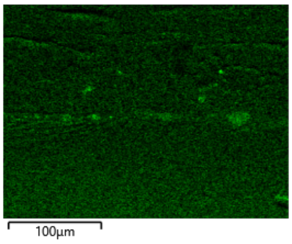
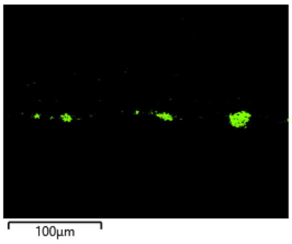
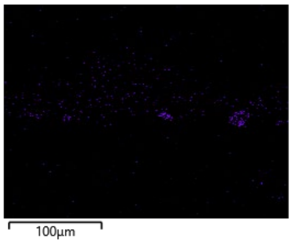
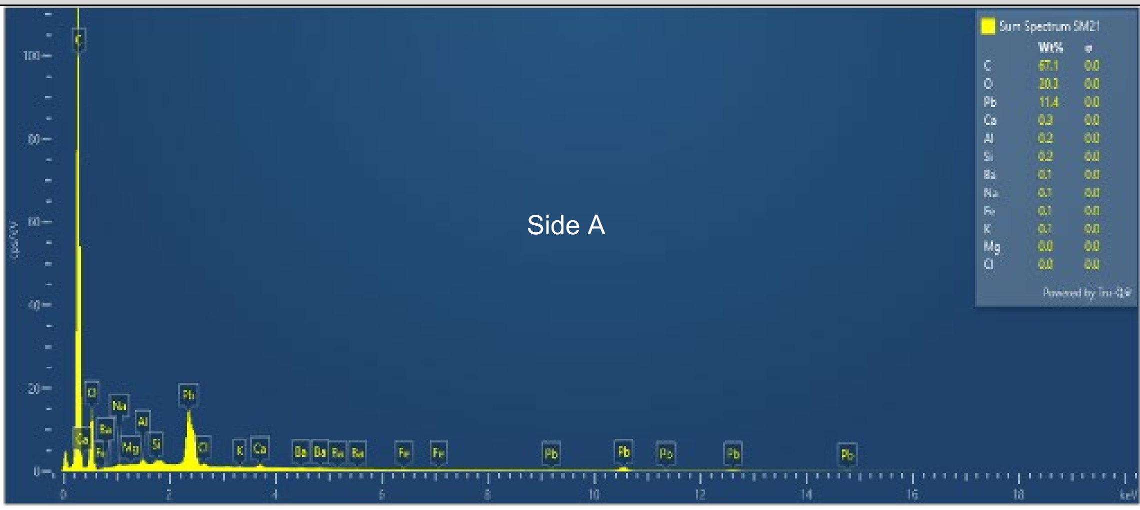


Figure III.5 Back-scattered electron image of lead-containing size in sample SM26 side A with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 1200x.

Table III.27 (continued) SEM-EDX results of scroll cross-section sample SM21

BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c.1916	SAMPLE	SM21

	SINGLE ELEMENT MAPS SIDE B OF THE BANNER	
EDS Layered Image 73  Sample SM21 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×	Al K series 	Ba L series 
Pb M series 	Ca K series 	S K series 
Si K series 	K K series 	Na K series 
O K series 	Fe K series 	As L series 

<table>
<tr><td colspan="6">Table III.27 (continued) SEM-EDX results of scroll cross-section sample SM21</td></tr>
<tr><td>BANNER</td><td colspan="5">The Scottish Tin Plate Braziers and Sheet Metal Workers' Society</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning & Son</td><td>YEAR</td><td>c. 1916</td><td>SAMPLE</td><td>SM21</td></tr>
<tr><td colspan="6">SELECTED EDX SPECTRA SIDE A OF THE BANNER</td></tr>
<tr><td colspan="6">
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<tr><td colspan="6">
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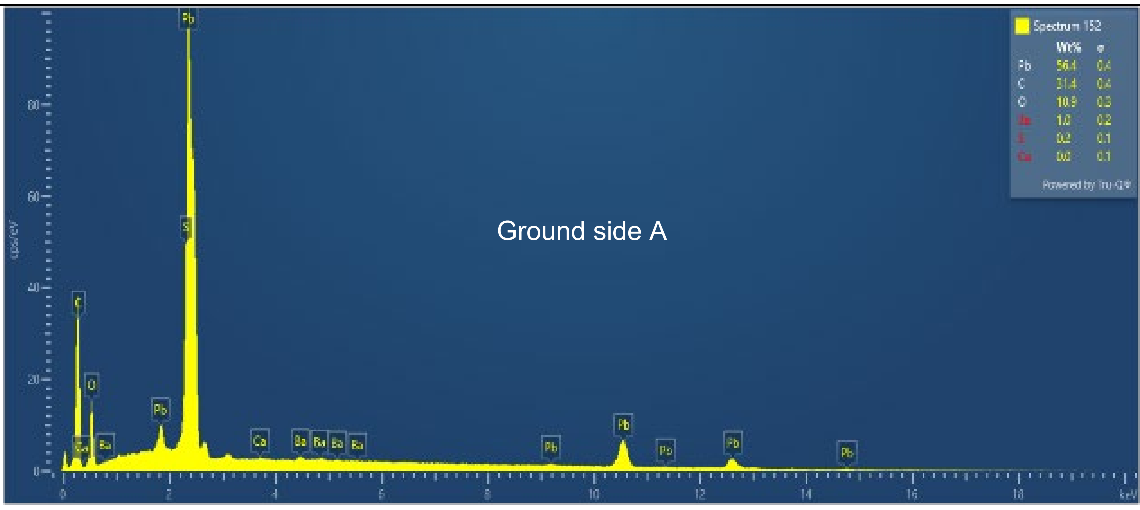
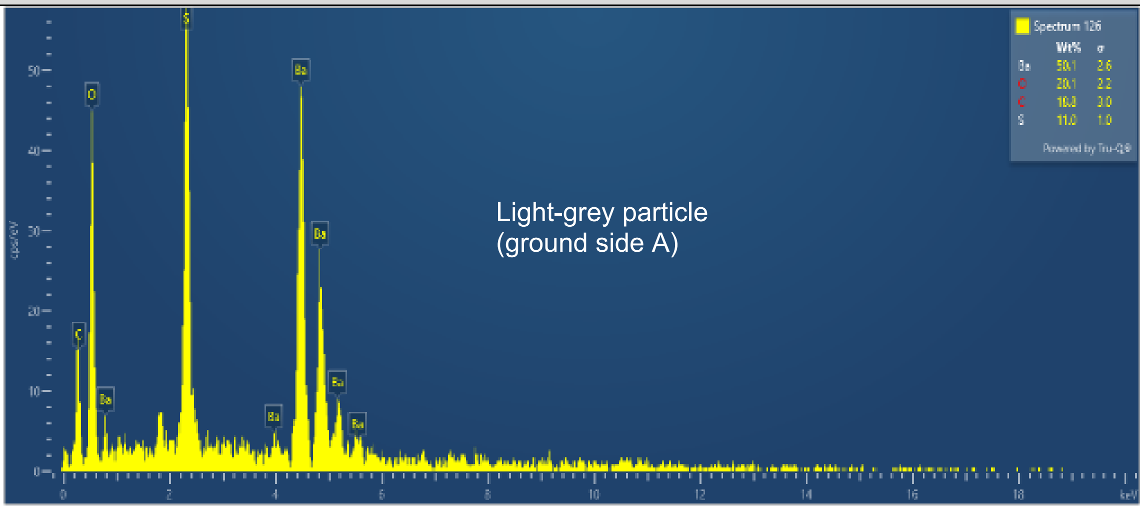
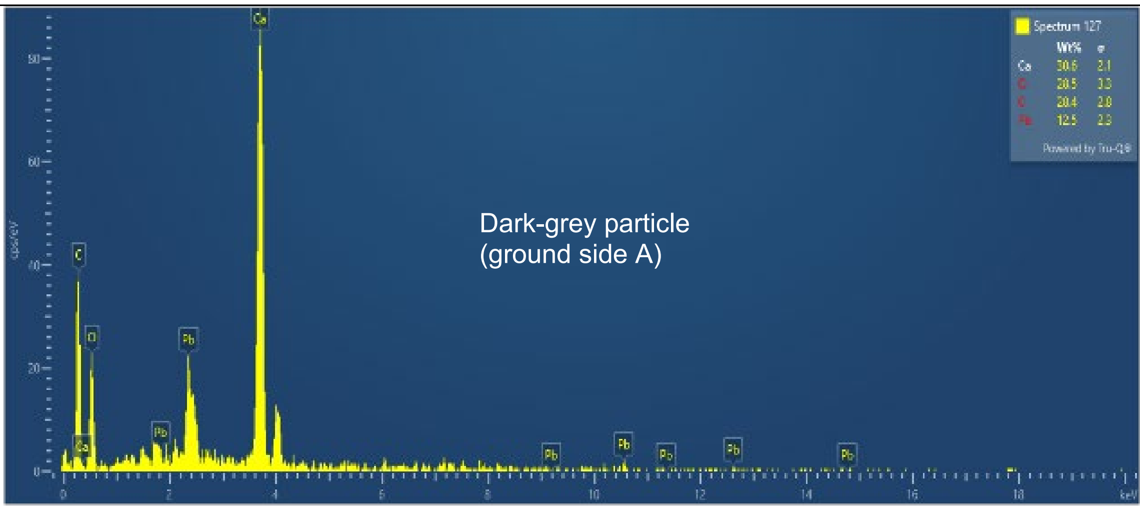
<tr><td colspan="6">
</td></tr>
</table>

Table III.27 (continued) SEM-EDX results of scroll cross-section sample SM21					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM21
SELECTED EDX SPECTRA SIDE A OF THE BANNER					





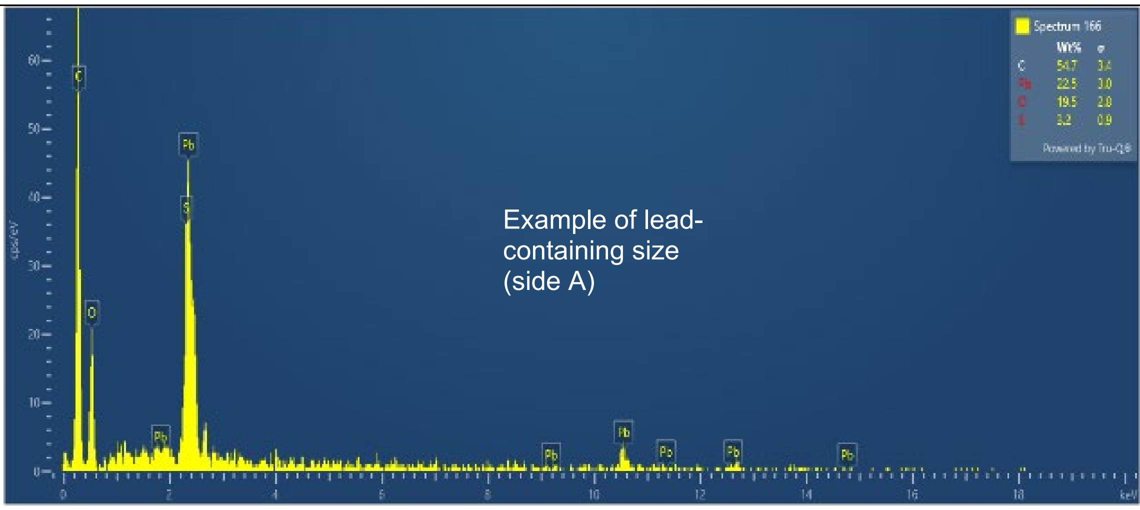
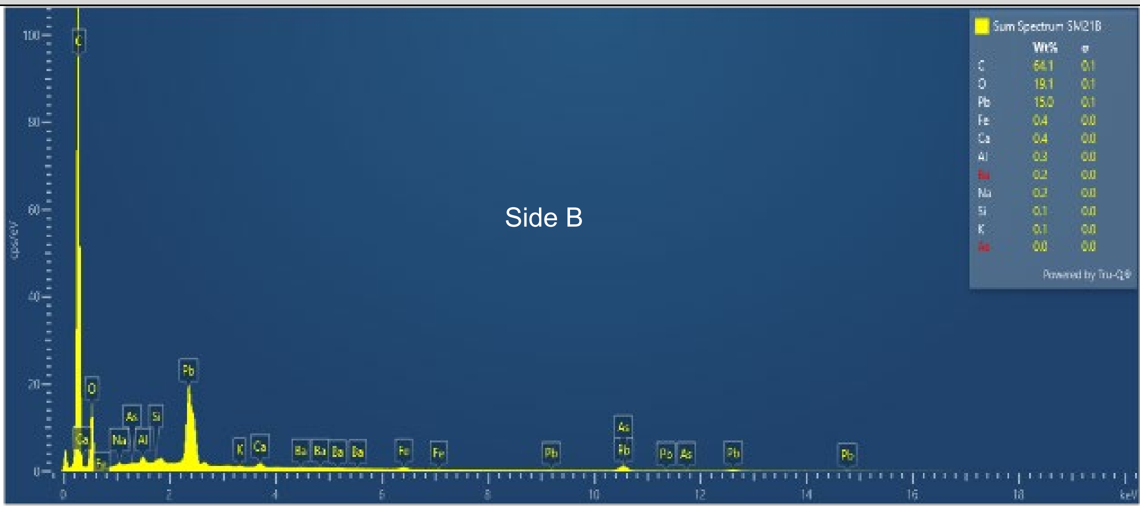
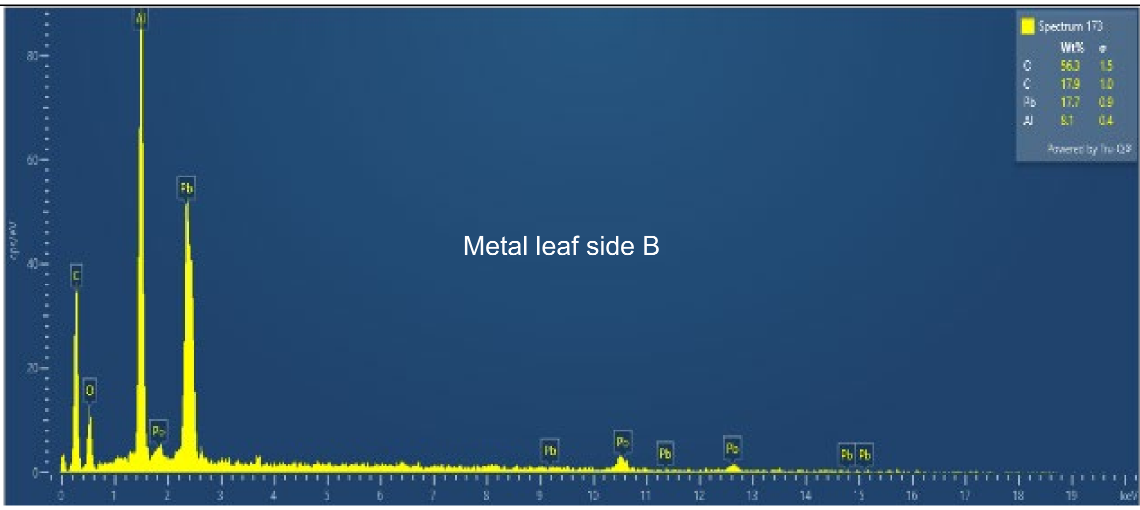


Table III.27 (continued) SEM-EDX results of scroll cross-section sample SM21					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM21
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





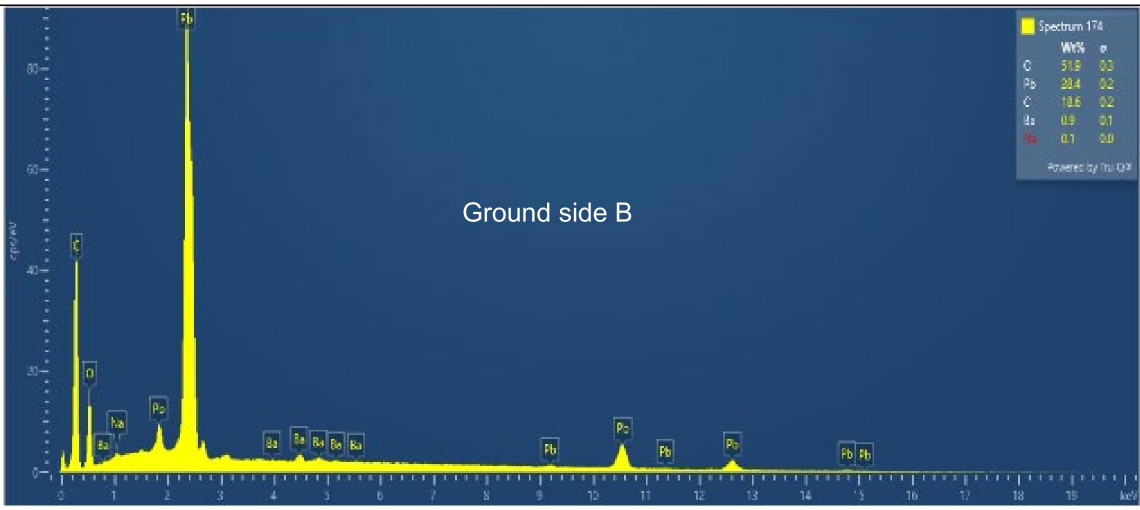
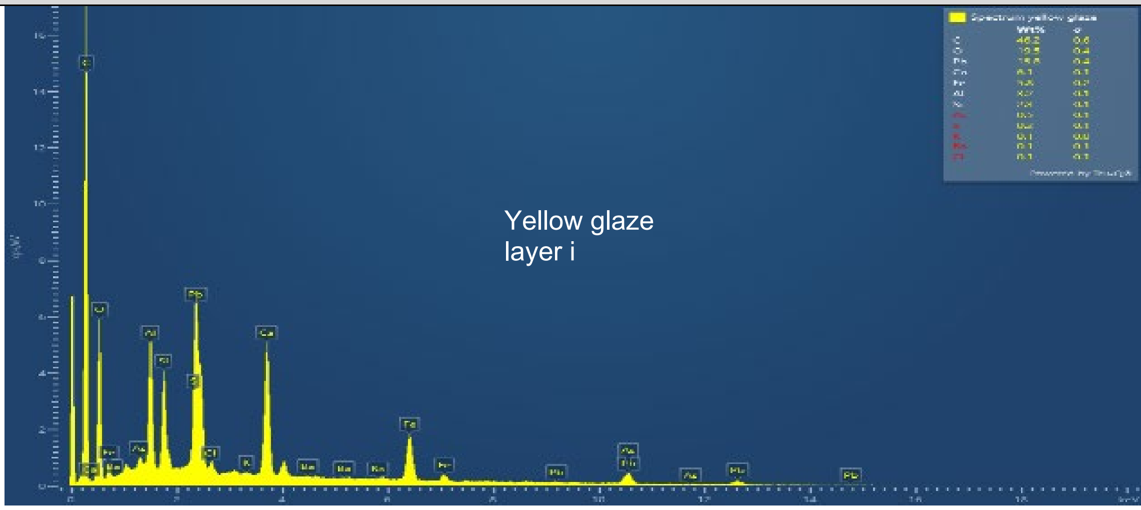
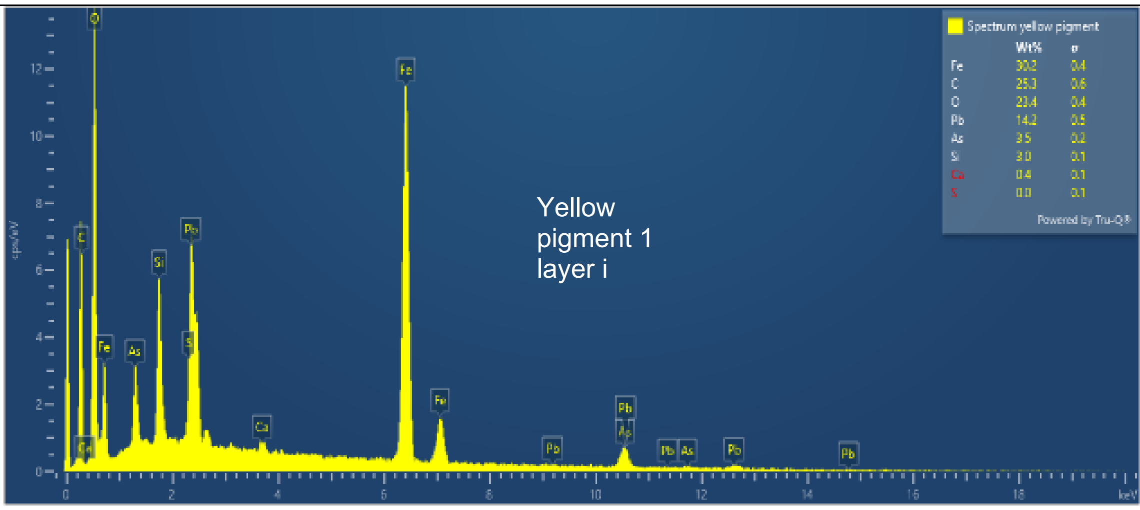
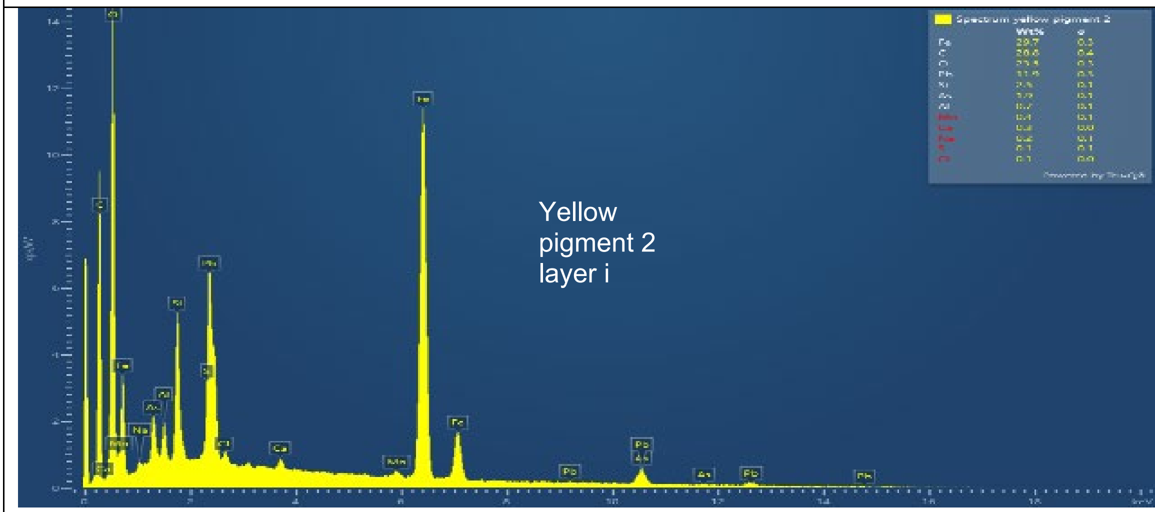


Table III.27 (continued) SEM-EDX results of scroll cross-section sample SM21					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM21
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

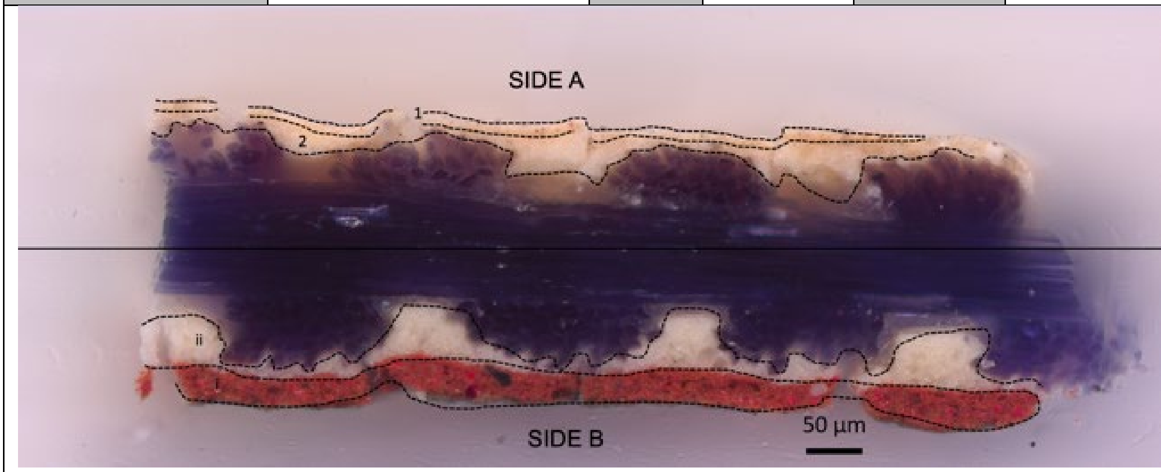




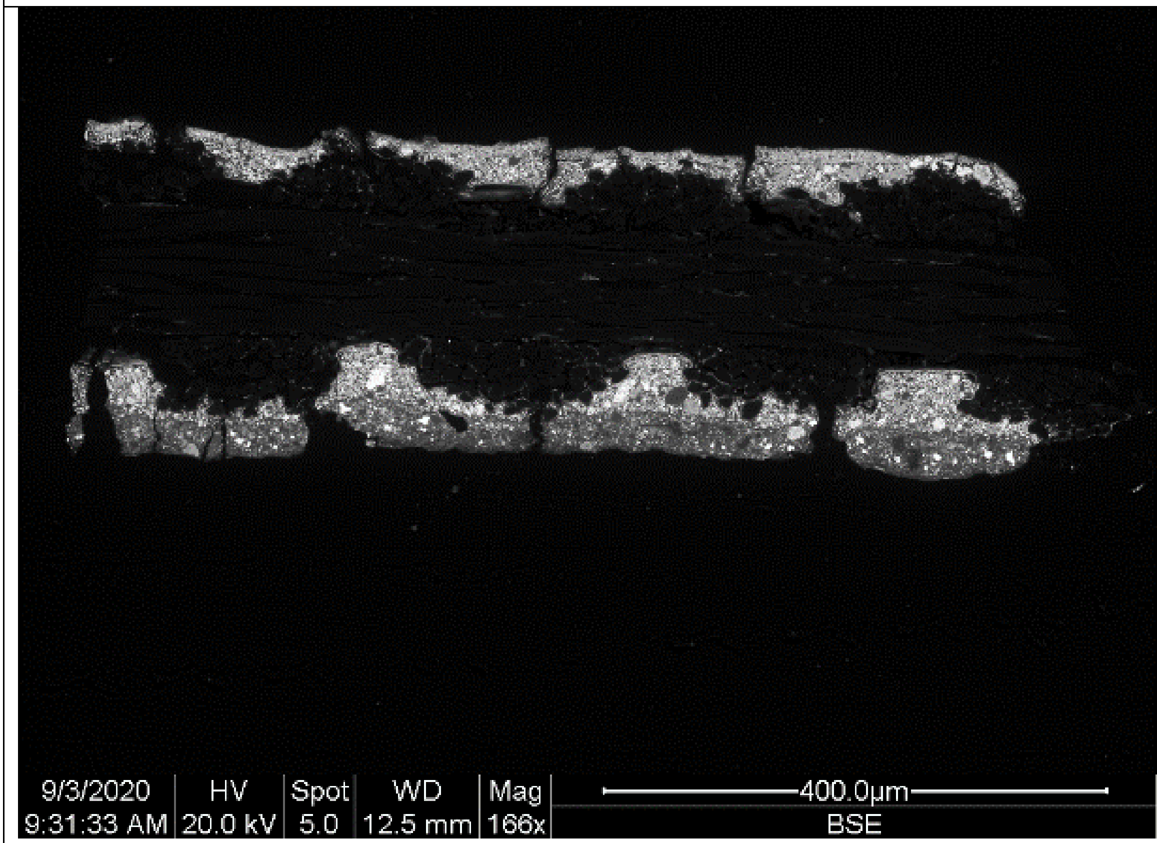


9.3.3.6 III.3.6 The Glasgow Typographical Society banner, paint cross-section sample

Table III.28 SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40

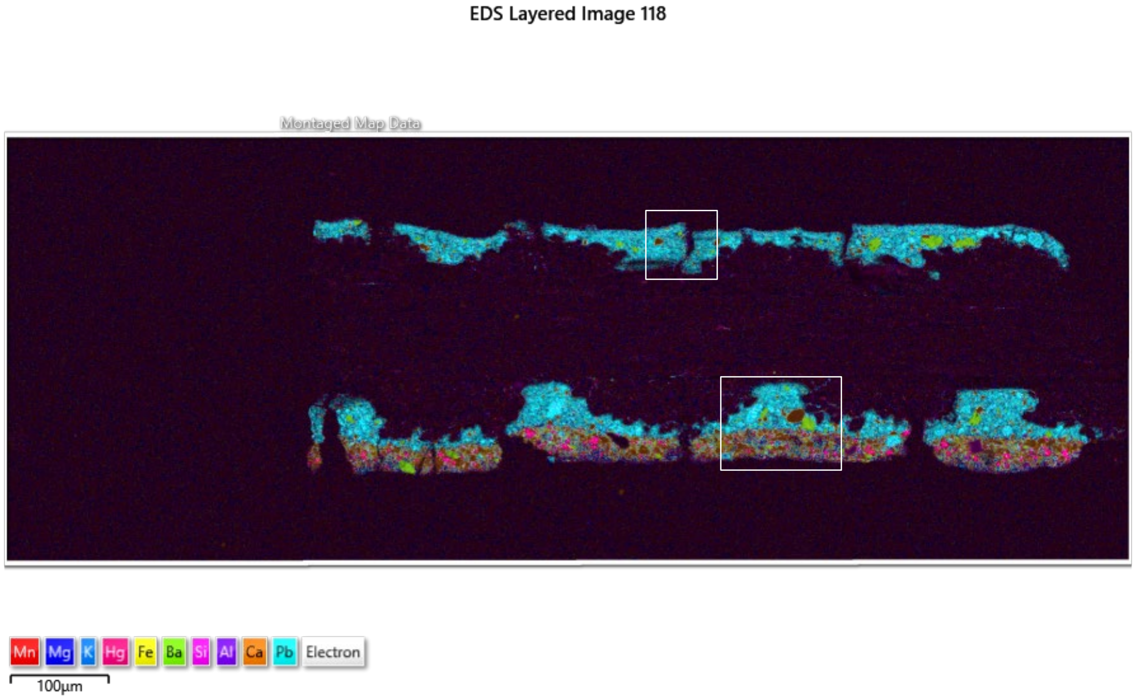


Sample TS40 annotated, incident light, bright field, Axioskop 2 Zeiss, 100×

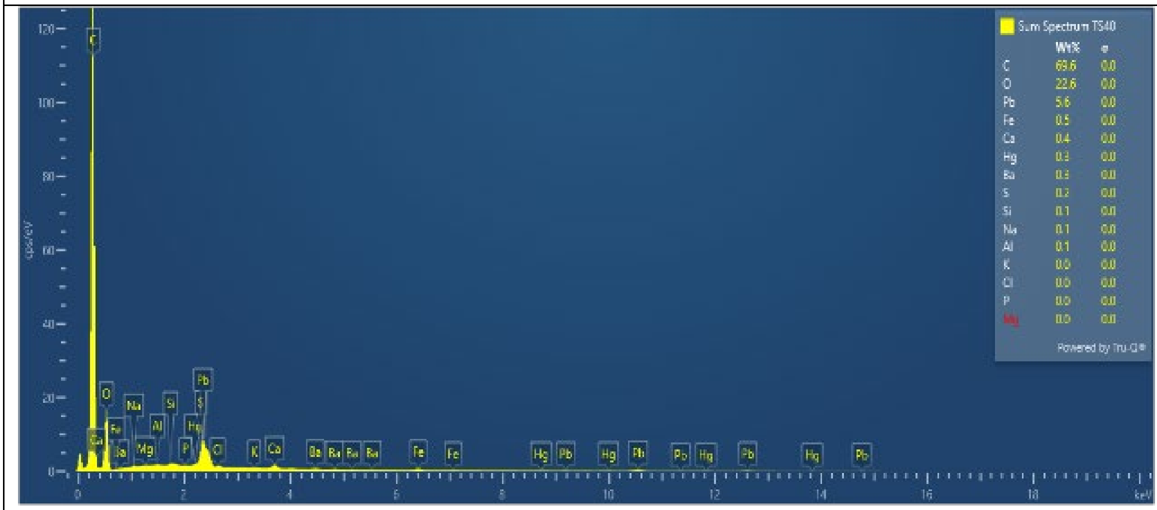


Sample TS40 backscattered electron image, Carl Zeiss Sigma SEM, 166×

Table III.28 (continued) SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40



Sample TS40 selected areas, composite element map, Carl Zeiss Sigma SEM,166×



Sample TS40 EDX sum spectrum, AZtec software

Table III.28 (continued) SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40

INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
1	31	Pb, C, O, Fe, Si, Ca, Mg, Mn	Lead carbonate, calcium carbonate, red iron oxides, iron-manganese oxide (umber pigment), quartz, magnesium carbonate (extender)
2	153	Pb, C, O, Ba, S, Ca	Lead carbonate, barium sulphate and calcium carbonate
	49	Ba, C, O, S	Barium sulphate particle
	51	O, Ca, C, Pb	Calcium carbonate particle

INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
i	32	C, O, Pb, Hg, Fe, Ca, S, Si, Ba, Al, Cr, Mg, Mn, Na	Lead carbonate, calcium carbonate, barium sulphate, calcium sulphate, mercury sulphide (vermilion pigment), iron-manganese oxide (umber pigment), silico-aluminates (clay), lead chromate, quartz, magnesium carbonate (extender)
	33	Hg, C, S	Mercury sulphide particle (vermilion pigment)
	69	C, O, Pb, Fe, Si, Ca, Al	Red iron oxide particle with associated silico-aluminates (clay) and calcium carbonate
ii	175	O, Pb, C, Ba, Ca, S	Lead carbonate, barium sulphate and calcium carbonate

Table III.28 (continued) SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40

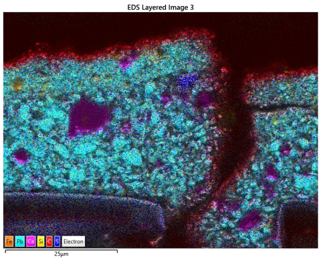
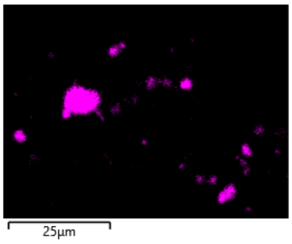
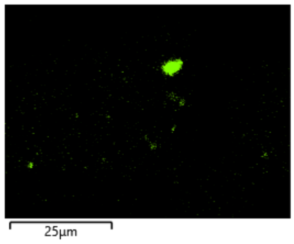
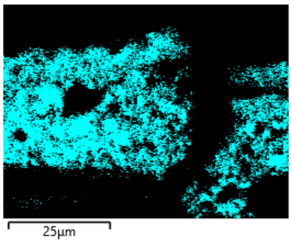
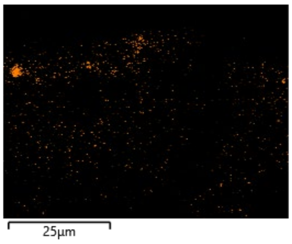
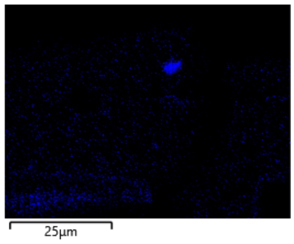
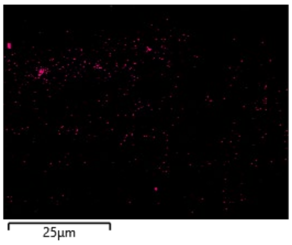
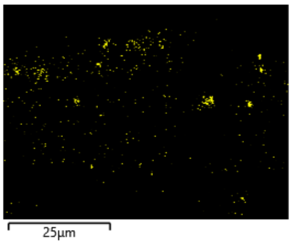
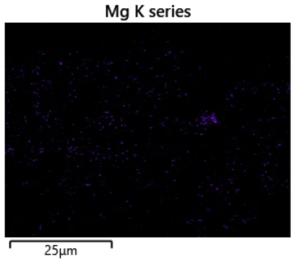
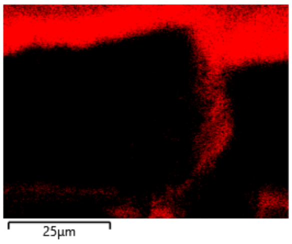
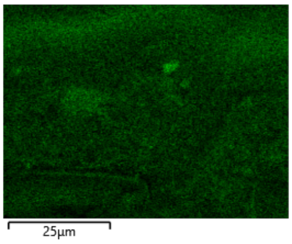
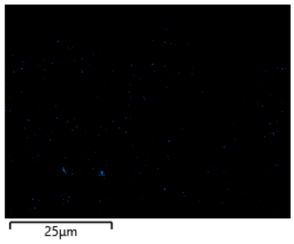
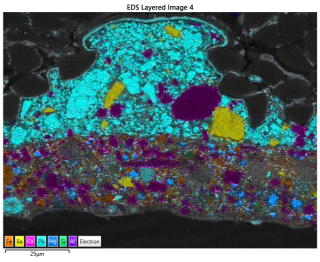
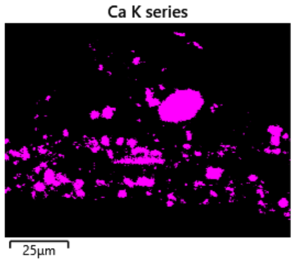
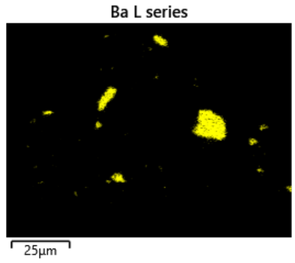
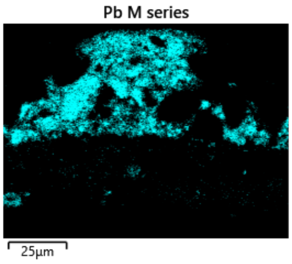
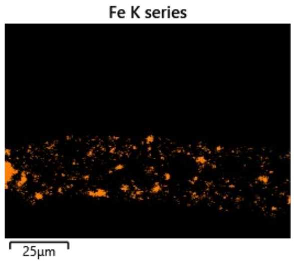
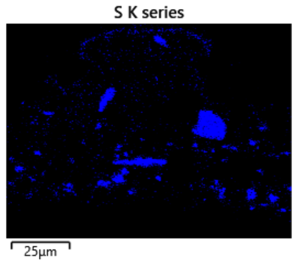
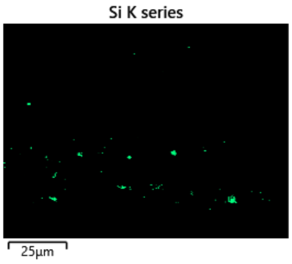
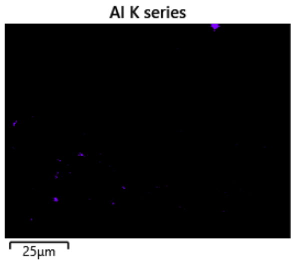
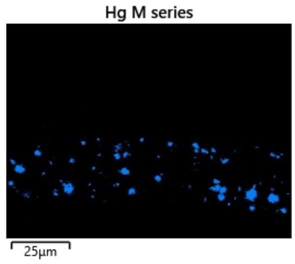
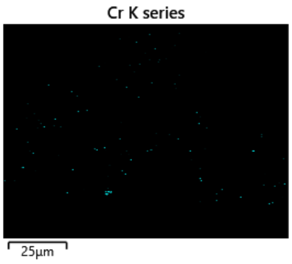
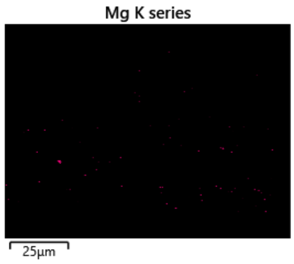
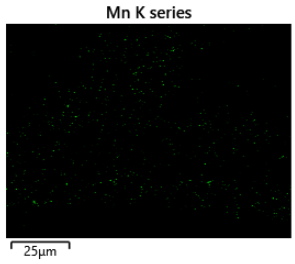
	SINGLE ELEMENT MAPS SIDE A OF THE BANNER	
 Sample TS40 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×	Ca K series 	Ba L series 
Pb M series 	Fe K series 	S K series 
Al K series 	Si K series 	Mg K series 
C K series 	O K series 	Na K series 

Table III.28 (continued) SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40

 Sample TS40 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×	SINGLE ELEMENT MAPS SIDE B OF THE BANNER	
		
		
		
		

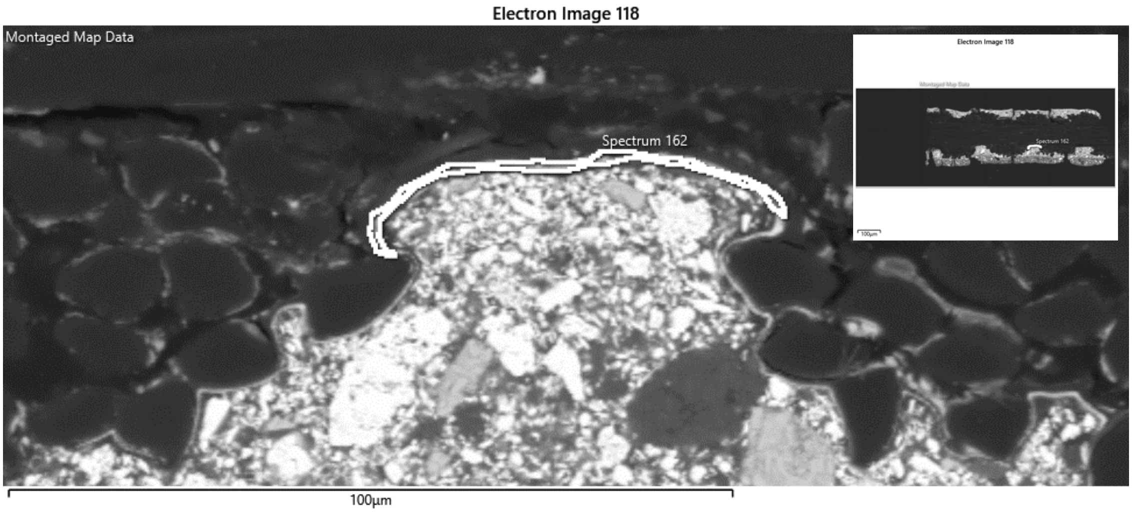
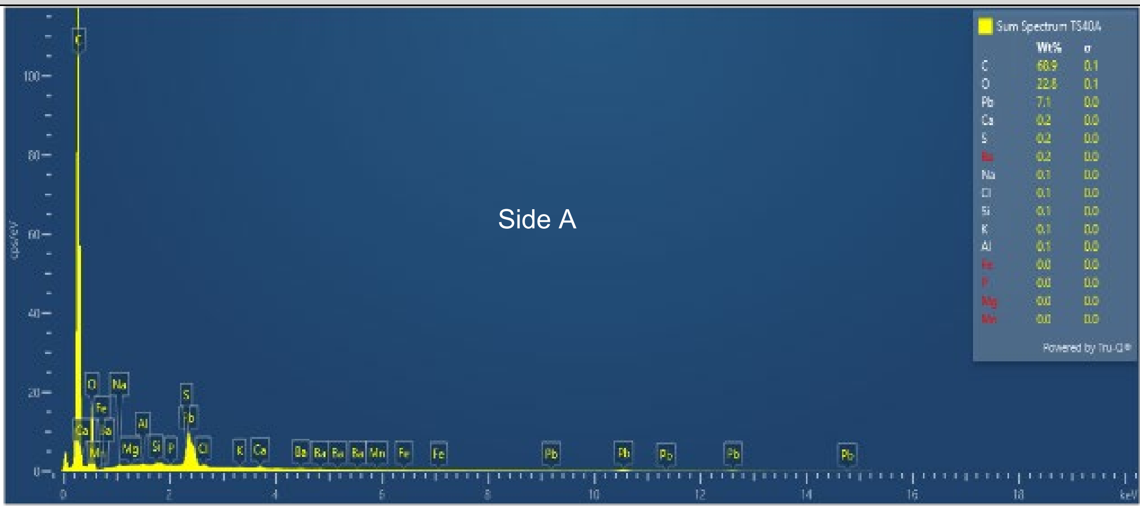
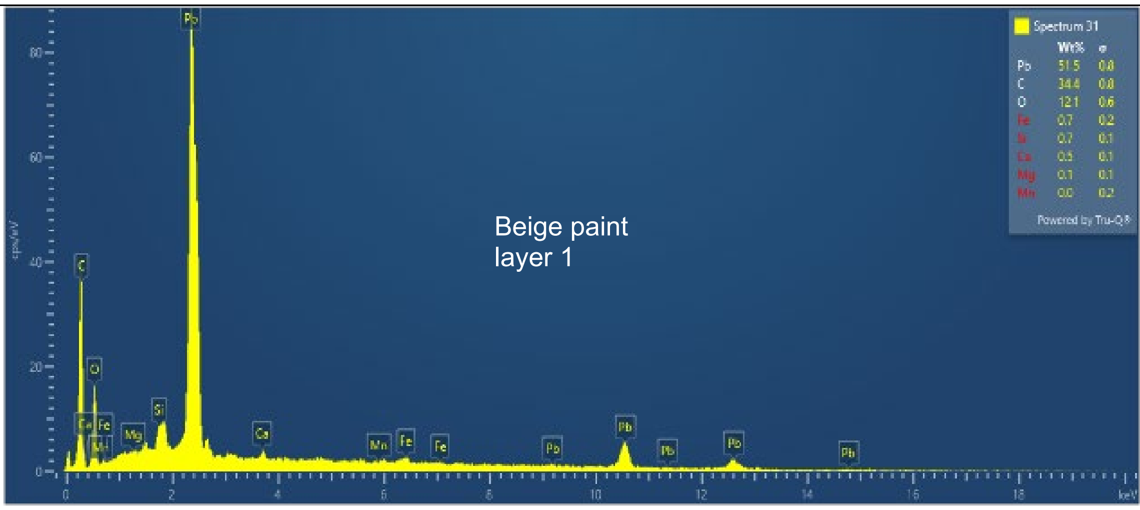


Figure III.6 Back-scattered electron image of lead-containing size in sample TS40 side B with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 1200×

Table III.28 (continued) SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40
SELECTED EDX SPECTRA SIDE A OF THE BANNER					





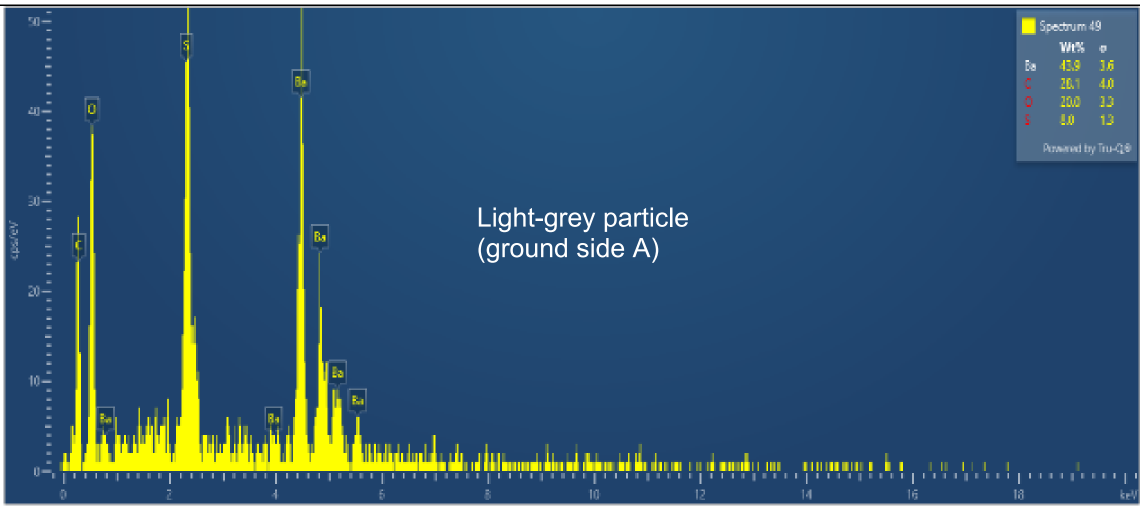


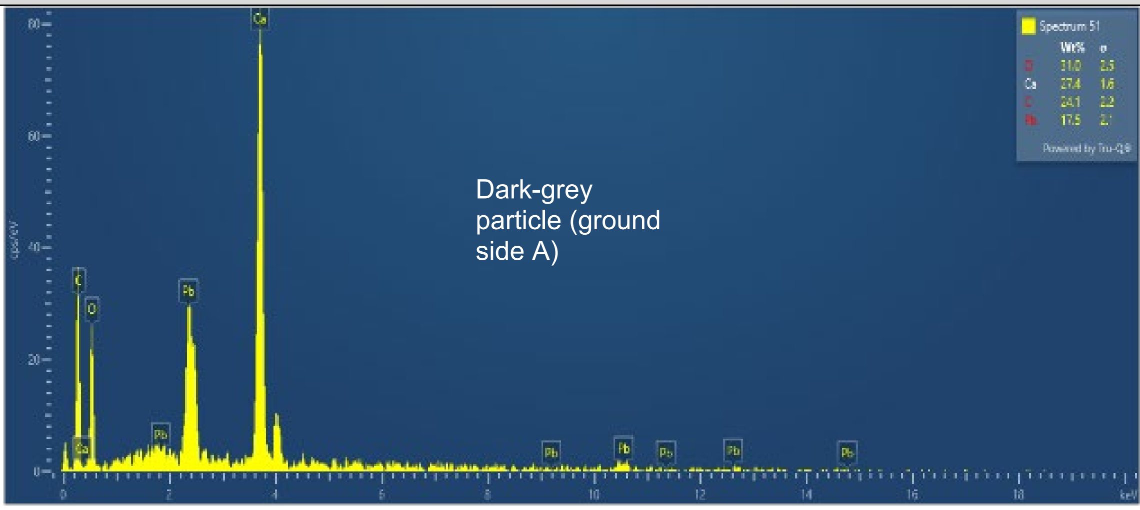
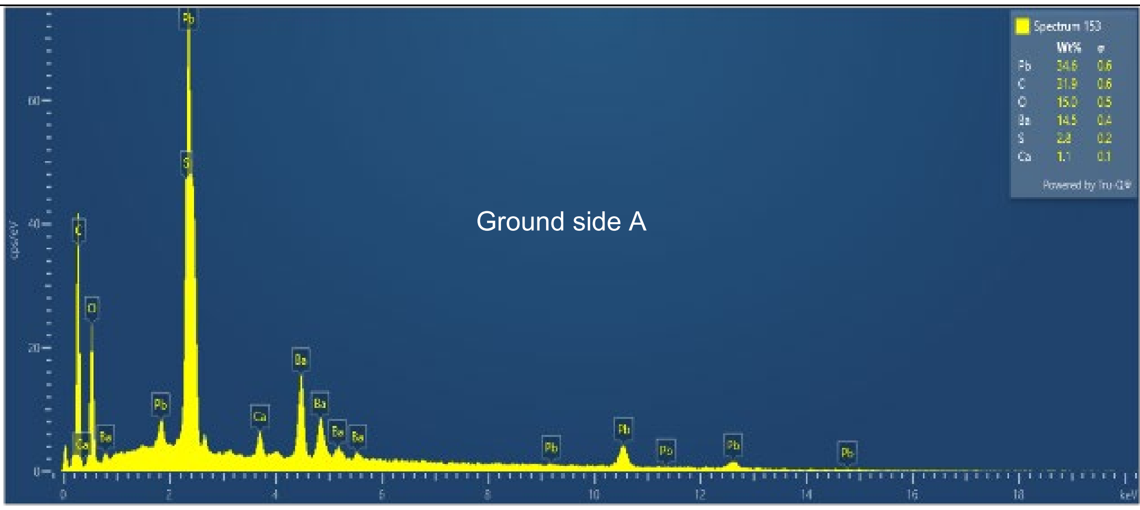
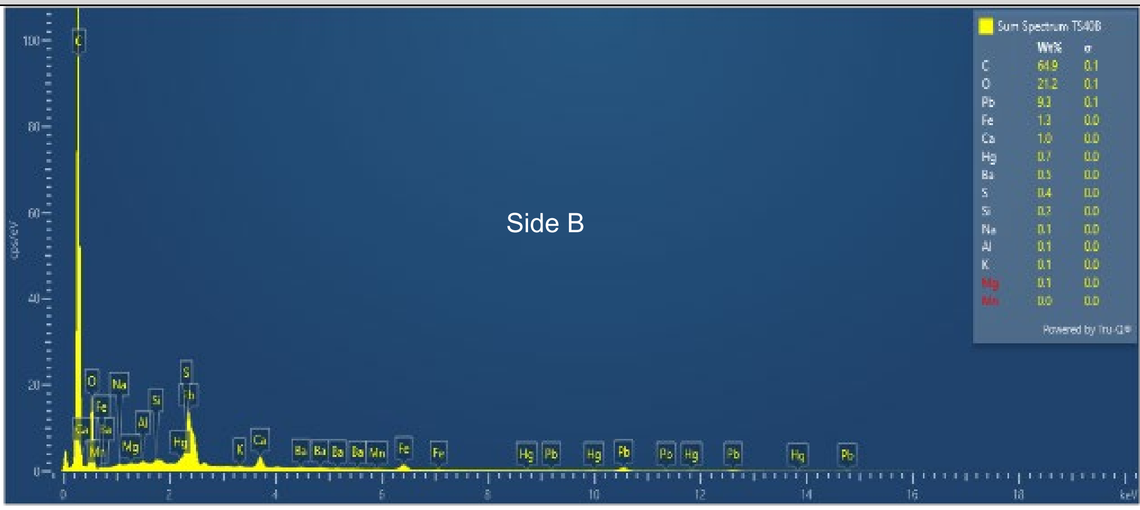
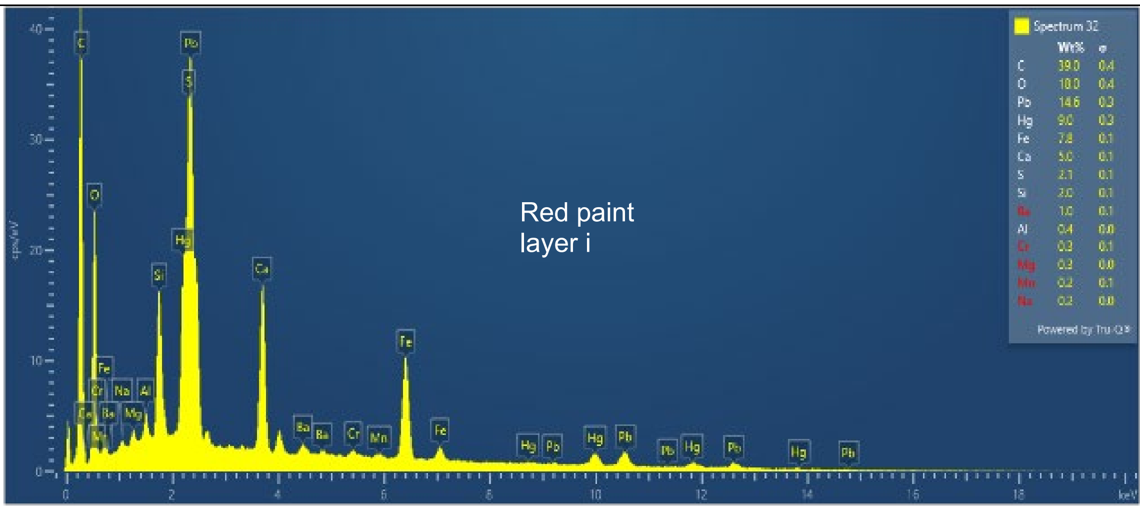
Table III.28 (continued) SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40
SELECTED EDX SPECTRA SIDE A OF THE BANNER					
					
					

Table III.28 (continued) SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





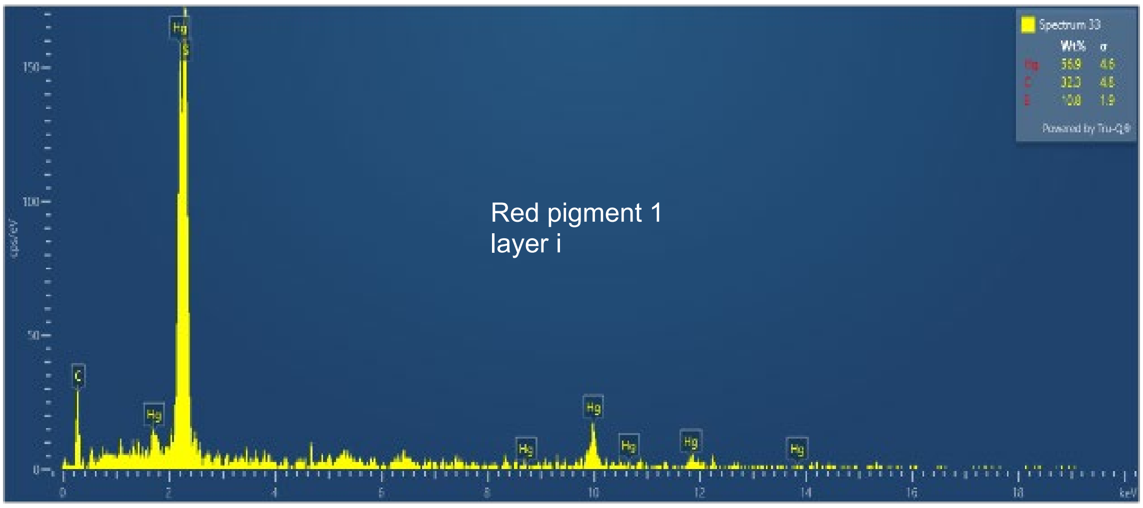
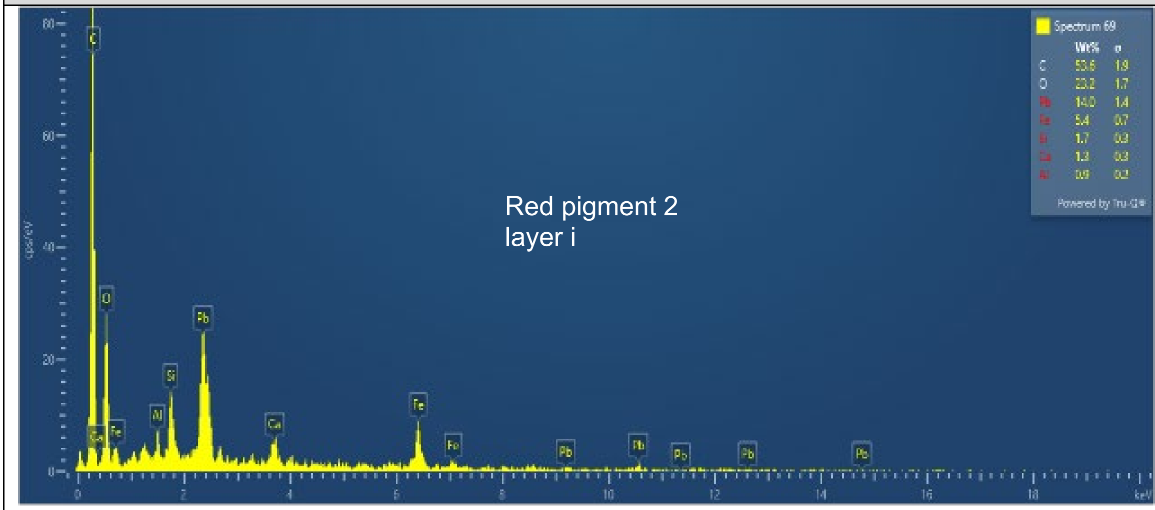
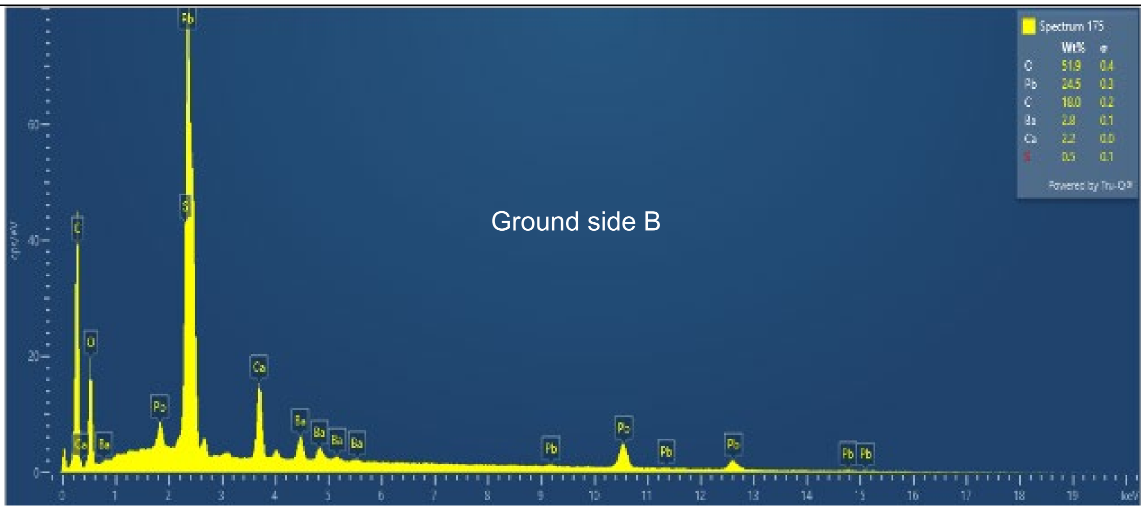
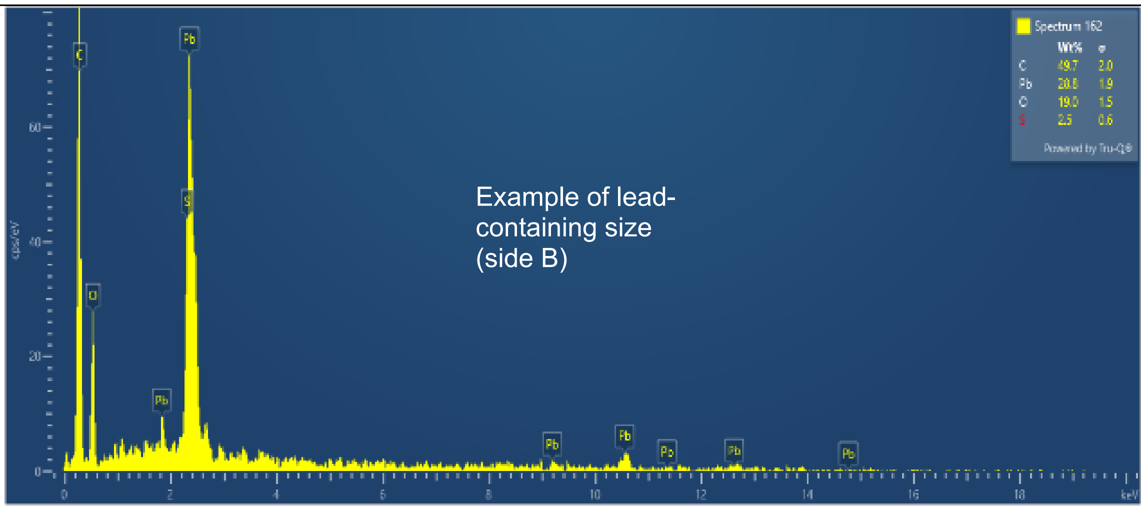


Table III.28 (continued) SEM-EDX results of paint cross-section sample TS40					
BANNER	The Glasgow Typographical Society				
MANUFACTURER	George Kenning	YEAR	1883	SAMPLE	TS40
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

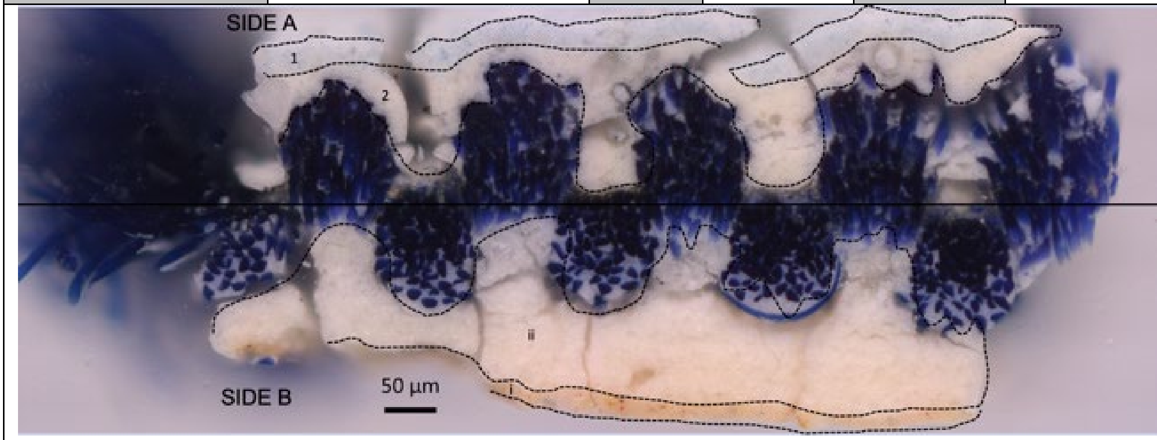




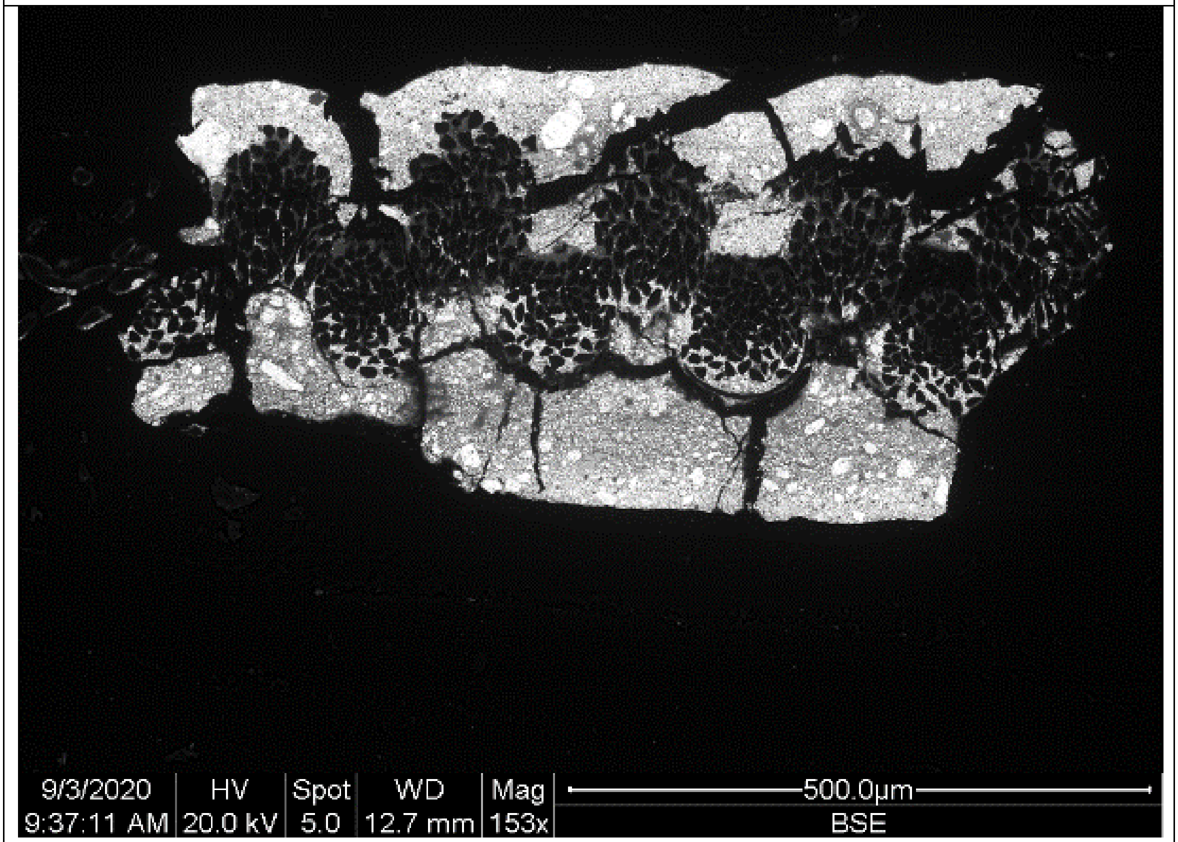


9.3.3.7 III.3.7 The Glasgow Upholsterers Society banner, paint sample

Table III.29 SEM-EDX results of paint cross-section sample GU09					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU09

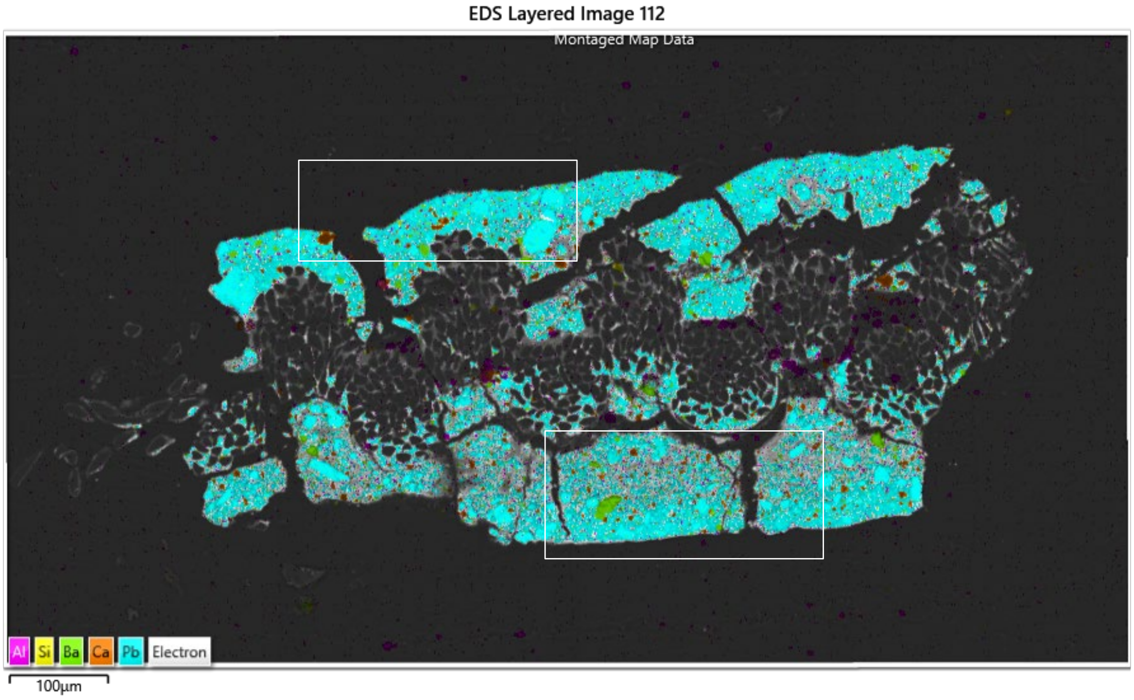


Sample GU09 annotated, incident light, bright field, Axioskop 2 Zeiss, 100×

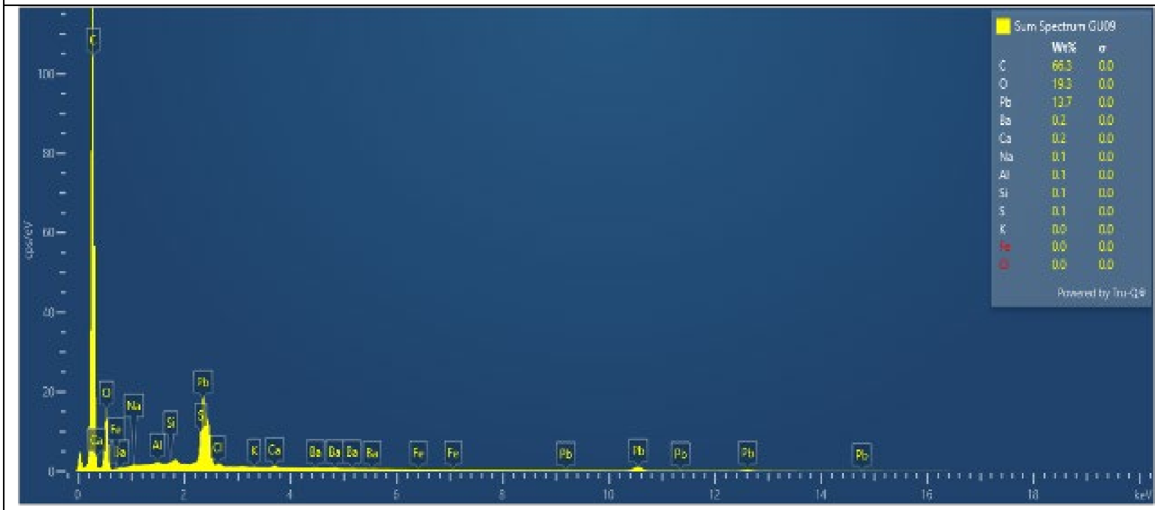


Sample GU09 backscattered electron image, Carl Zeiss Sigma SEM, 153×

Table III.29 (continued) SEM-EDX results of paint cross-section sample GU09					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU09



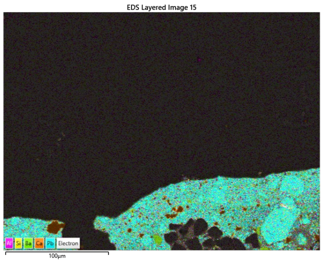
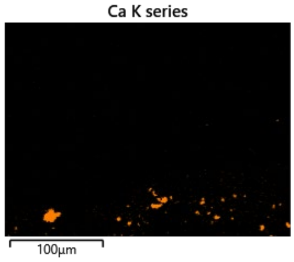
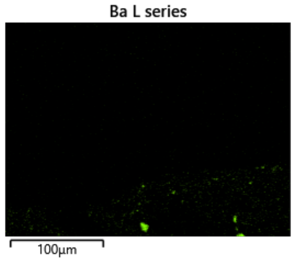
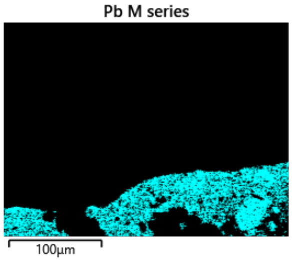
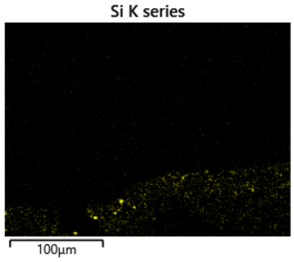
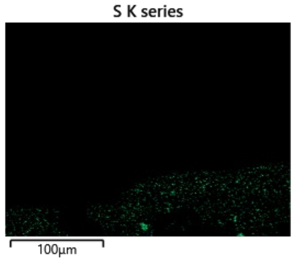
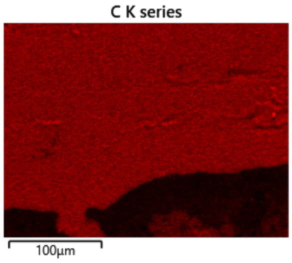
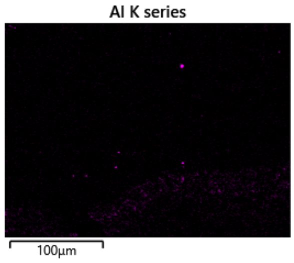
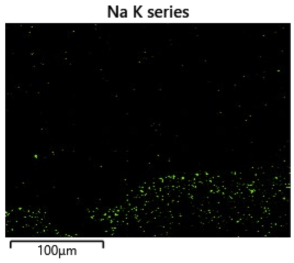
Sample GU09 selected areas, composite element map, Carl Zeiss Sigma SEM,153×

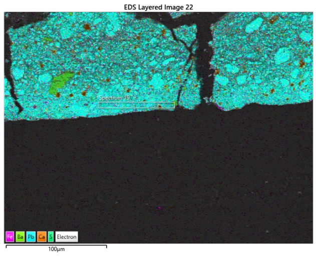
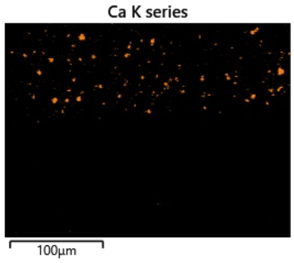
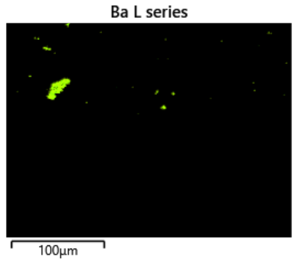
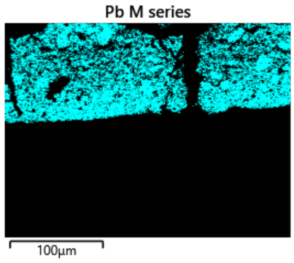
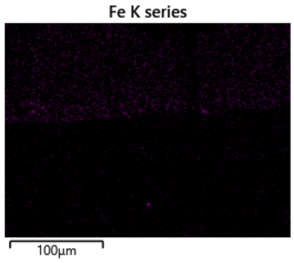
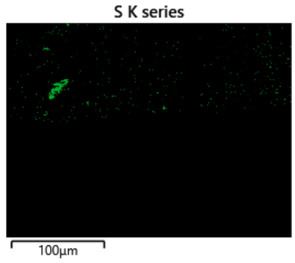
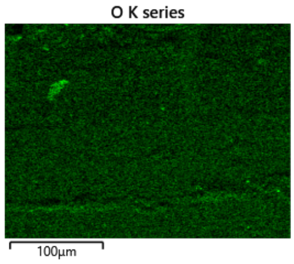
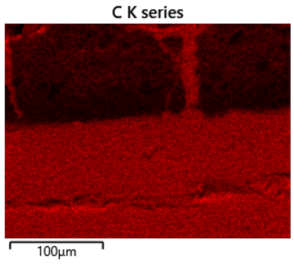
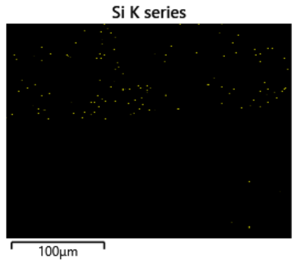


Sample GU09 EDX sum spectrum, AZtec software

Table III.29 (continued) SEM-EDX results of paint cross-section sample GU09						
BANNER	The Glasgow Upholsterers Society					
MANUFACTURER	George Kenning		YEAR	1884	SAMPLE	GU09
INTERPRETATION SIDE A OF THE BANNER						
Layer	Spectrum number	Elements	Materials			
1	18	Pb, C, O, Si, Al, Na, Ba, S, Mg	Lead carbonate, barium sulphate, sulphur-sodium silico-aluminate (synthetic ultramarine pigment), magnesium carbonate (extender)			
2	177	O, Pb, C, Ca	Lead carbonate and calcium carbonate			
	132	Pb, C, O, Ca	Lead carbonate and calcium carbonate particles			
	79	Ba, C, O, Pb, S	Barium sulphate particle (with lead carbonate)			
INTERPRETATION SIDE B OF THE BANNER						
Layer	Spectrum number	Elements	Materials			
i	19	Pb, C, O, Ba, Fe, Ca, Si, Mg, Al	Lead carbonate, yellow iron oxide (ochre pigment) with associated silico-aluminates (clay), barium sulphate and magnesium carbonate extenders			
	83	Pb, C, O	Lead carbonate particle			
ii	154	Pb, C, O, Ba, Ca, S	Lead carbonate, calcium carbonate and barium sulphate			

Table III.29 (continued) SEM-EDX results of paint cross-section sample GU09					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU09

 Sample GU09 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×	SINGLE ELEMENT MAPS SIDE A OF THE BANNER	
		
		
		

<table>
<tr><td colspan="6">Table III.29 (continued) SEM-EDX results of paint cross-section sample GU09</td></tr>
<tr><td>BANNER</td><td colspan="5">The Glasgow Upholsterers Society</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning</td><td>YEAR</td><td>1884</td><td>SAMPLE</td><td>GU09</td></tr>
<tr><td rowspan="2">Sample GU09 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×</td><td colspan="5">SINGLE ELEMENT MAPS SIDE B OF THE BANNER</td></tr>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="2"></td><td colspan="3"></td></tr>
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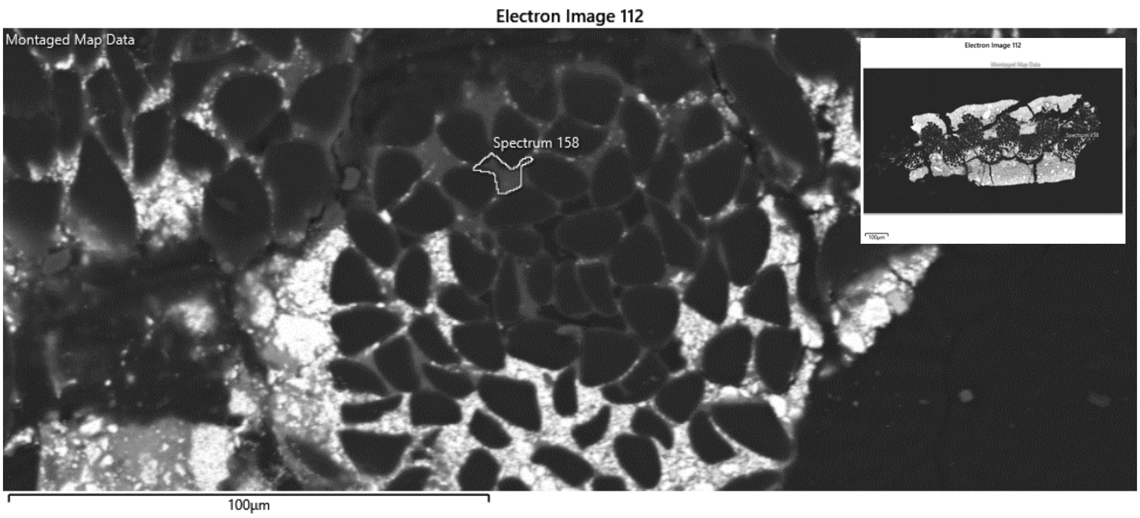
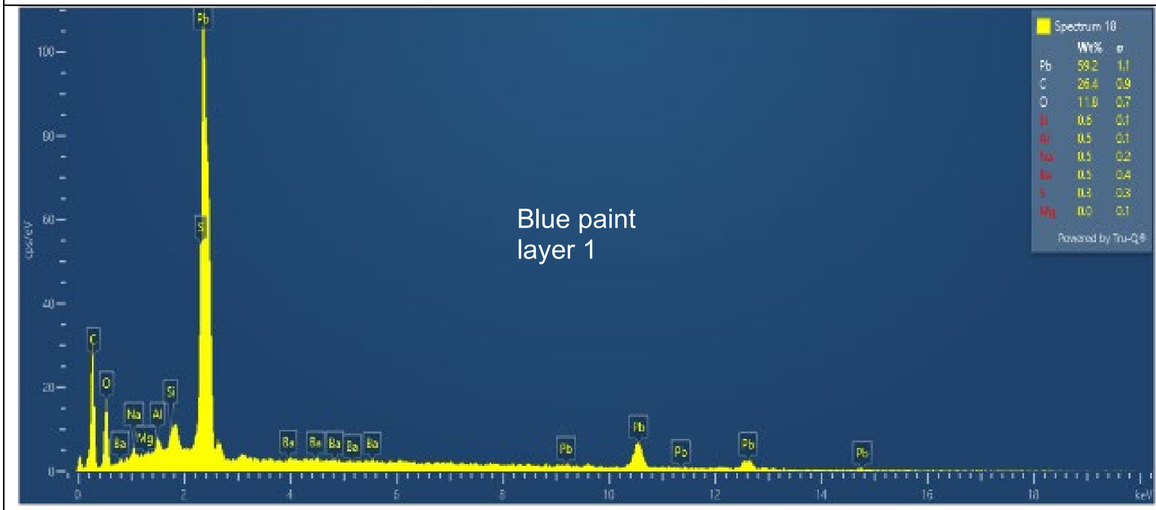


Figure III.7 Back-scattered electron image of lead-containing material (possible seeped linseed oil from the ground) in sample GU09 side B with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 1200×

Table III.29 (continued) SEM-EDX results of paint cross-section sample GU09					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU09
SELECTED EDX SPECTRA SIDE A OF THE BANNER					



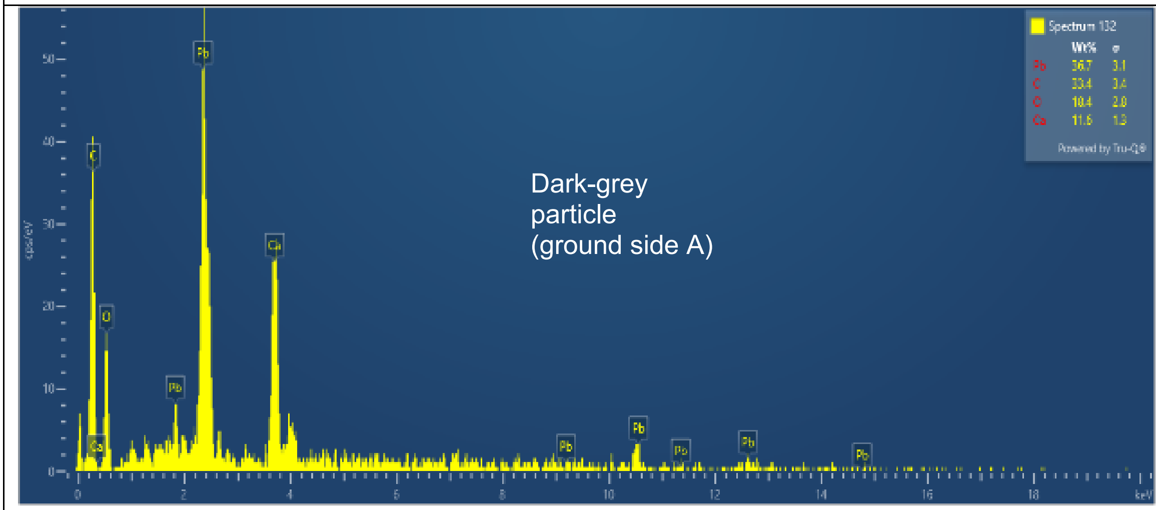
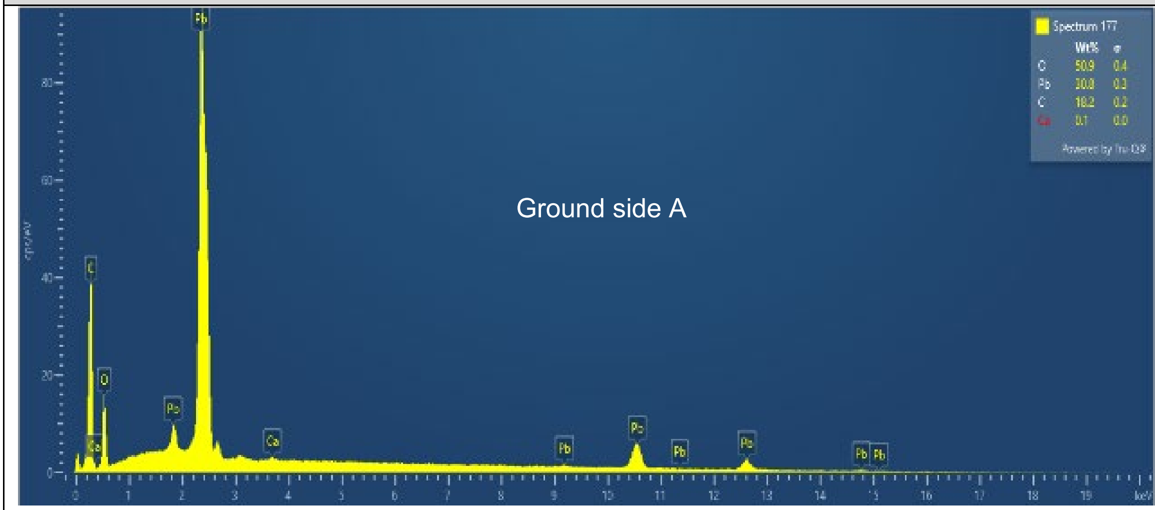


Table III.29 (continued) SEM-EDX results of paint cross-section sample GU09					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU09
SELECTED EDX SPECTRA SIDE A OF THE BANNER					



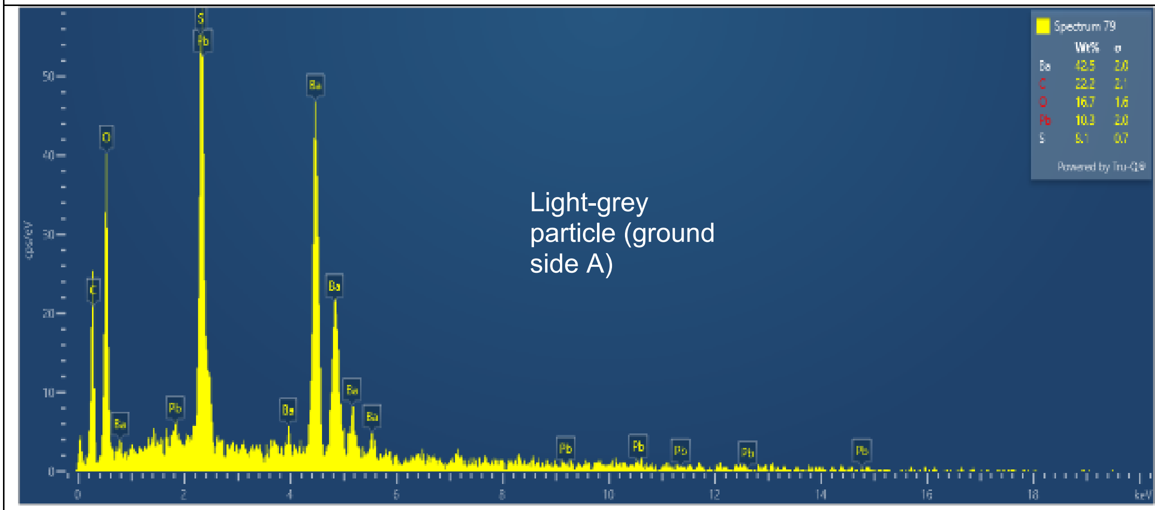
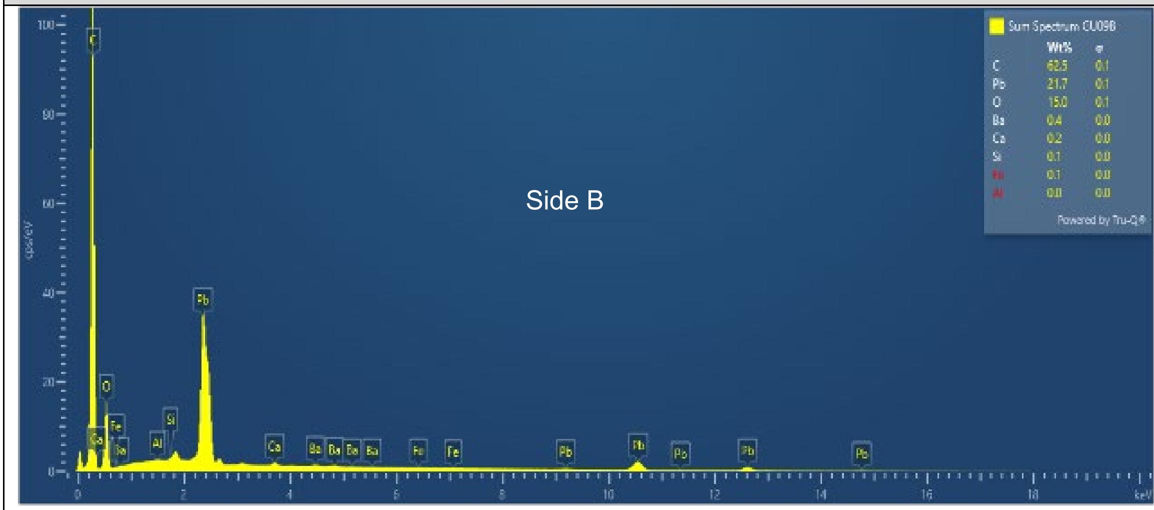
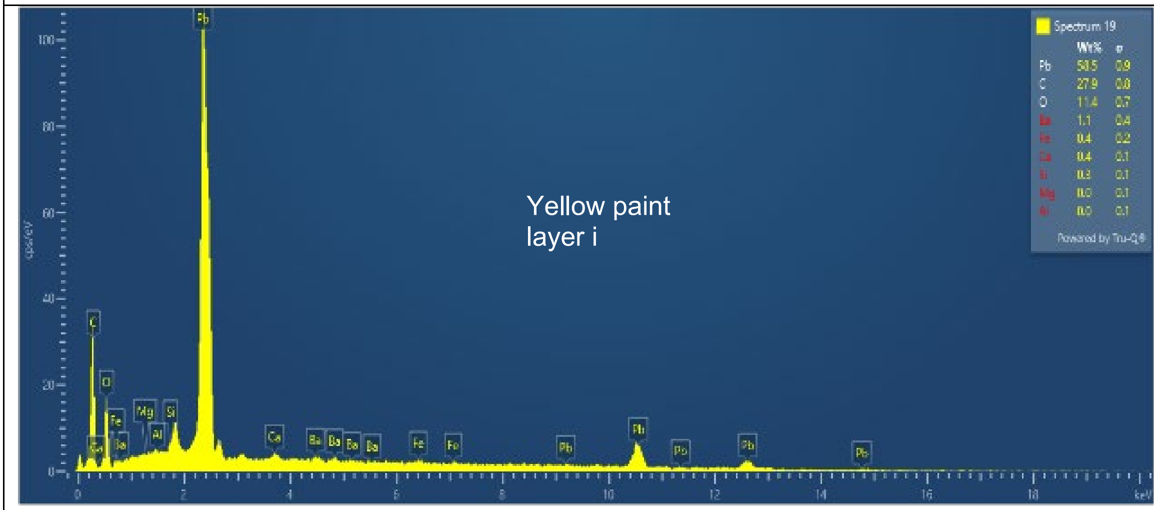


Table III.29 (continued) SEM-EDX results of paint cross-section sample GU09					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU09
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





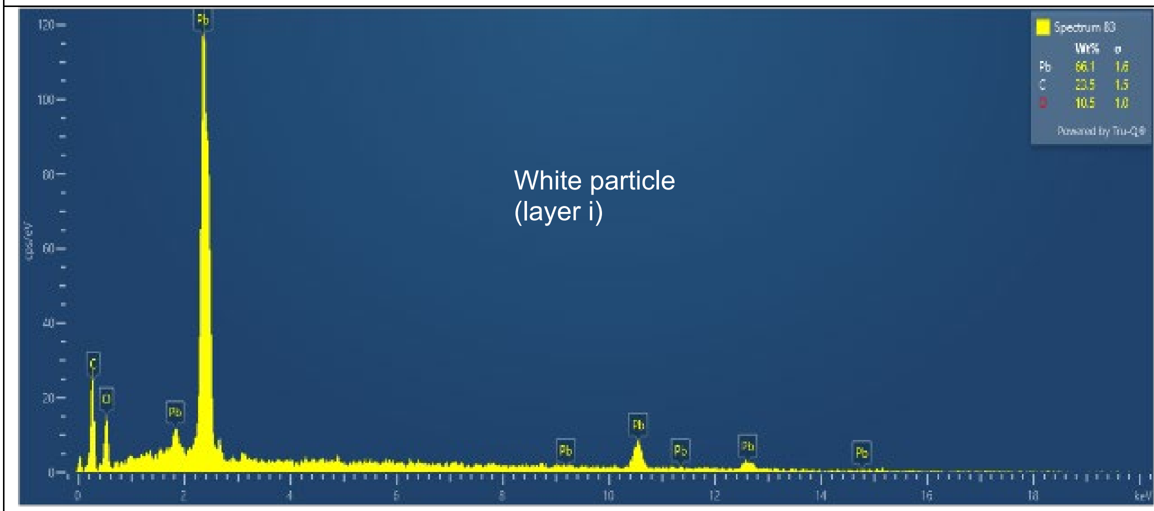
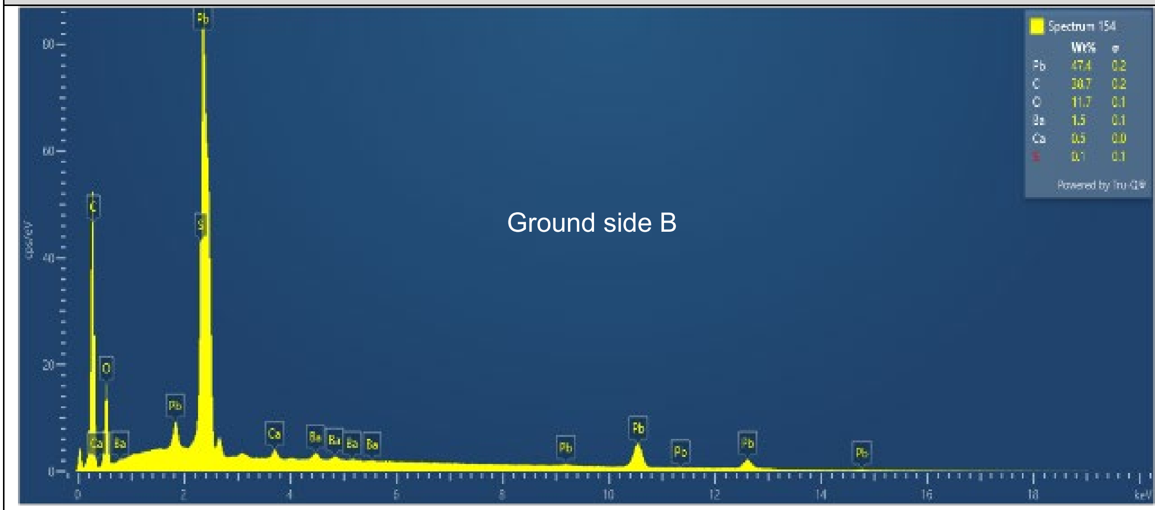
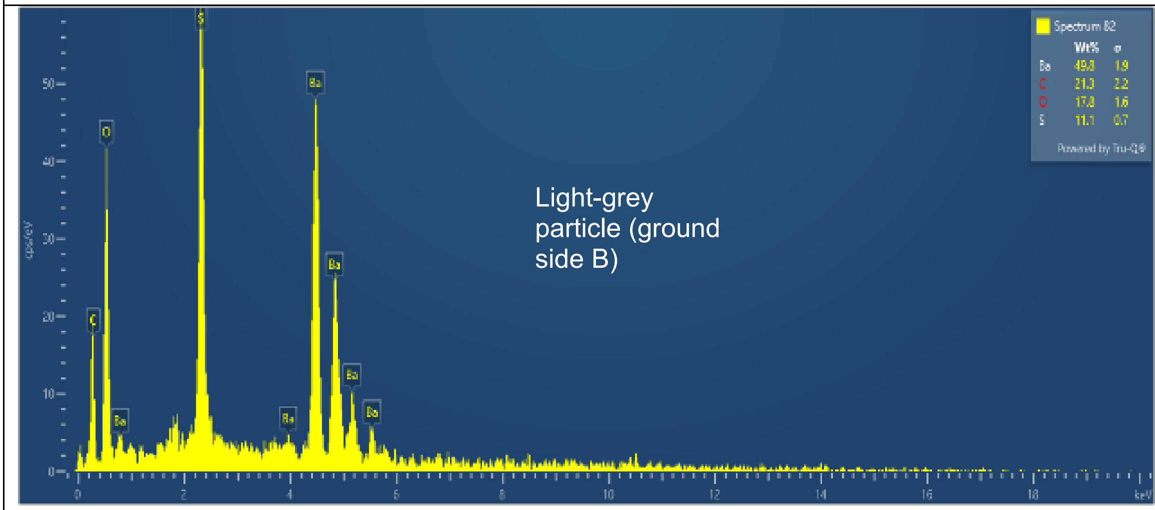
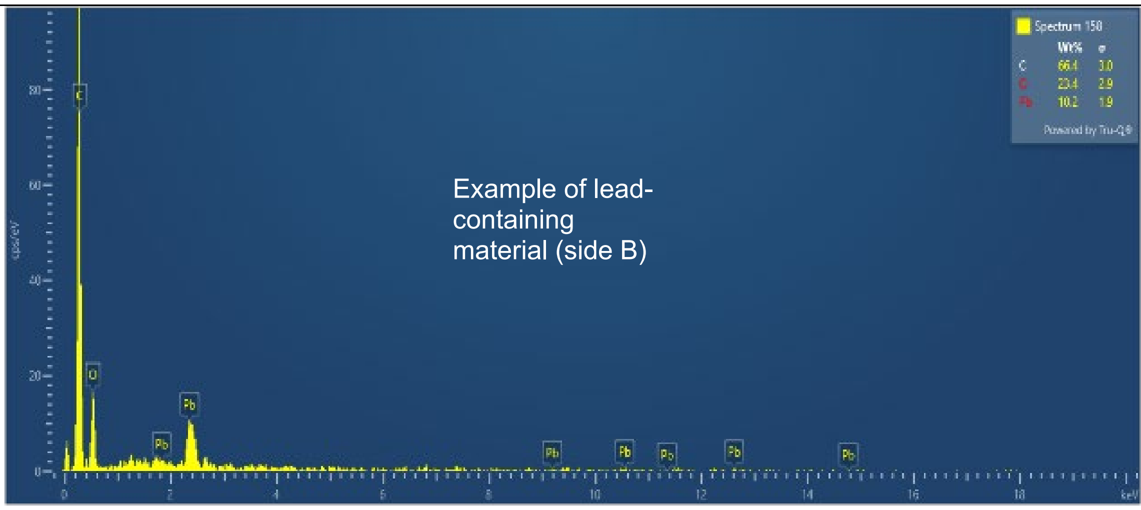


Table III.29 (continued) SEM-EDX results of paint cross-section sample GU09					
BANNER	The Glasgow Upholsterers Society				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	GU09
SELECTED EDX SPECTRA SIDE B OF THE BANNER					



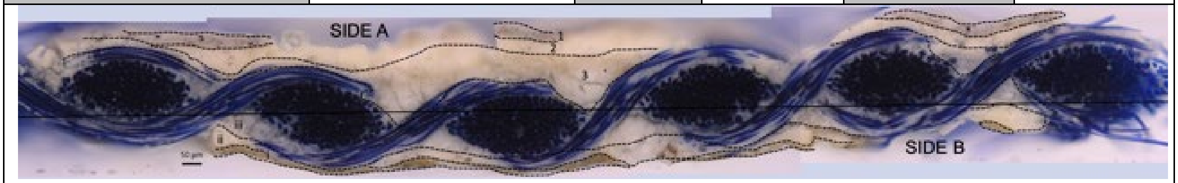




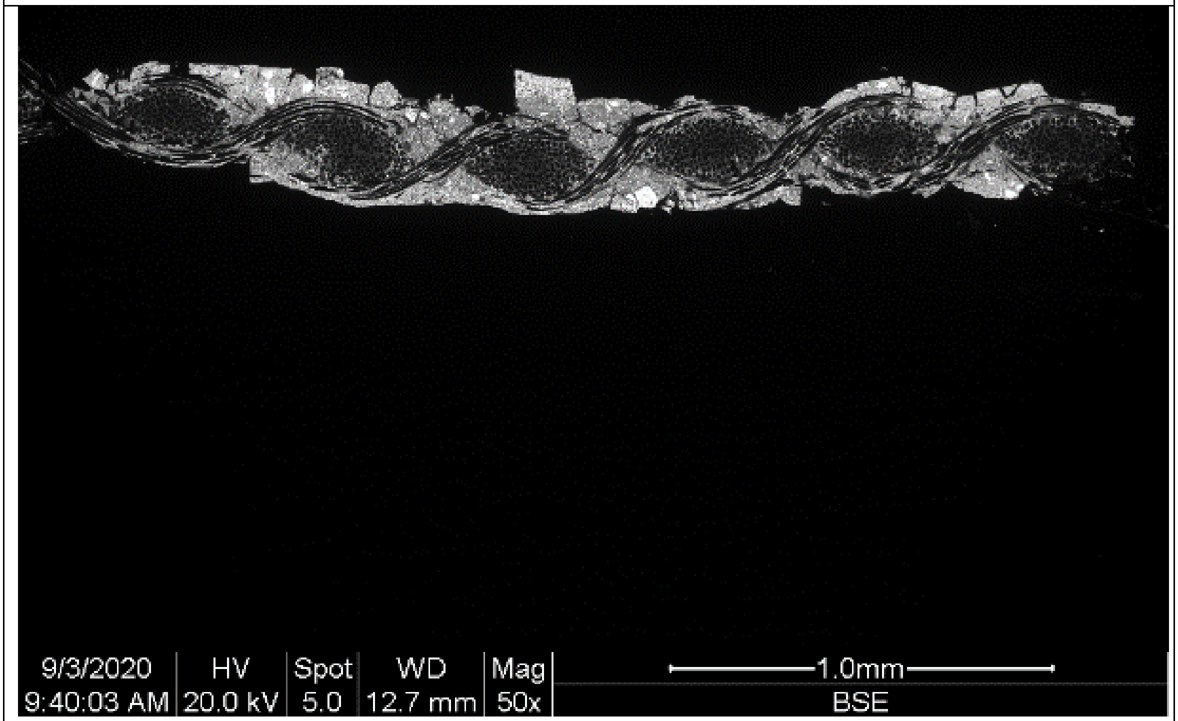
9.3.3.8 III.3.8 The Grain Millers of Glasgow banner, paint sample

Table III.30 SEM-EDX results of paint cross-section sample MG10

BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10

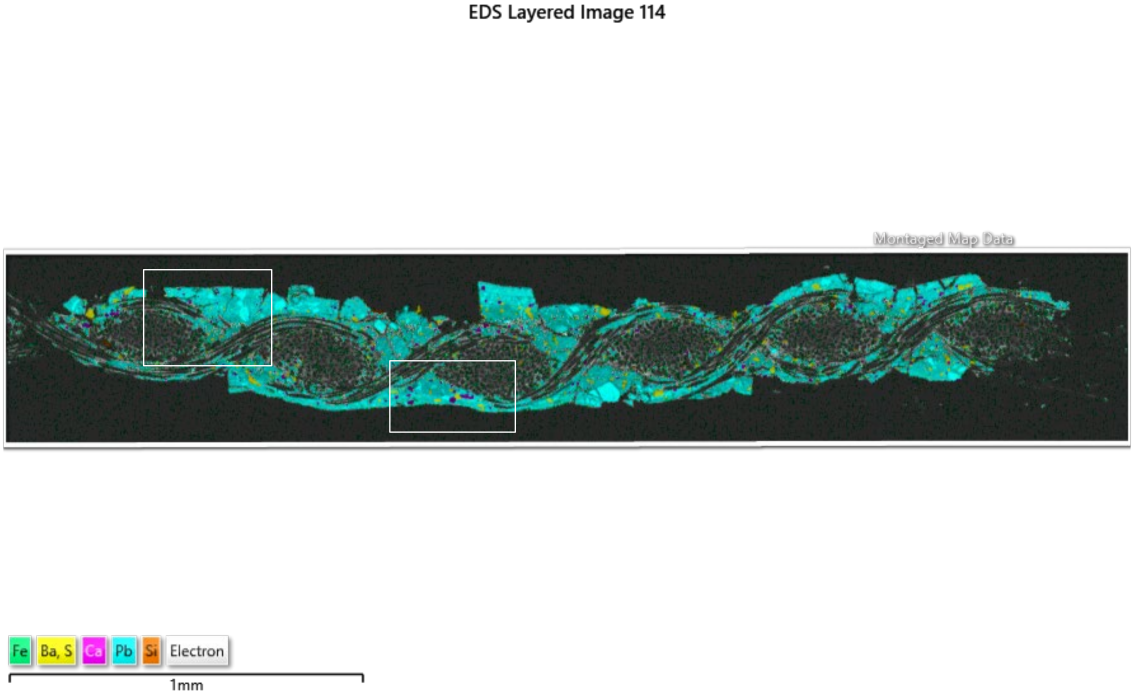


Sample MG10 annotated, incident light, bright field, Axioskop 2 Zeiss, 100×

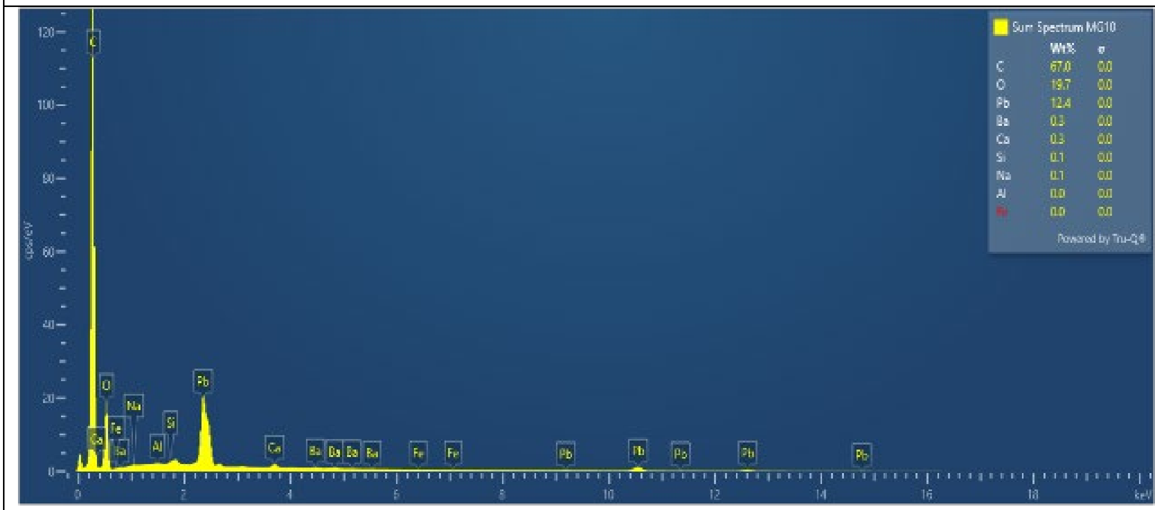


Sample MG10 backscattered electron image, Carl Zeiss Sigma SEM, 50×

Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10



Sample MG10 selected areas, composite element map, Carl Zeiss Sigma SEM, 50×



Sample MG10 EDX sum spectrum, Aztec software

Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10

BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10

INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
1	20	Pb, C, O, Ca, Ba, P, Si, Fe, S, Al, Mg, Na	Lead carbonate, barium sulphate, calcium carbonate, sulphur-sodium silico-aluminate (synthetic ultramarine pigment), iron oxides, calcinated bone (calcium phosphate, collagen-associated sulphur), magnesium carbonate (extender)
2	185	O, Pb, C, Ca	Lead carbonate and calcium carbonate
3	136	Pb, C, O, Ca, Ba, S, Si, Al, Cl	Lead carbonate, barium sulphate, calcium carbonate, silicon (sanding cloths), aluminium oxide (sanding cloths), salt-associated chlorine

INTERPRETATION SIDE B OF THE BANNER			
Layer	Spectrum number	Elements	Materials
i	21	Pb, C, O, Ba, Ca, Si, Fe, Mn, Al, Mg	Lead carbonate, barium sulphate, calcium carbonate, iron-manganese oxide (umber pigment), associated silico-aluminates (clay), quartz, magnesium carbonate (extender)
ii	186	O, Pb, C, Ca	Lead carbonate and calcium carbonate
iii	178	O, C, Pb, Ca, Ba	Lead carbonate, calcium carbonate and barium sulphate
	134	Ba, O, C, S	Barium sulphate particle

Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10

BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10

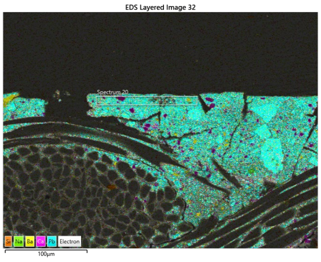
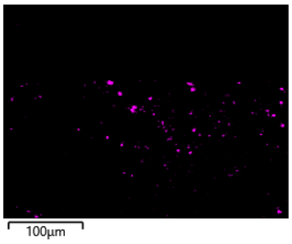
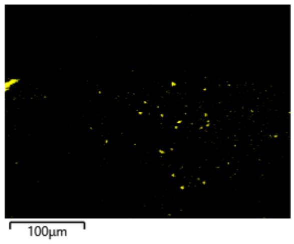
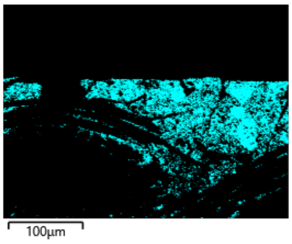
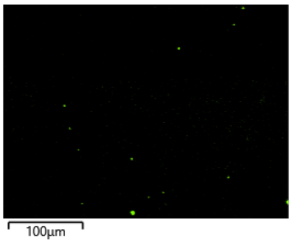
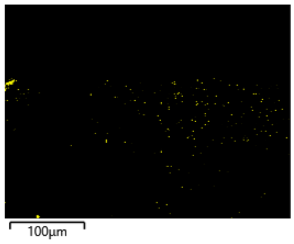
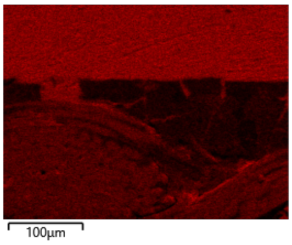
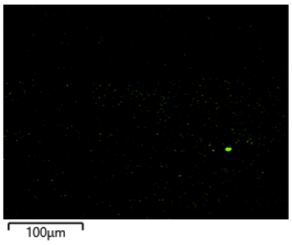
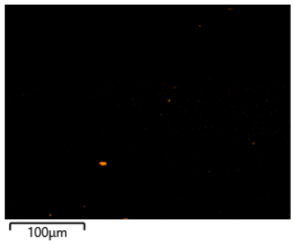
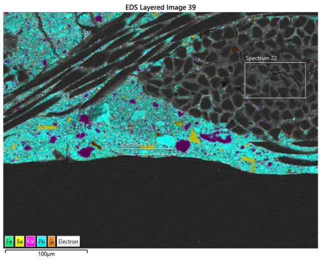
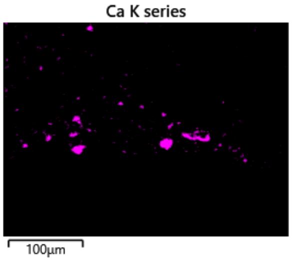
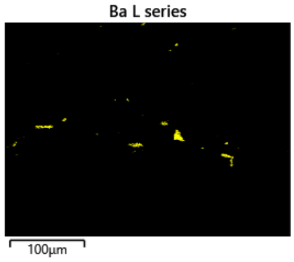
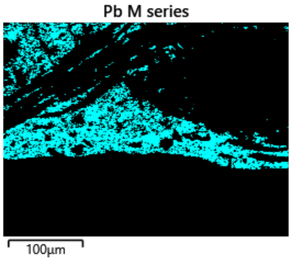
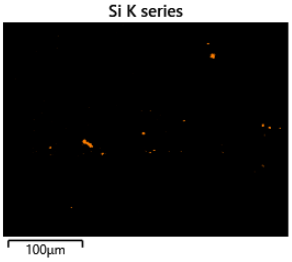
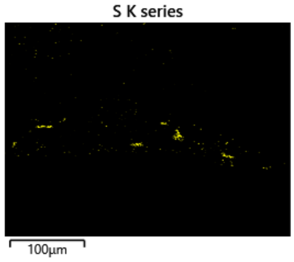
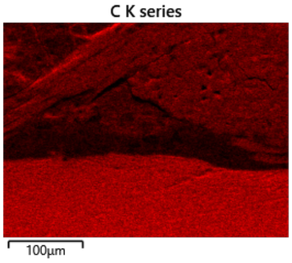
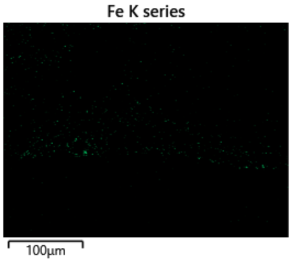
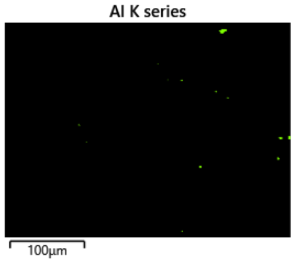
EDS Layered Image 32  Sample MG10 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 800×	SINGLE ELEMENT MAPS SIDE A OF THE BANNER	
	Ca K series 	Ba L series 
Pb M series 	Al K series 	S K series 
C K series 	Na K series 	Si K series 

Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10

 Sample MG10 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 800×	SINGLE ELEMENT MAPS SIDE B OF THE BANNER	
		
		
		

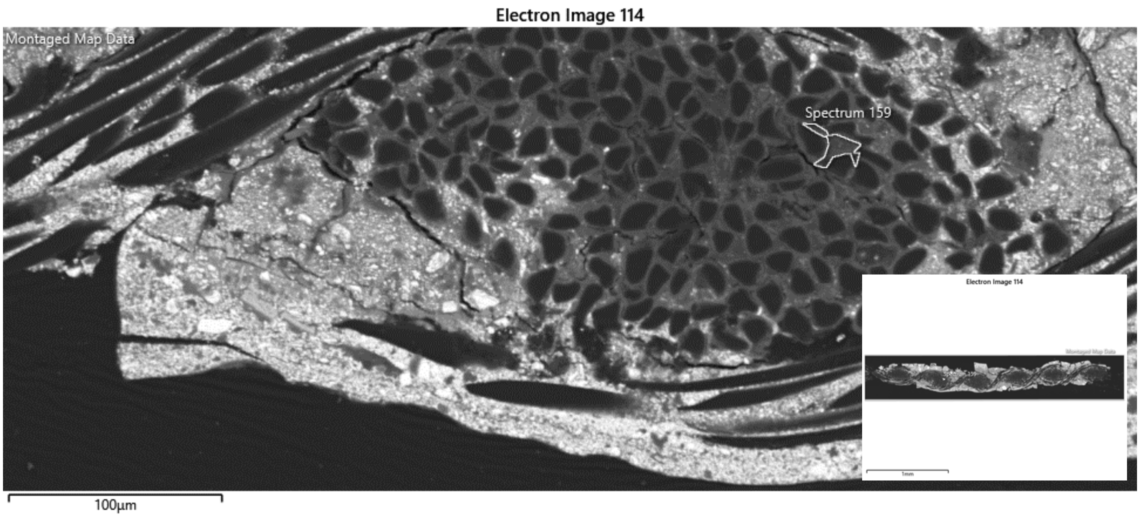
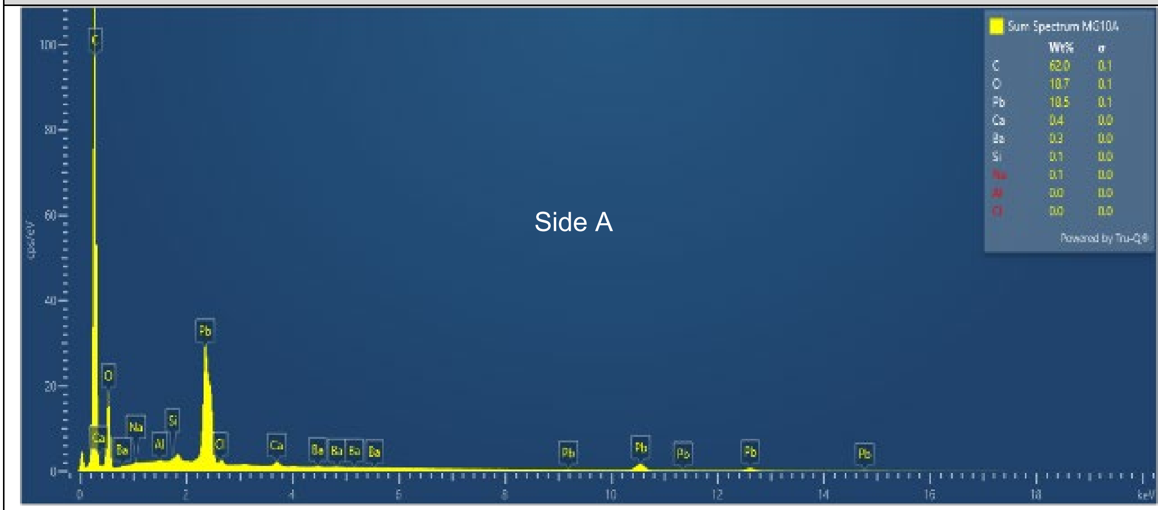
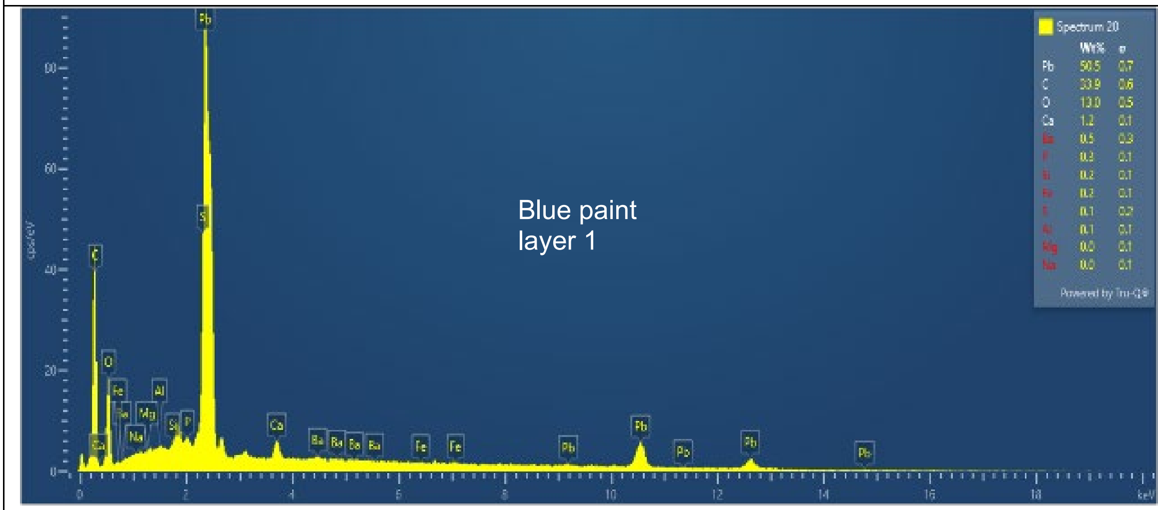


Figure III.8 Back-scattered electron image of lead-containing material (possible seeped linseed oil from the ground) in sample MG10 side B with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 800×

Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10
SELECTED EDX SPECTRA SIDE A OF THE BANNER					





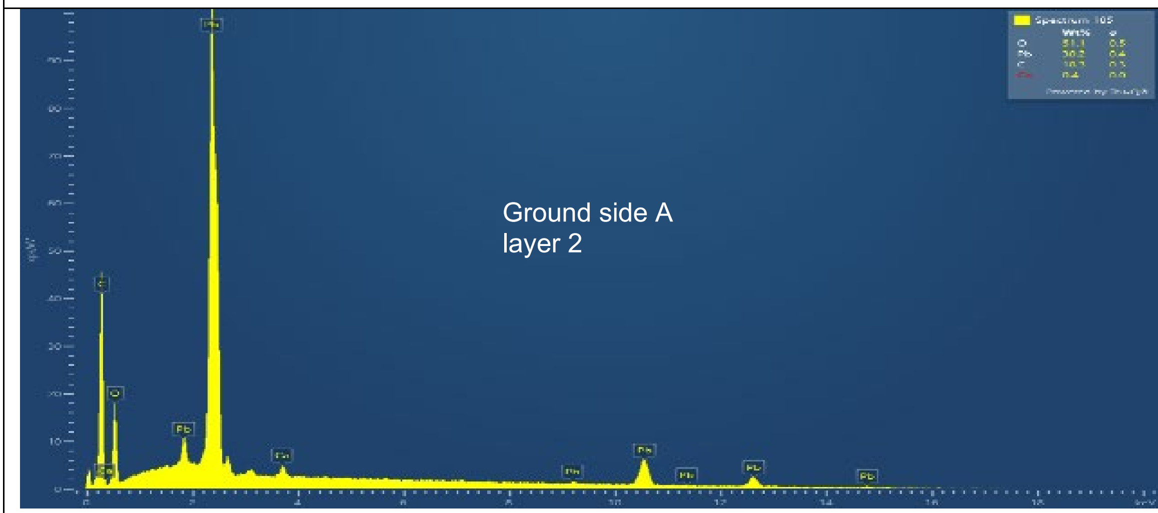


Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10
SELECTED EDX SPECTRA SIDE A OF THE BANNER					

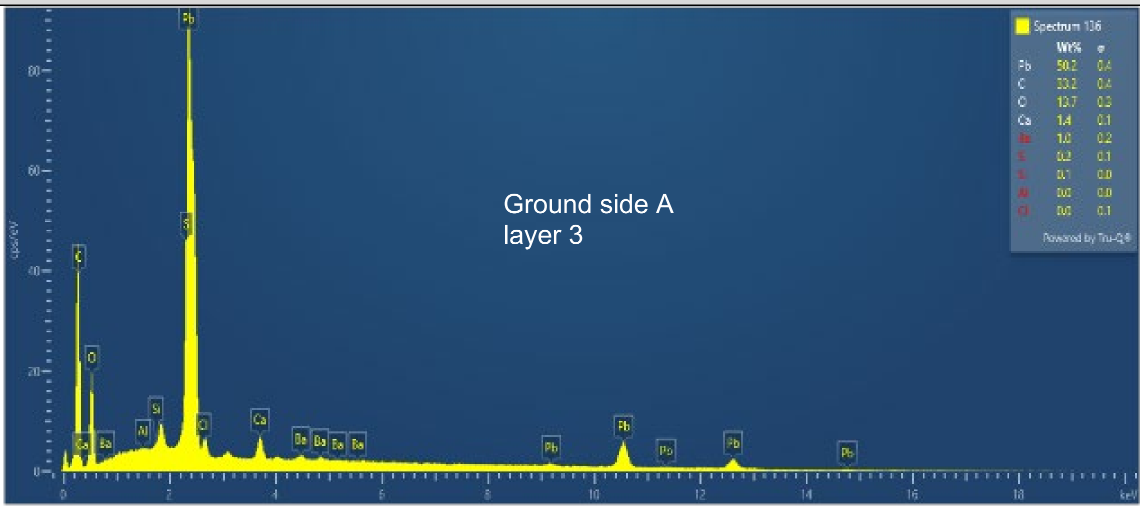


Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

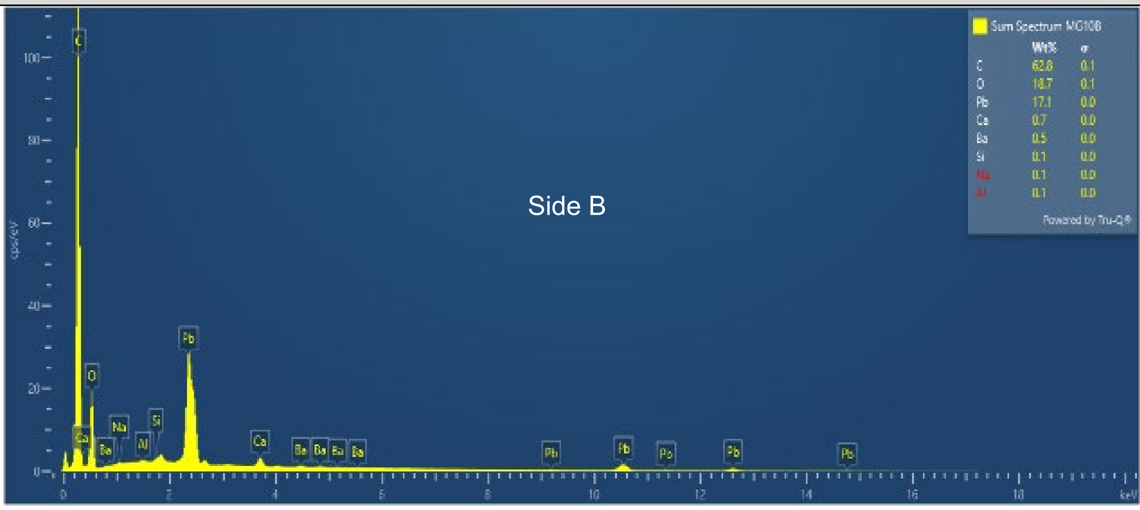
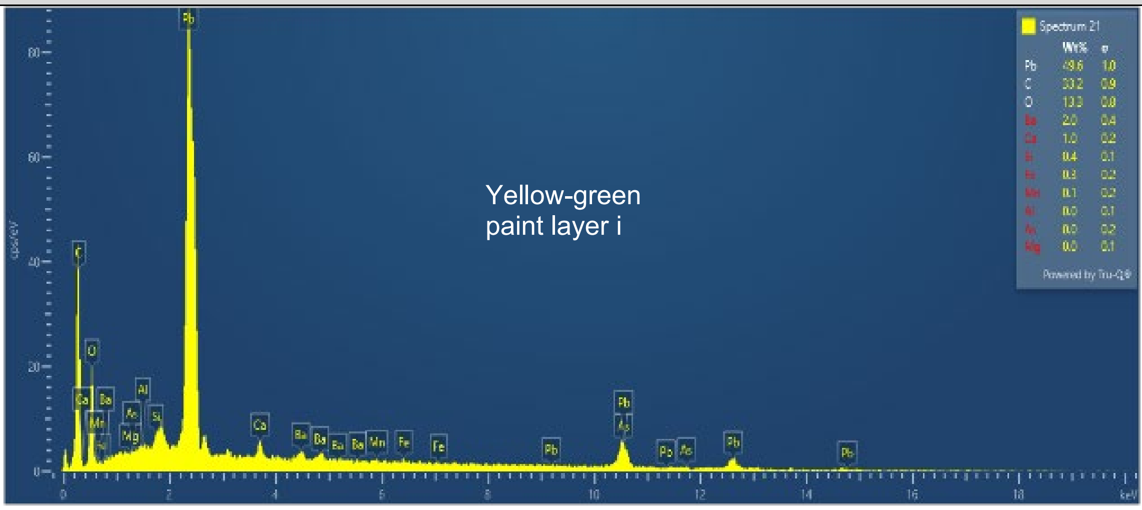
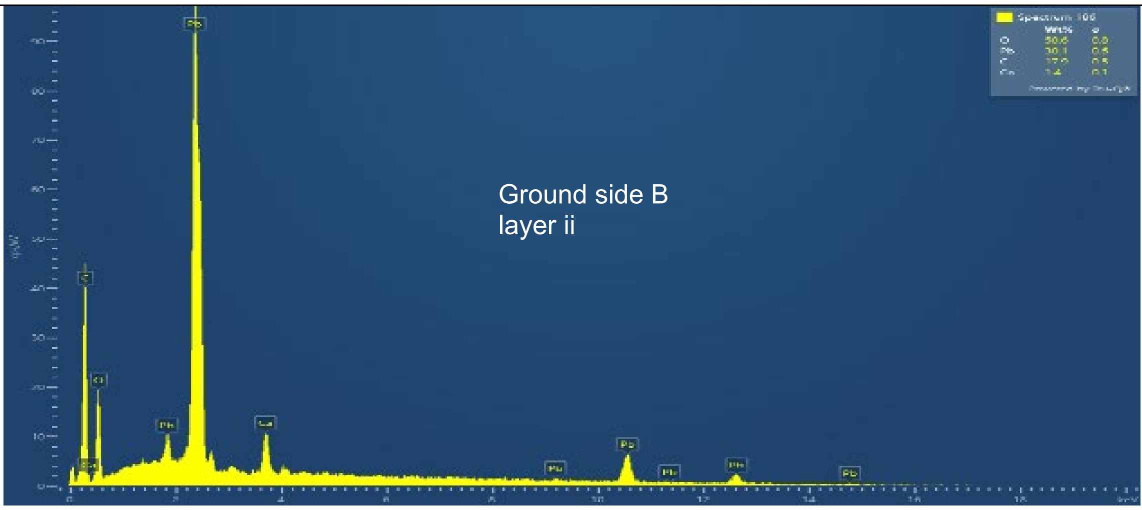


Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10					
BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





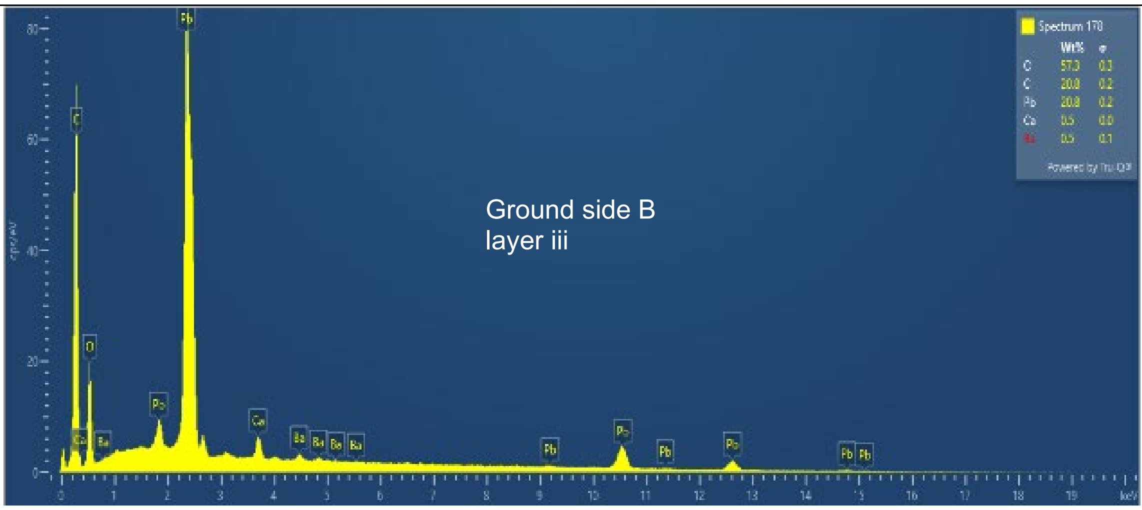
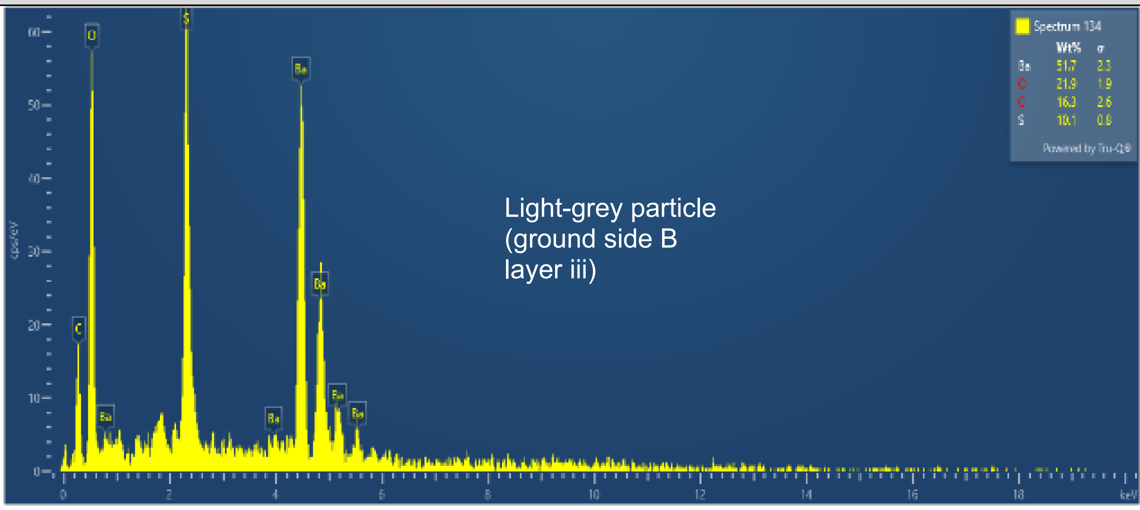
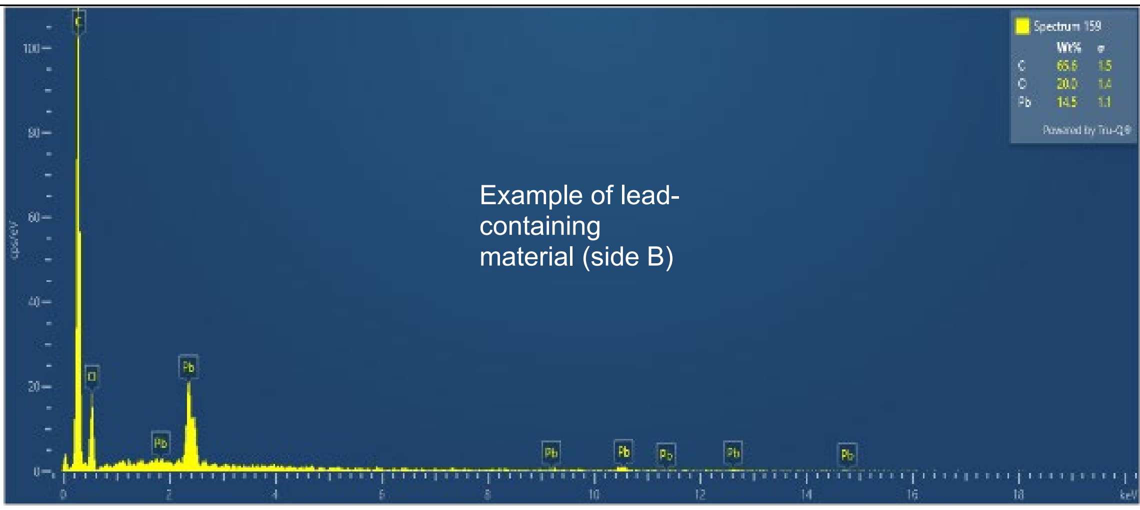


Table III.30 (continued) SEM-EDX results of paint cross-section sample MG10

BANNER	The Grain Millers of Glasgow				
MANUFACTURER	George Kenning	YEAR	1884	SAMPLE	MG10

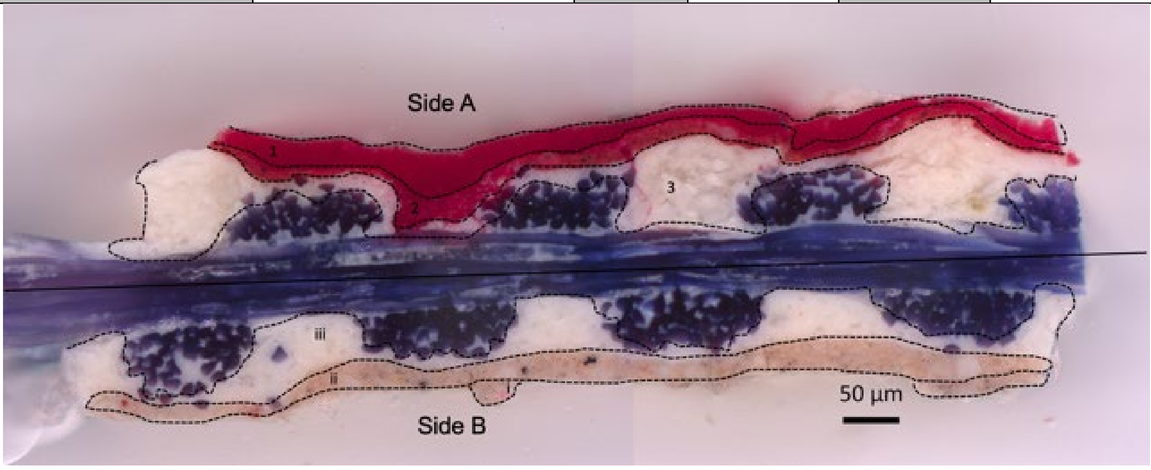
SELECTED EDX SPECTRA SIDE B OF THE BANNER



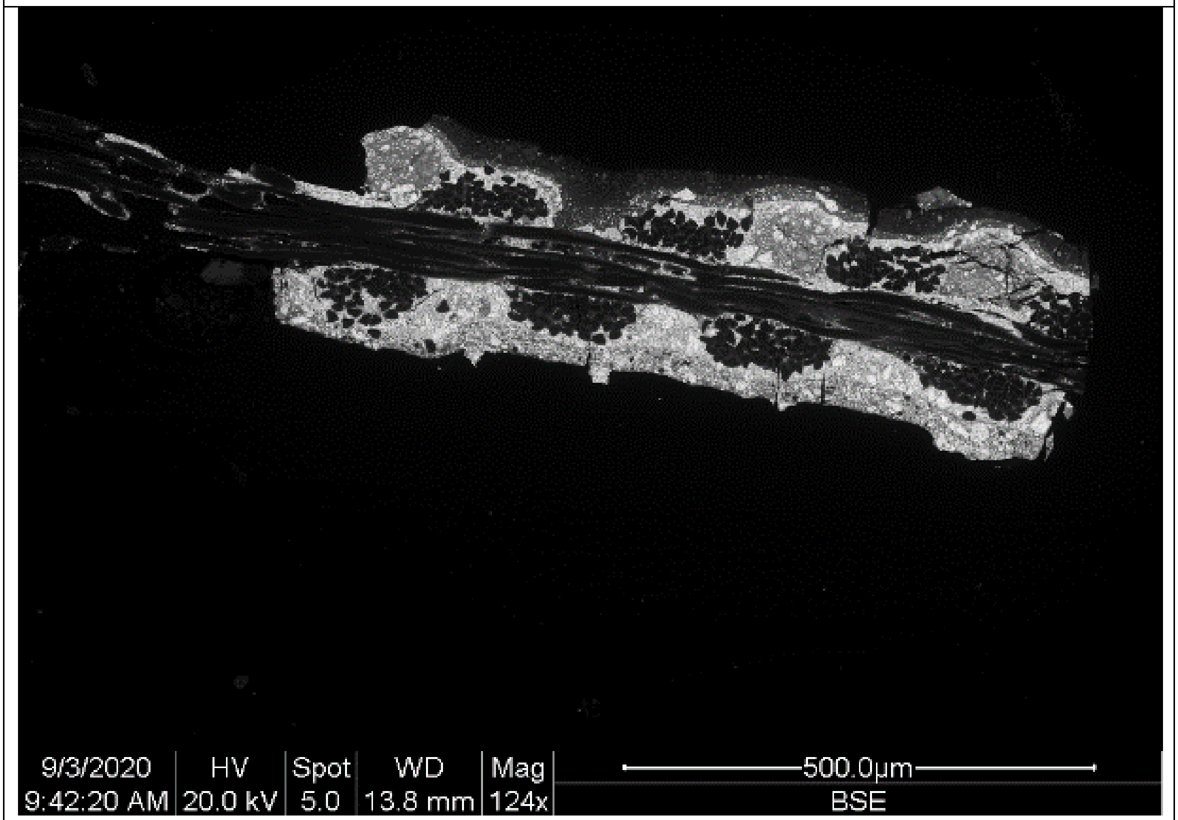


9.3.3.9 III.3.9 The National Union of Vehicle Builders, Glasgow Branch banner, paint sample

Table III.31 SEM-EDX results of paint cross-section sample VB12					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12



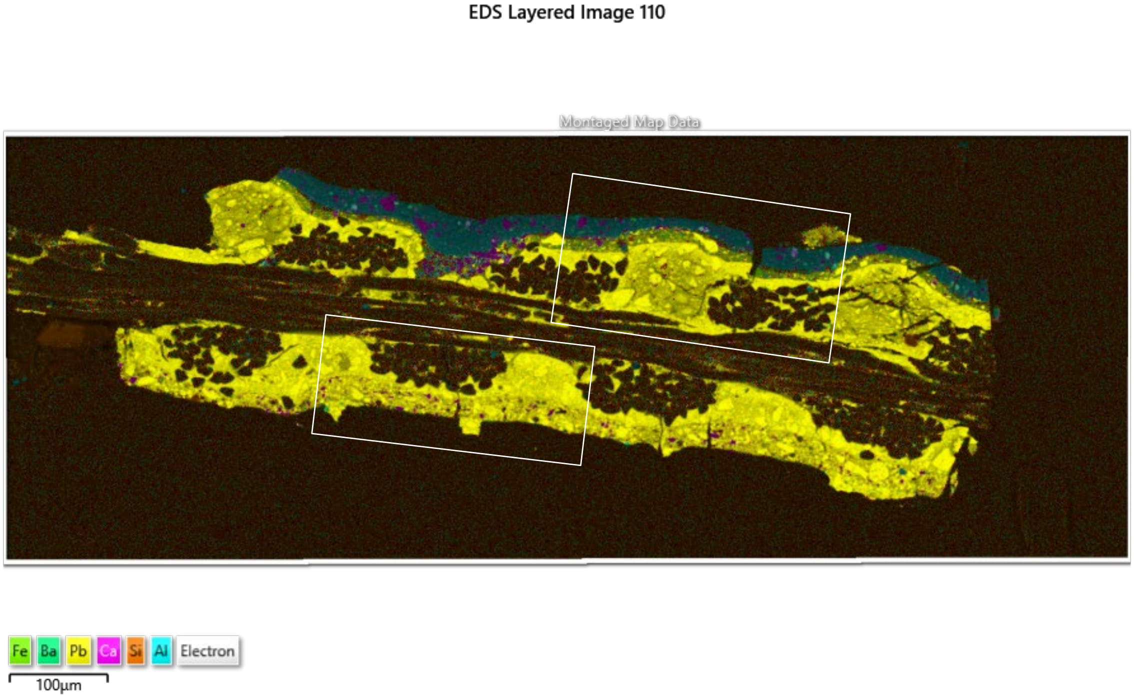
Sample VB12 annotated, incident light, bright field, Axioskop 2 Zeiss,100×



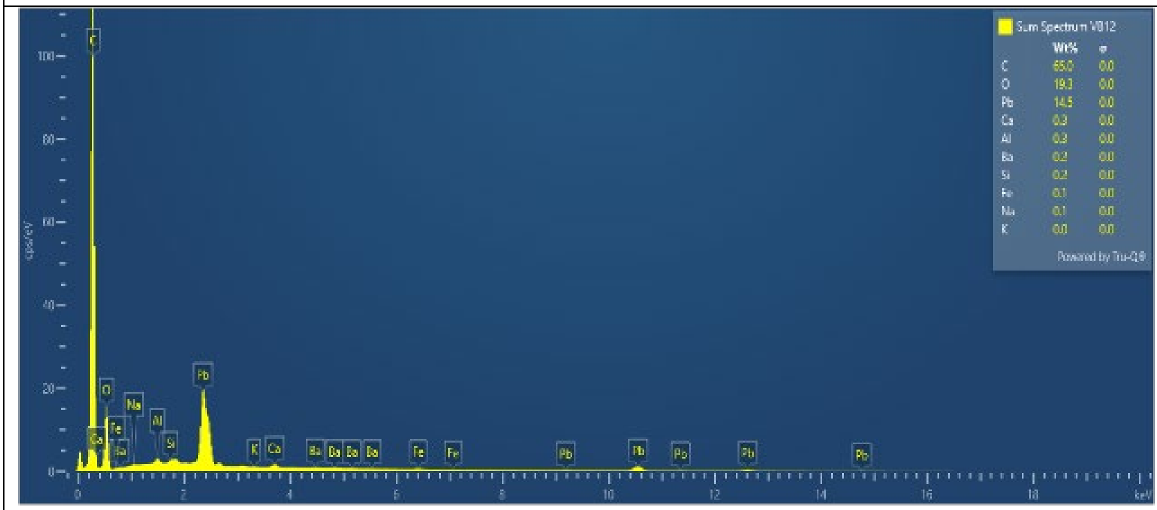
Sample VB12 backscattered electron image, Carl Zeiss Sigma SEM, 124×

Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12

BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12



Sample VB12 selected areas, composite element map, Carl Zeiss Sigma SEM, 124×



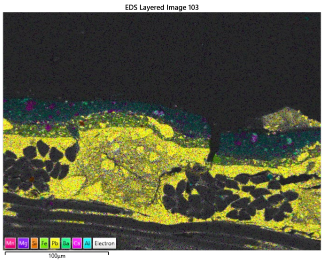
Sample VB12 EDX sum spectrum, Aztec software

Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12			
BANNER	The National Union of Vehicle Builders, Glasgow Branch		
MANUFACTURER	George Kenning & Son	YEAR 1914	SAMPLE VB12
INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
1	39	C, O, Al, Ba, Ca, S, P, Si	Barium sulphate, calcium sulphate, red lake pigment (potassium alum substrate), silicon (sanding cloths)
2	40	C, Pb, O, Fe, Si, Al, Ca	Lead carbonate, iron oxides with associated silico-aluminates (clay) and calcium carbonate
3	42	Pb, C, O	Lead carbonate
INTERPRETATION SIDE B OF THE BANNER			
Layer	Spectrum number	Elements	Materials
i	37	Pb, C, O, Al, Ca, Mg, Fe	Lead carbonate, calcium carbonate, iron oxides, magnesium carbonate (extender), aluminium stearate (plasticiser)
ii	38	O, Pb, C, Ca, S, Si, Fe, Al, Ba, Mg	Lead carbonate, barium sulphate, iron oxides with associated silico-aluminates (clay), magnesium carbonate (extender), vegetable black
	169	O, C, Pb	Carbon particle (with lead carbonate)
iii	179	O, Pb, C	Lead carbonate

Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12

BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12

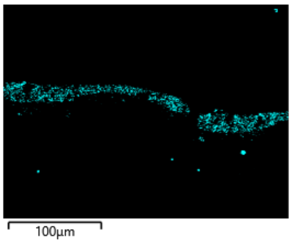
EDS Layered Image 103



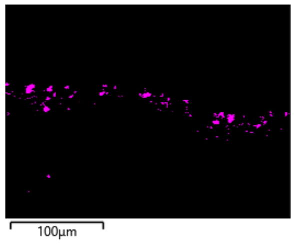
Sample VB12 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×

SINGLE ELEMENT MAPS SIDE A OF THE BANNER

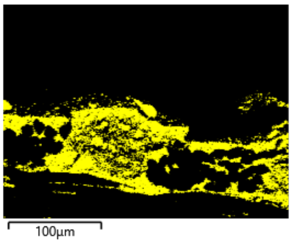
Al K series



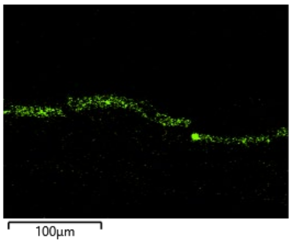
Ca K series



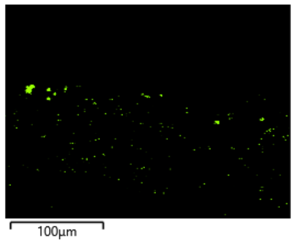
Pb M series



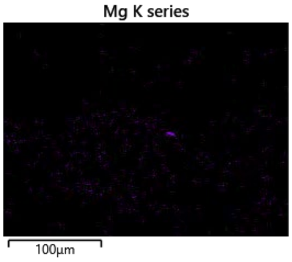
Fe K series



S K series



Mg K series



Ba L series

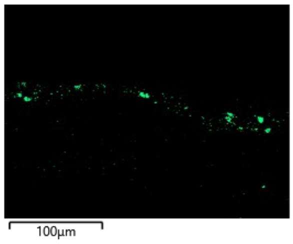
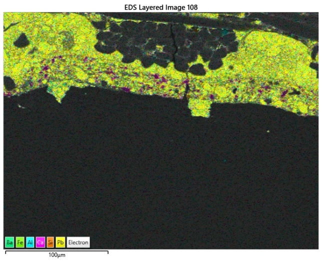
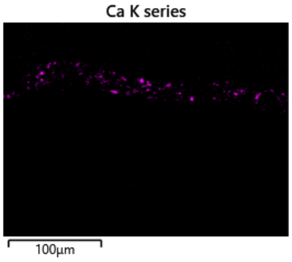
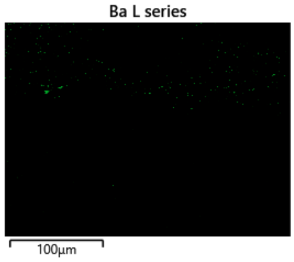
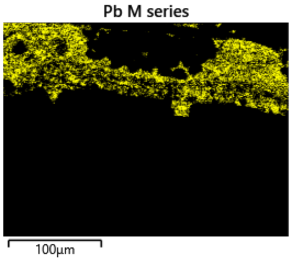
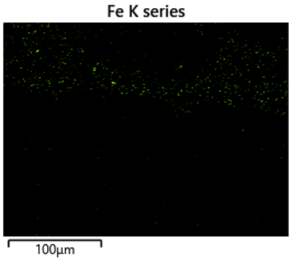
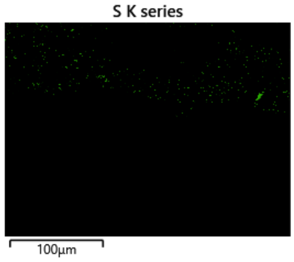
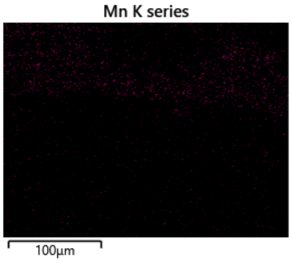
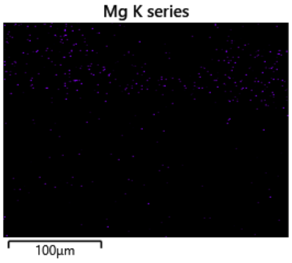
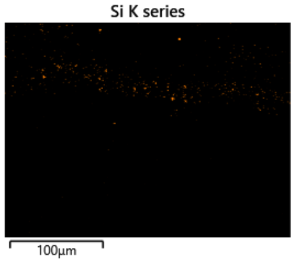


Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12
 Sample VB12 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×	SINGLE ELEMENT MAPS SIDE B OF THE BANNER				
					
					
					

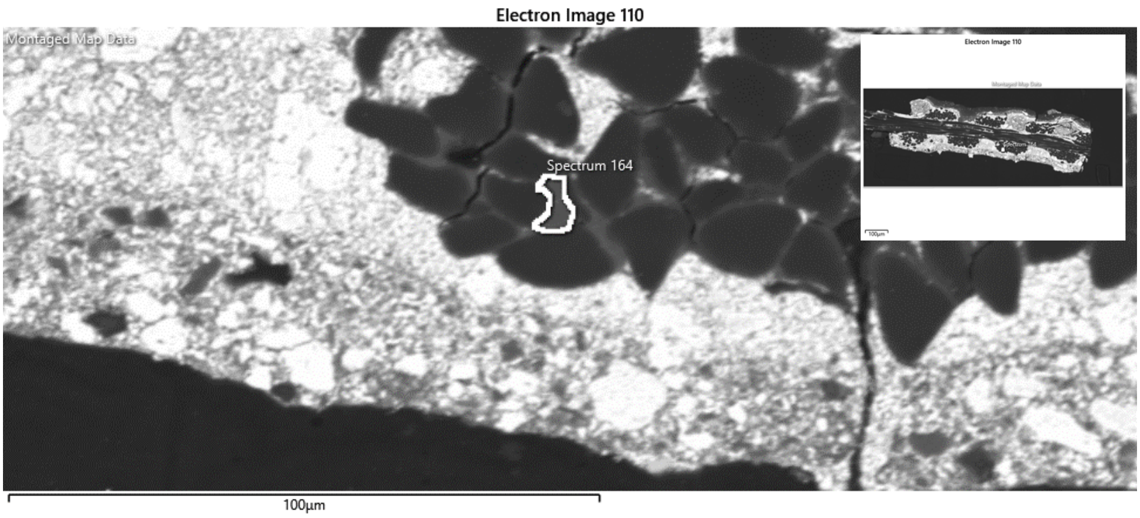
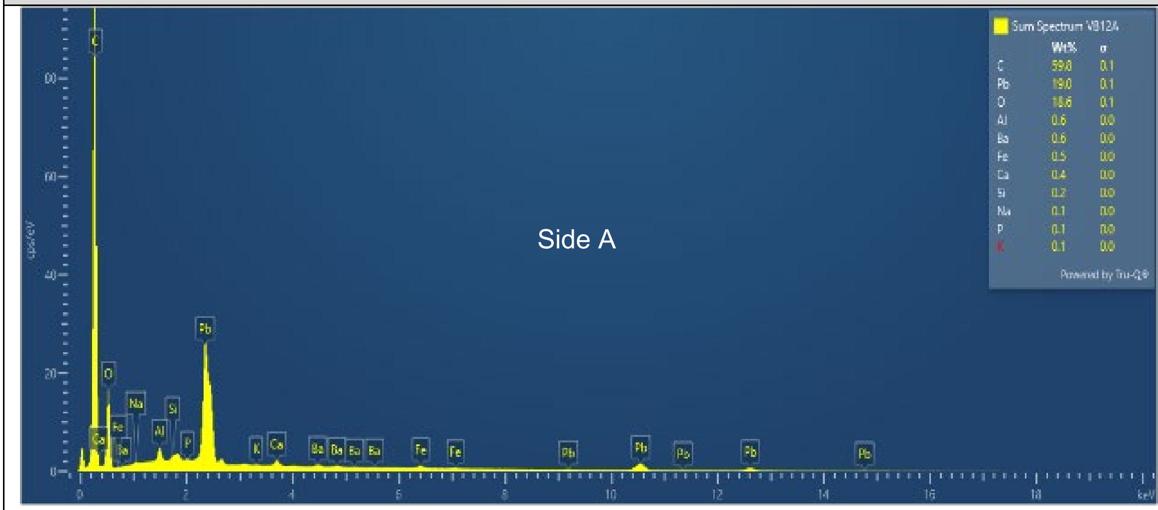
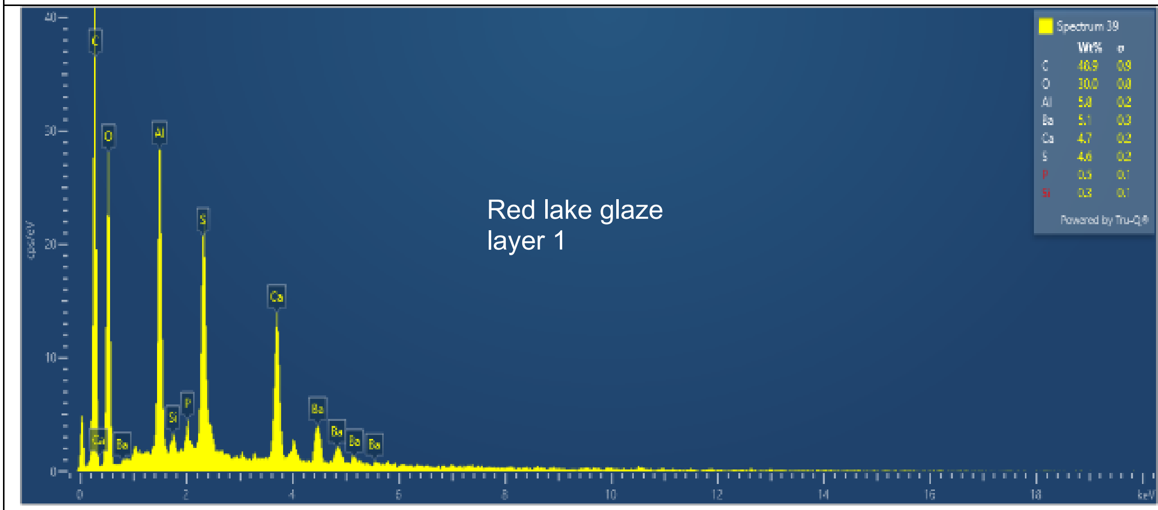


Figure III.9 Back-scattered electron image of lead-containing material (possible seeped linseed oil from the ground) in sample VB12 side B with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 1200×

Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12
SELECTED EDX SPECTRA SIDE A OF THE BANNER					





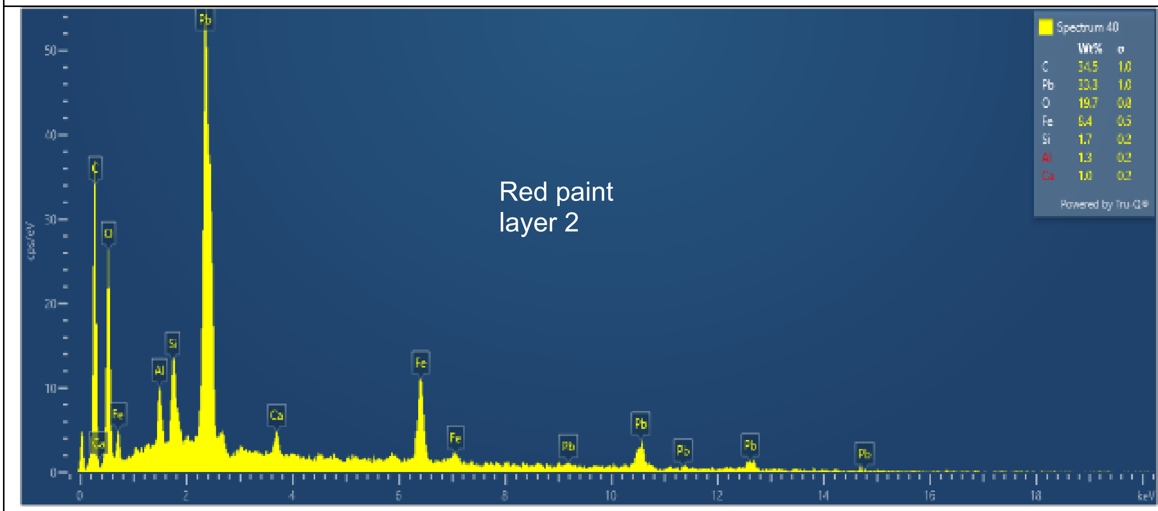


Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12
SELECTED EDX SPECTRA SIDE A OF THE BANNER					

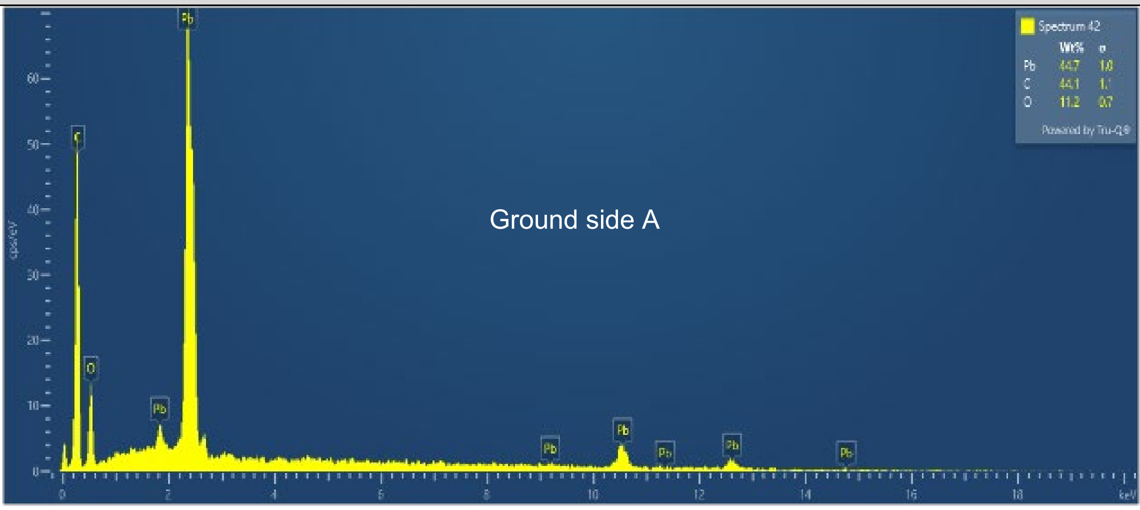


Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

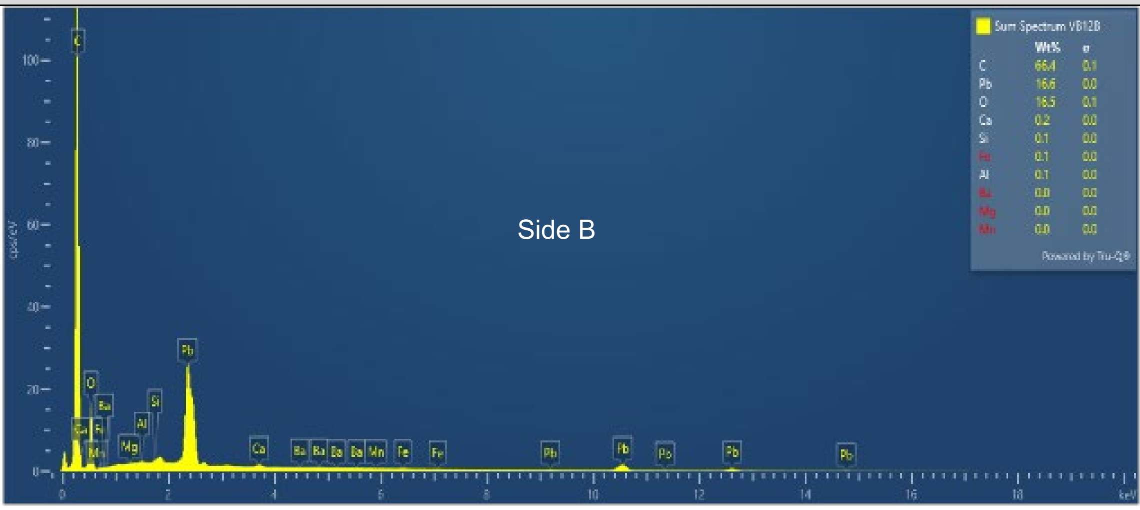
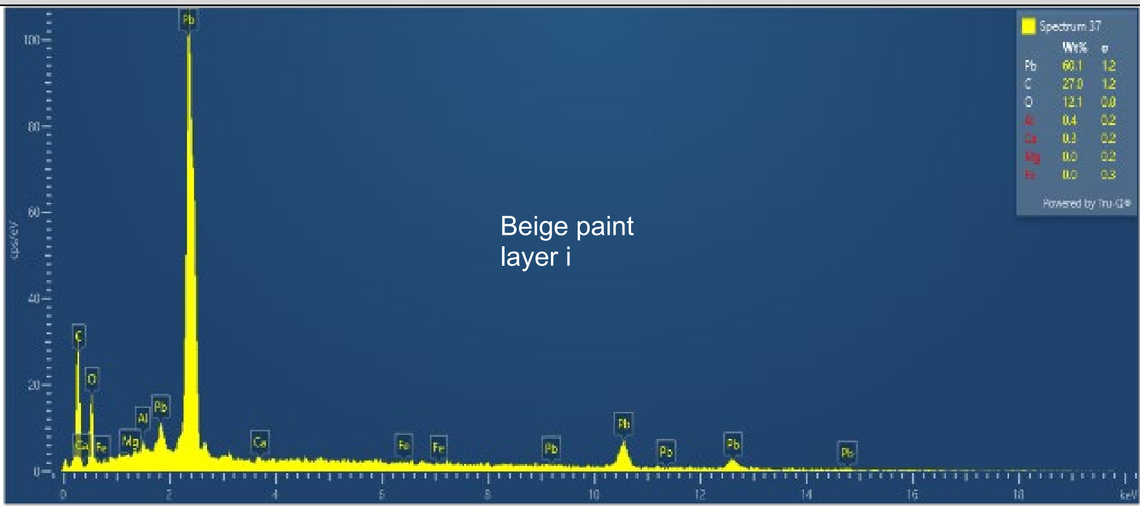
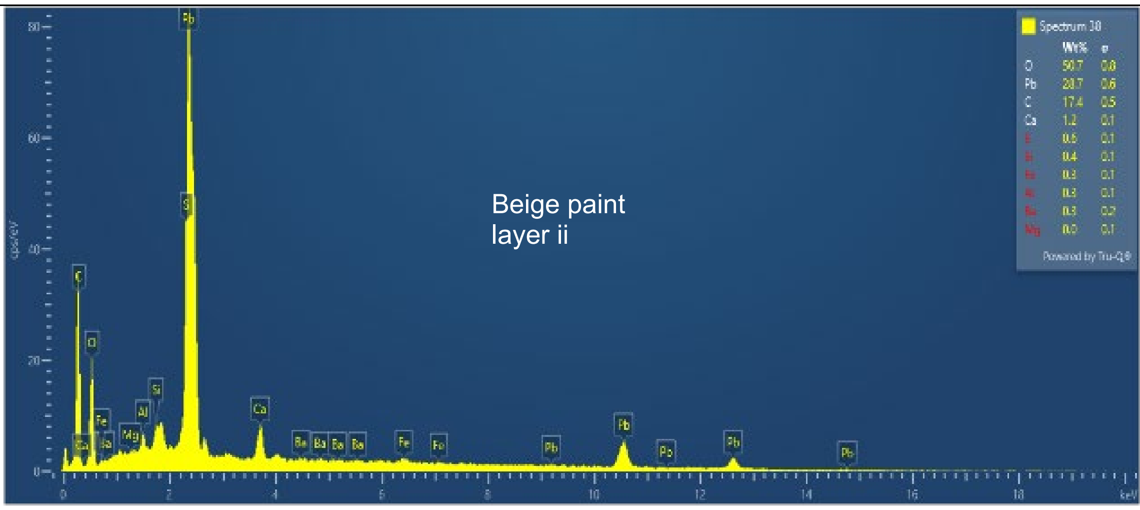


Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





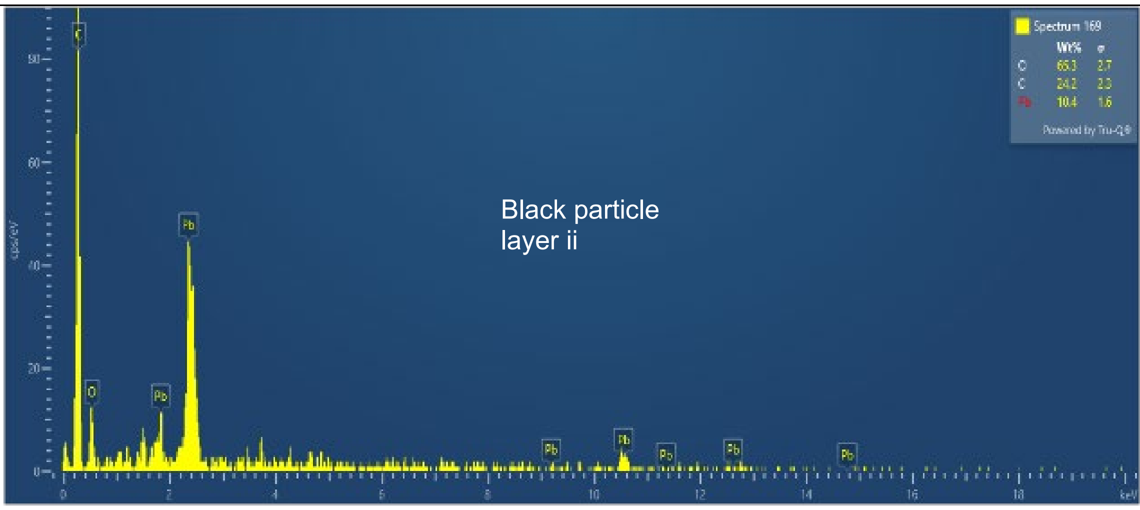
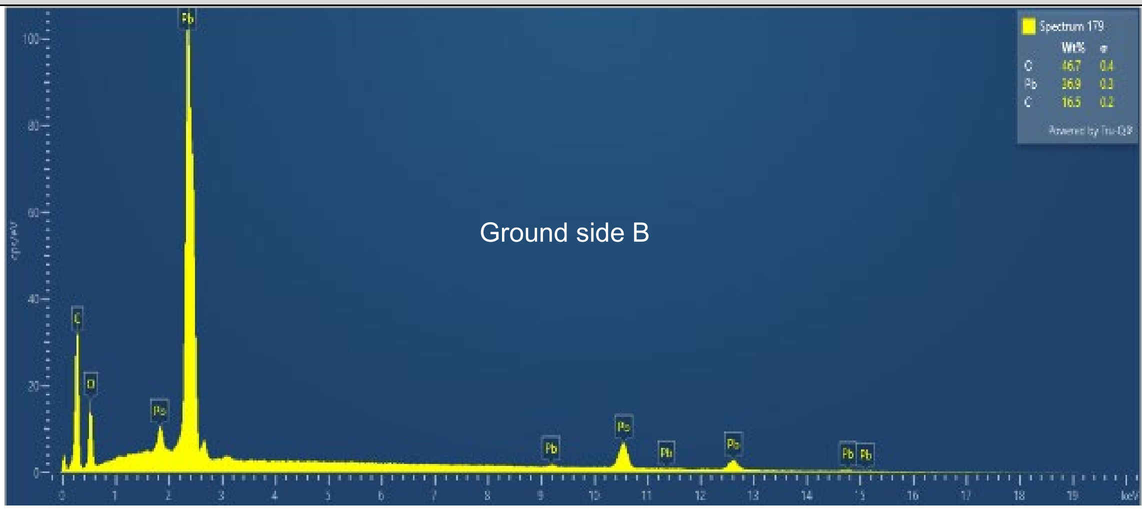
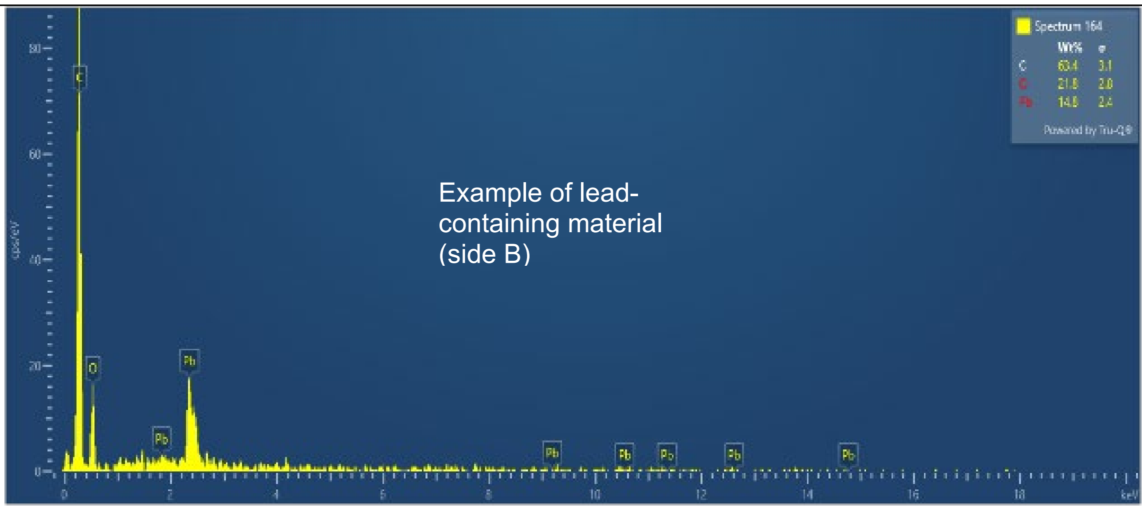


Table III.31 (continued) SEM-EDX results of paint cross-section sample VB12					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB12
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

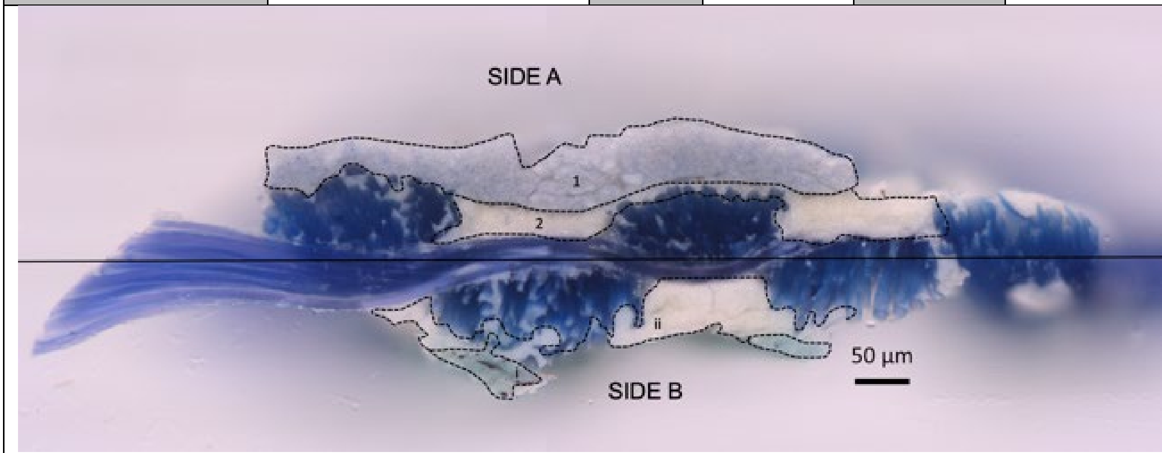




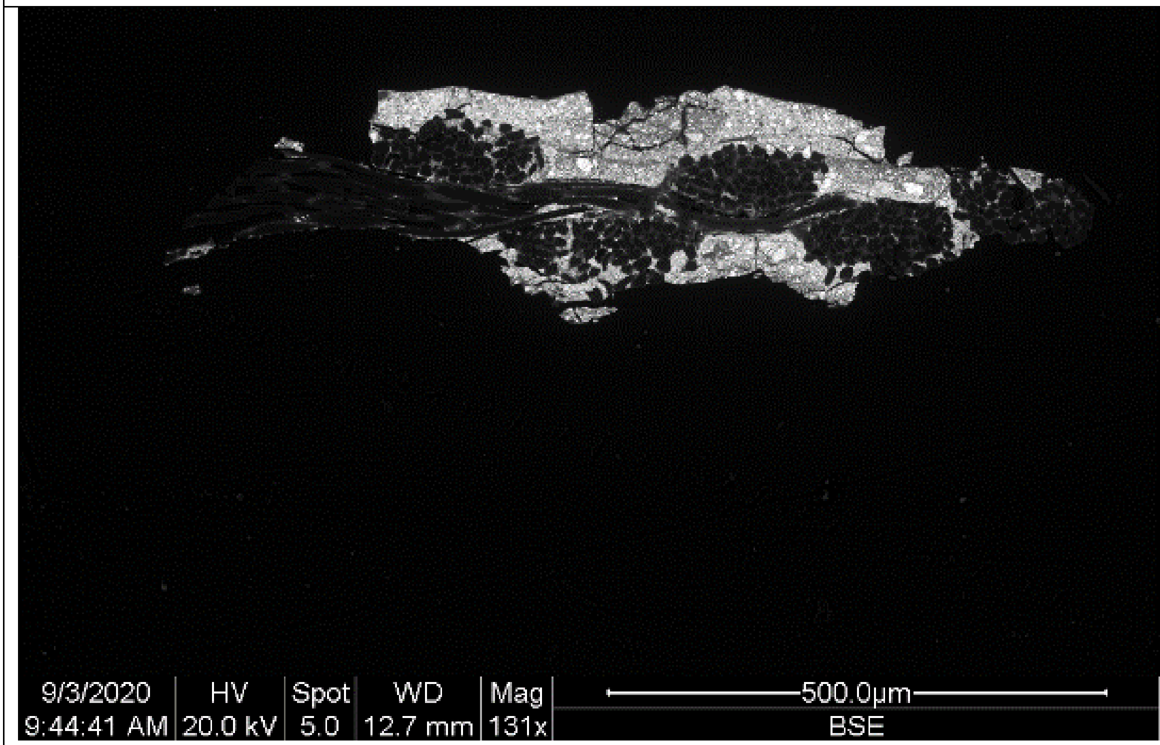
9.3.3.10 III.3.10 The Scottish Tin Plate Braziers and Sheet Metal Workers' Society banner, paint sample

Table III.32 SEM-EDX results of paint cross-section sample SM16

BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16



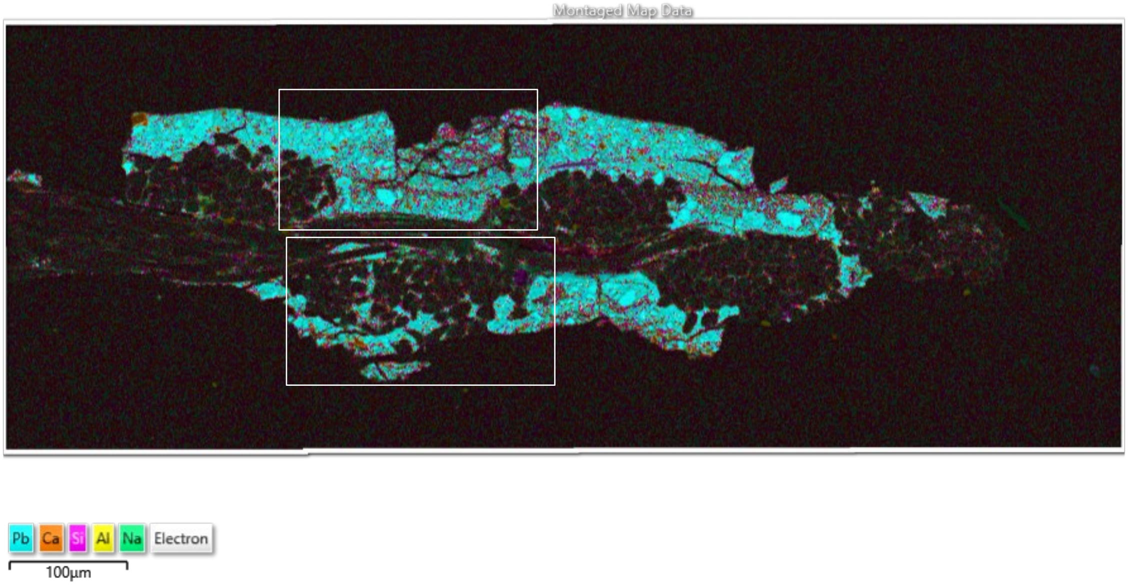
Sample SM16 annotated, incident light, bright field, Axioskop 2 Zeiss,100×



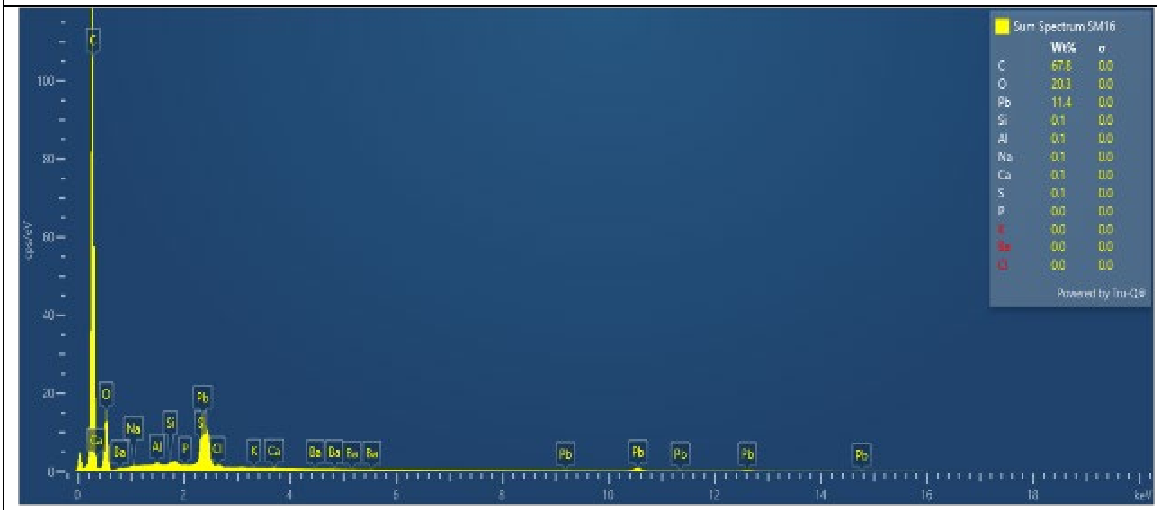
Sample SM16 backscattered electron image, Carl Zeiss Sigma SEM, 131×

Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16

BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16



Sample SM16 selected areas, composite element map, Carl Zeiss Sigma SEM, 131×

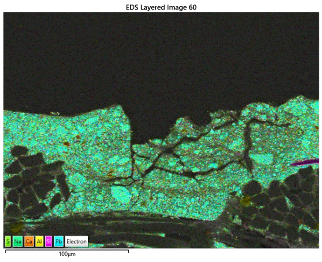
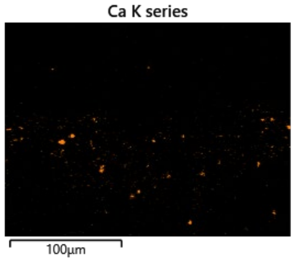
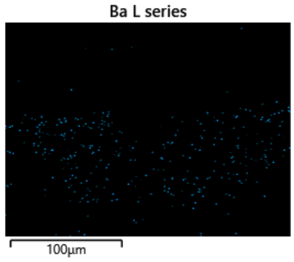
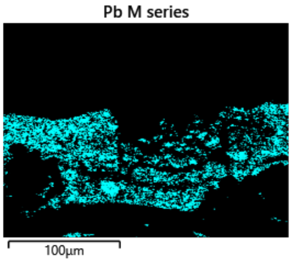
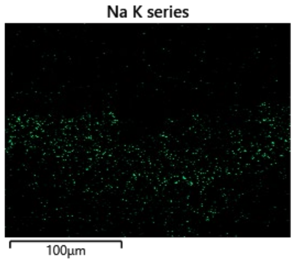
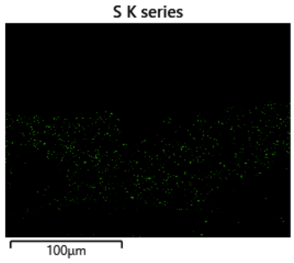
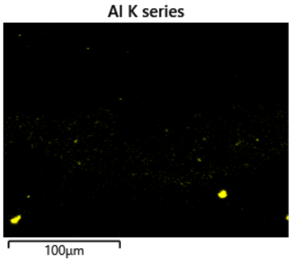
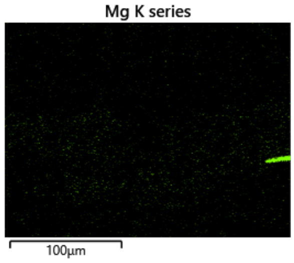
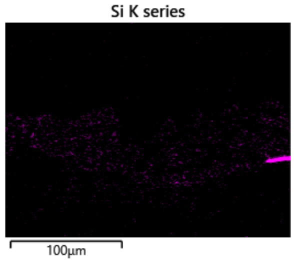


Sample SM16 EDX sum spectrum, Aztec software

Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16						
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society					
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16	

INTERPRETATION SIDE A OF THE BANNER			
Layer	Spectrum number	Elements	Materials
1	23	Pb, C, O, Ca, Si, Al, Na, S, Mn, Mg	Lead carbonate, calcium carbonate, sulphur-sodium silico-aluminate (synthetic ultramarine pigment), manganese (drier), magnesium carbonate (extender)
2	156	Pb, C, O, Ca, S, Ba	Lead carbonate, calcium carbonate and barium sulphate
	140	Pb, C, O, Ca	Calcium carbonate particle (with lead carbonate)
INTERPRETATION SIDE B OF THE BANNER			
Layer	Spectrum number	Elements	Materials
i	25	Pb, C, O, Ca	Lead carbonate, calcium carbonate
ii	180	O, Pb, C	Lead carbonate
	148	Pb, C, O, Ca	Calcium carbonate particle (with lead carbonate)

Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16

	SINGLE ELEMENT MAPS SIDE A OF THE BANNER	
 Sample SM16 side A (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×		
		
		

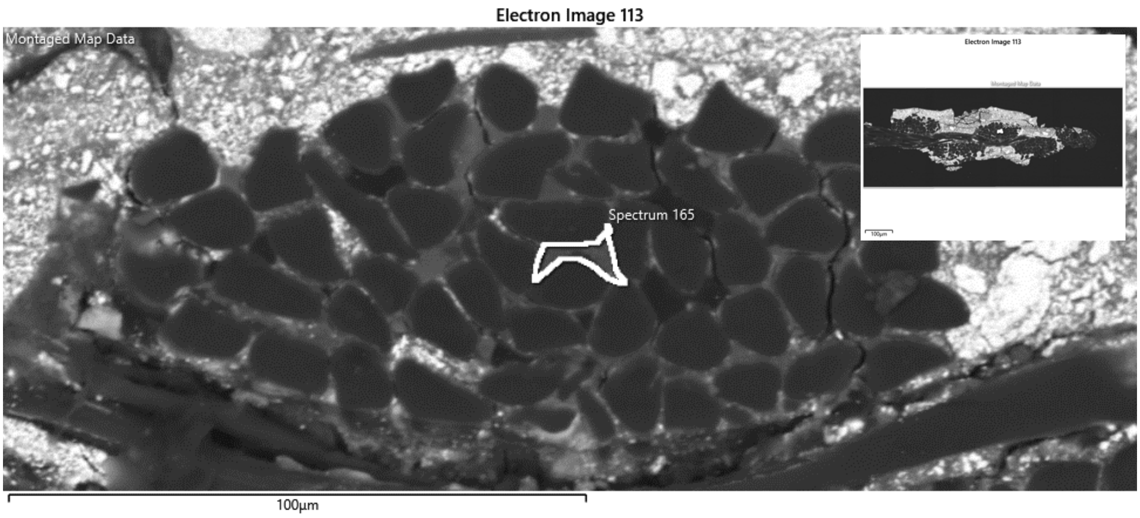


Figure III.10 Back-scattered electron image of lead-containing material (possible seeped linseed oil form the ground) in sample SM16 side A with inset of location and spectrum number indication, Carl Zeiss Sigma SEM, 1200×

Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16

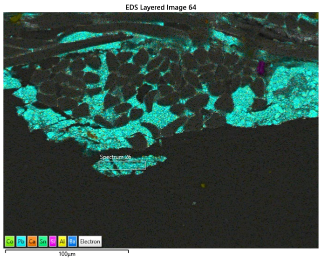
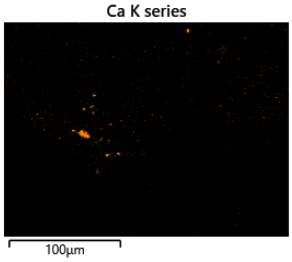
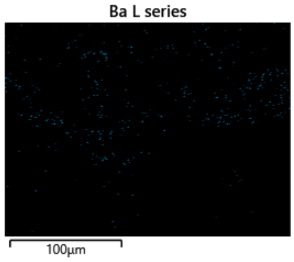
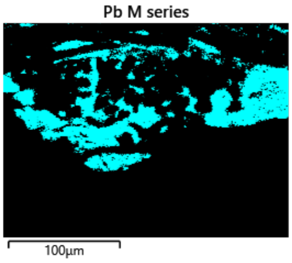
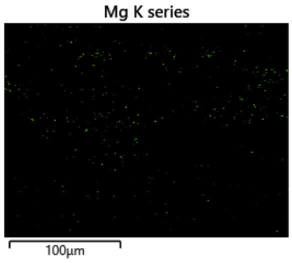
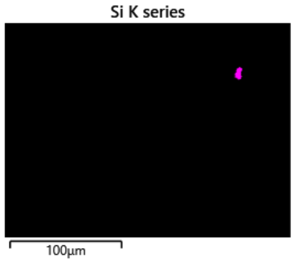
 Sample SM16 side B (element distribution), Carl Zeiss Sigma SEM, composite element map, 1200×	SINGLE ELEMENT MAPS SIDE B OF THE BANNER	
		
		

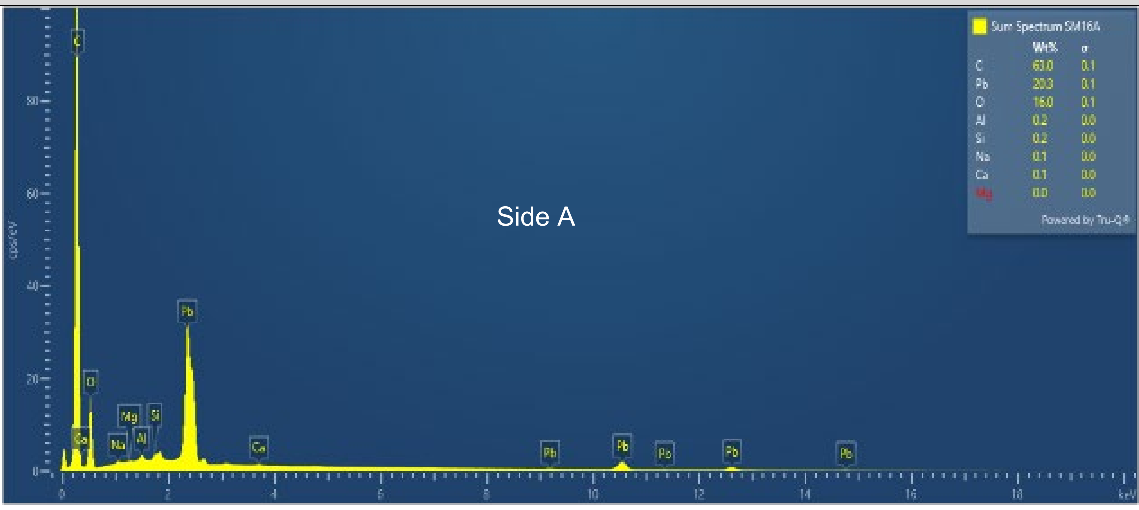
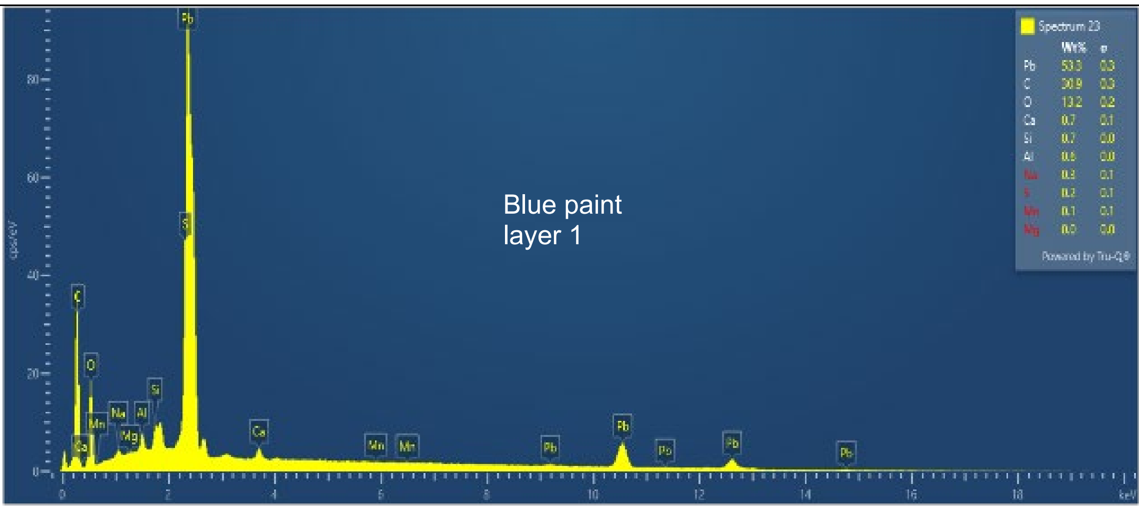
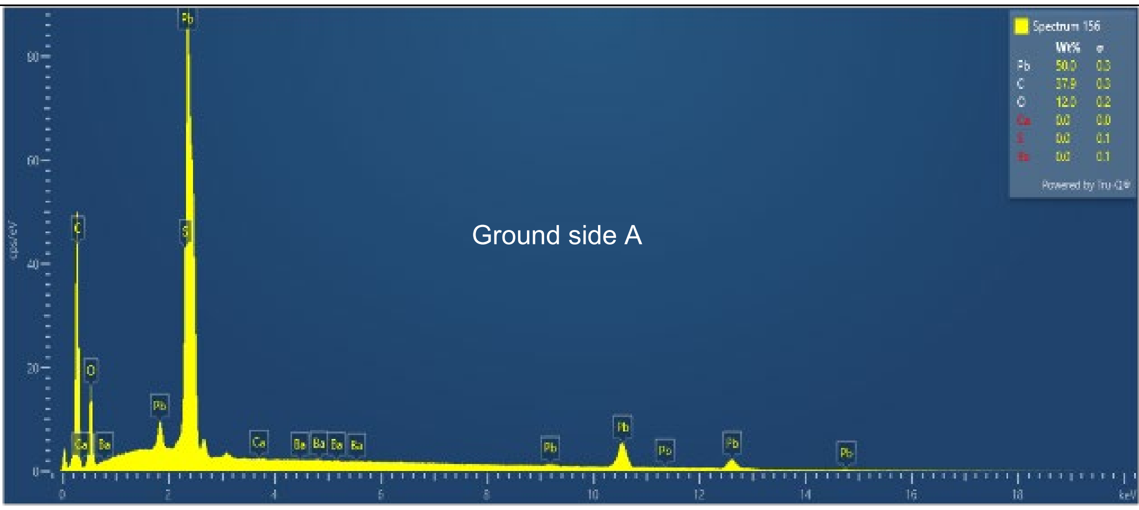
Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16
SELECTED EDX SPECTRA SIDE A OF THE BANNER					
					
					
					

Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers’ Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16
SELECTED EDX SPECTRA SIDE A OF THE BANNER					

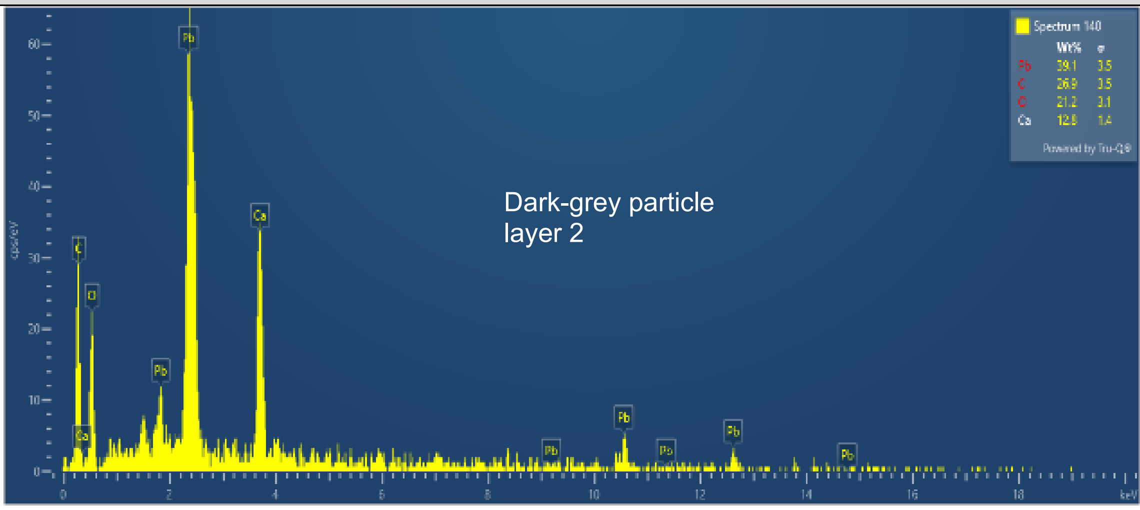


Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers’ Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16
SELECTED EDX SPECTRA SIDE B OF THE BANNER					

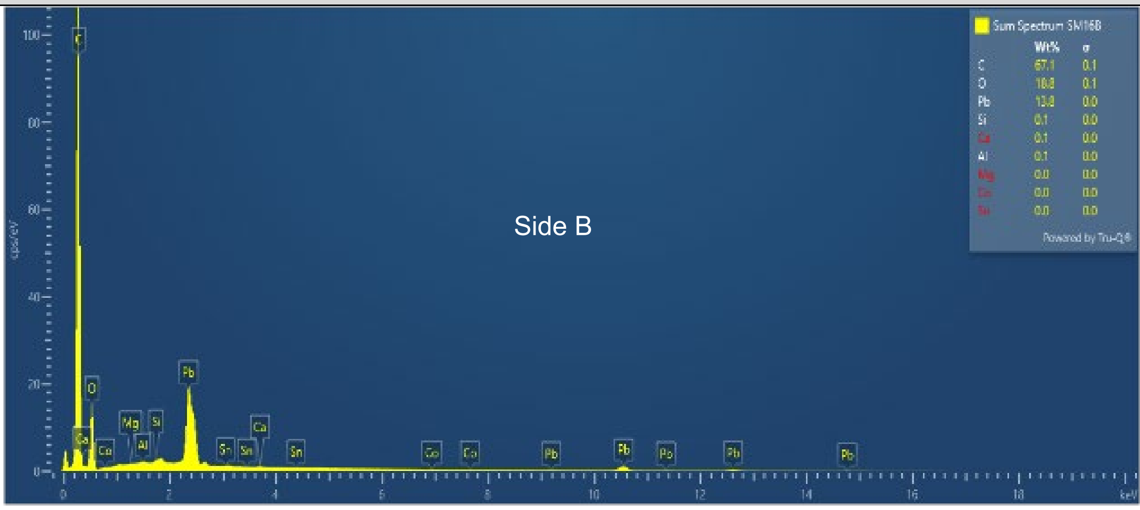
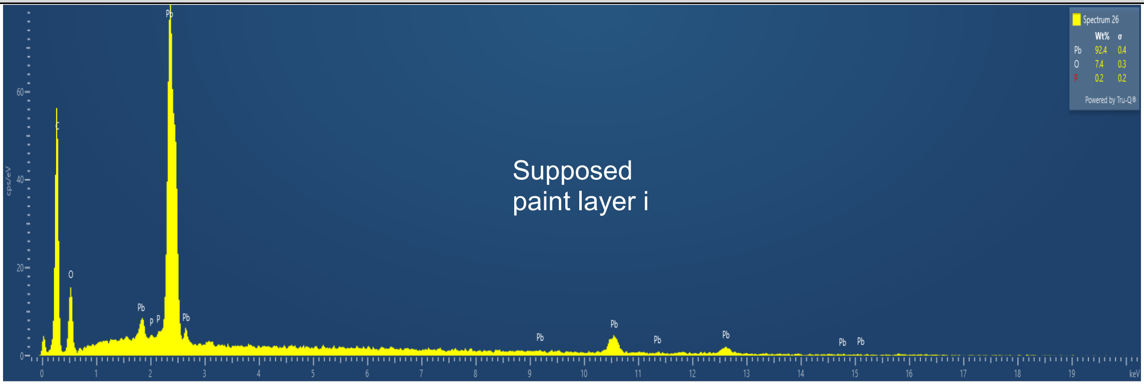
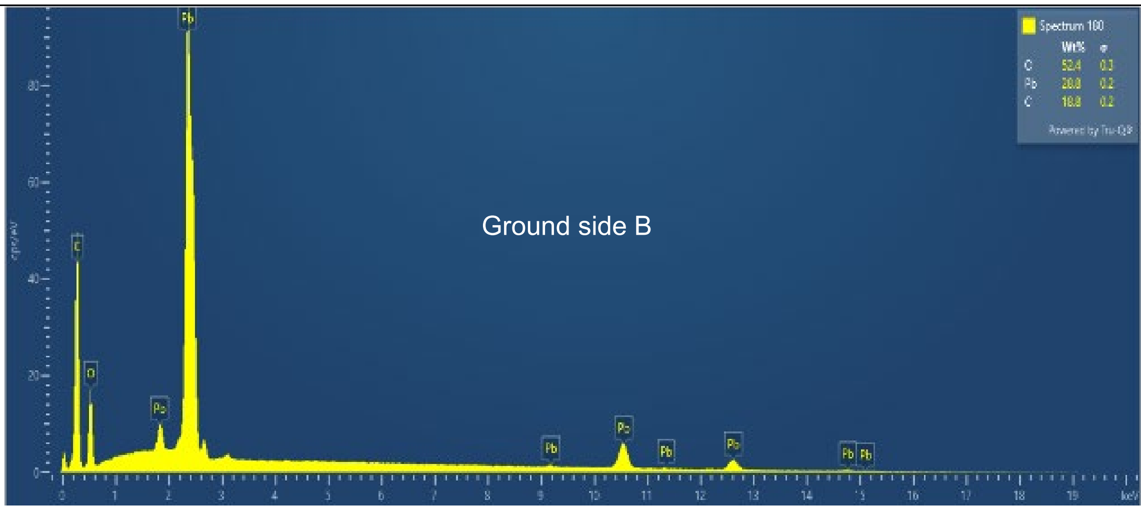


Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16
SELECTED EDX SPECTRA SIDE B OF THE BANNER					





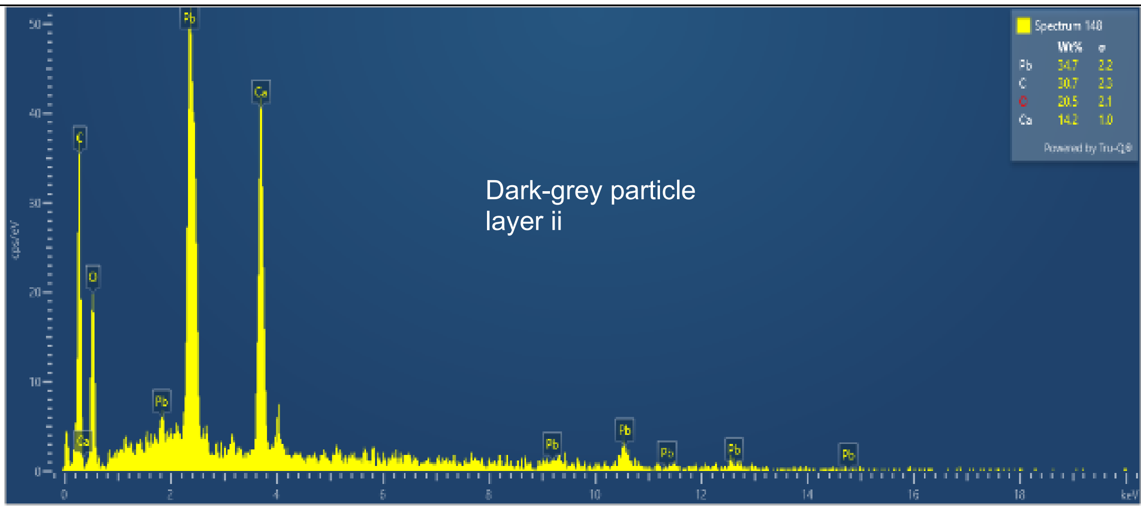
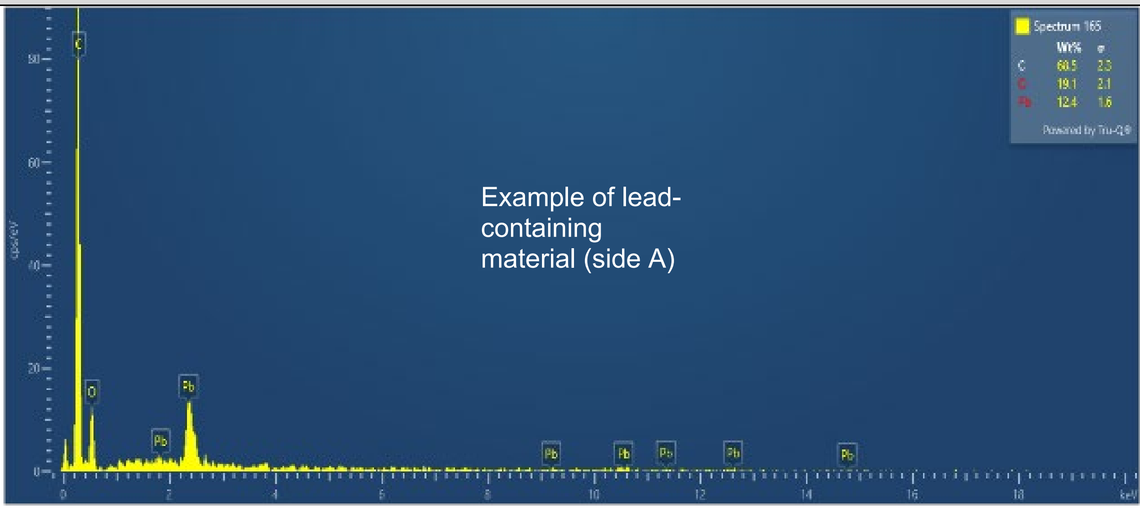


Table III.32 (continued) SEM-EDX results of paint cross-section sample SM16					
BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers' Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM16
SELECTED EDX SPECTRA SIDE B OF THE BANNER					



9.3.4 III.4 GC/MS

9.3.4.1 III.4.1 AA&R Report

No GC-MS spectra were provided by AA&R, only the following results.

Art Analysis & Research Inc.
London | New York

CONFIDENTIAL REPORT

Ref. AAR1339 | 23 July 2020

Binding Medium Analysis of Paint Samples
Prepared for the University of Glasgow

CONFIDENTIAL REPORT: BINDING MEDIUM ANALYSIS

Paint Samples from a Series of Historical Banners

Summary:

Five samples taken from a series of historical banners was sent to AA&R for GC-MS analysis. All 5 samples were analysed by GCMS and gave similar results, indicating the presence of a drying oil with palmitate/stearate ratios consistent with linseed oil. The azelate/suberate ratios suggest the oil may be partially heat-bodied in all cases. All of the chromatograms included a noticeable peak for methyl oleate (from monounsaturated oleic acid), most pronounced in sample 3, which could indicate incomplete drying of the oil or a relatively young paint film. All samples also contained a minor amount of a natural resin, probably pine resin.

Results:

Sample 1, TS19, was analysed by GC-MS. The results from the GC-MS show that this sample is composed of oil and a natural resin belonging to the Pinaceae family, probably pine resin. The oil was determined as linseed oil based on the palmitate to stearate ratio of 1.78.[1] The azelate to suberate ratio of 4.5 suggests the oil may be partially heat-bodied.[2] The chromatogram included a noticeable peak for methyl oleate (from monounsaturated oleic acid).

The sample was predominantly oil with the resin occurring only in trace amounts.

Peaks associated with oil: Fatty acid methyl esters.

R_T (min)	Component	B+	M+	Peak Area
10.55	Octanedioic acid, dimethyl ester (Suberate)	55	-	9.92×10^9
11.96	Nonanedioic acid, dimethyl ester (Azelate)	55	-	4.48×10^{10}
13.02	Decanedioic acid, dimethyl ester	55	-	3.43×10^9
13.81	Tetradecanoic acid, methyl ester	74	242	-
16.52	Hexadecanoic acid, methyl ester (Palmitate)	74	270	3.64×10^{10}

[1] Linseed oil typically has palmitate to stearate ratios between 1 and 2.
[2] The azelate to suberate ratio is somewhere between those reported for a raw (non-heat-bodied) oil, around 7, and those reported for heat-bodied oils, around 2, see Mills, J. and White, R. 'Organic Mass-Spectrometry of Art Materials: Work in Progress'. National Gallery Technical Bulletin Vol 6, pp 3–18.

19.52	Octadecenoic acid, methyl ester (Oleate)	55	296	5.37×10^{9}
19.97	Octadecanoic acid, methyl ester (Stearate)	74	298	2.05×10^{10}

Fatty acid ratios: P/S = 1.78; A/P = 1.23; A/Su = 4.51.
The peak areas for the fatty acids were measured and the ratio of one fatty acid to another was calculated. The palmitate to stearate ratio is 1.78 which is consistent with linseed oil. The azelate/suberate ratio suggests the oil may be partially heat-bodied.

Peaks associated with Pinaceae resins.

R_T (min)	Component	B+	M+
23.29	Dehydroabietic acid, methyl ester	239	-
26.24	7-oxo-dehydroabietic acid, methyl ester	253	328
28.34	15-hydroxy-7-oxo-deydroabietic acid, methyl ester	329	-

Sample 2, GU29_A, was analysed by GC-MS. The results from the GC-MS show that this sample is composed of oil and a natural resin belonging to the Pinaceae family, probably pine resin. The oil was determined as linseed oil based on the palmitate to stearate ratio of 1.42. The azelate to suberate ratio of 5.3 suggests the oil may be partially heat-bodied. The chromatogram included a noticeable peak for methyl oleate (from monounsaturated oleic acid).

The sample was predominantly oil with the resin occurring only in trace amounts.

Peaks associated with oil: Fatty acid methyl esters.

R_T (min)	Component	B+	M+	Peak Area
10.72	Octanedioic acid, dimethyl ester (Suberate)	55	-	1.19×10^{10}
11.96	Nonanedioic acid, dimethyl ester (Azelate)	55	-	6.33×10^{10}
13.02	Decanedioic acid, dimethyl ester	55	-	5.19×10^{9}
13.81	Tetradecanoic acid, methyl ester	74	242	-
16.77	Hexadecanoic acid, methyl ester (Palmitate)	74	270	5.21×10^{10}
19.68	Octadecenoic acid, methyl ester (Oleate)	55	296	1.59×10^{10}
20.15	Octadecanoic acid, methyl ester (Stearate)	74	298	3.66×10^{10}

Fatty acid ratios: P/S = 1.42; A/P = 1.21; A/Su = 5.32.

The peak areas for the fatty acids were measured and the ratio of one fatty acid to another was calculated. The palmitate to stearate ratio is 1.42 which is consistent with linseed oil. The azelate/suberate ratio suggests the oil may be partially heat-bodied.

Peaks associated with Pinaceae resins.

R_T (min)	Component	B+	M+
23.27	Dehydroabietic acid, methyl ester	239	-
26.32	7-oxo-dehydroabietic acid, methyl ester	253	328
28.41	15-hydroxy-7-oxo-deydroabietic acid, methyl ester	329	-

Sample 3, GU29_B, was analysed by GC-MS. The results from the GC-MS show that this sample is composed of oil and a natural resin belonging to the Pinaceae family, probably pine resin. The oil was determined as linseed oil based on the palmitate to stearate ratio of 1.33. The azelate to suberate ratio of 4.37 suggests the oil may be partially heat-bodied. The chromatogram included a fairly large peak for methyl oleate (from monounsaturated oleic acid), which could indicate incomplete drying of the oil or a relatively young paint film.

The sample was predominantly oil with the resin occurring only in trace amounts.

Peaks associated with oil: Fatty acid methyl esters.

R_T (min)	Component	B+	M+	Peak Area
10.64	Octanedioic acid, dimethyl ester (Suberate)	55	-	2.67×10^{10}
11.94	Nonanedioic acid, dimethyl ester (Azelate)	55	-	1.17×10^{11}
13.03	Decanedioic acid, dimethyl ester	55	-	1.54×10^{10}
13.80	Tetradecanoic acid, methyl ester	74	242	-
16.77	Hexadecanoic acid, methyl ester (Palmitate)	74	270	1.14×10^{11}
19.68	Octadecenoic acid, methyl ester (Oleate)	55	296	4.99×10^{10}
20.16	Octadecanoic acid, methyl ester (Stearate)	74	298	8.56×10^{10}

Fatty acid ratios: P/S = 1.33; A/P = 1.01; A/Su = 4.37.
The peak areas for the fatty acids were measured and the ratio of one fatty acid to another was calculated. The palmitate to stearate ratio is 1.33 which is consistent with linseed oil. The azelate/suberate ratio suggests the oil may be partially heat-bodied.

Peaks associated with Pinaceae resins.

R_T (min)	Component	B+	M+
23.27	Dehydroabietic acid, methyl ester	239	-
26.30	7-oxo-dehydroabietic acid, methyl ester	253	328
28.39	15-hydroxy-7-oxo-deydroabietic acid, methyl ester	329	-

Sample 4, VB30, was analysed by GC-MS. The results from the GC-MS show that this sample is composed of oil, with a trace of natural resin belonging to the Pinaceae family, probably pine resin. Only one component was identified originating from the resin, suggesting this is present in a smaller amount than in the other samples. The oil was determined as linseed oil based on the palmitate to stearate ratio of 1.51. The azelate to suberate ratio of 4.96 suggests the oil may be partially heat-bodied. The chromatogram included a noticeable peak for methyl oleate (from monounsaturated oleic acid).

The sample was predominantly oil with the resin occurring only in trace amounts.

Peaks associated with oil: Fatty acid methyl esters.

R_T (min)	Component	B+	M+	Peak Area
10.62	Octanedioic acid, dimethyl ester (Suberate)	55	-	1.02×10^{11}
11.91	Nonanedioic acid, dimethyl ester (Azelate)	55	-	5.06×10^{11}
13.00	Decanedioic acid, dimethyl ester	55	-	4.98×10^{10}
13.79	Tetradecanoic acid, methyl ester	74	242	-
16.60	Hexadecanoic acid, methyl ester (Palmitate)	74	270	1.94×10^{11}
19.56	Octadecenoic acid, methyl ester (Oleate)	55	296	7.58×10^{10}
20.01	Octadecanoic acid, methyl ester (Stearate)	74	298	1.28×10^{11}

Fatty acid ratios: P/S = 1.51; A/P = 2.60; A/Su = 4.96.
The peak areas for the fatty acids were measured and the ratio of one fatty acid to another was calculated. The palmitate to stearate ratio is 1.51 which is consistent with linseed oil. The azelate/suberate ratio suggests the oil may be partially heat-bodied.

Peaks associated with Pinaceae resins.

R_T (min)	Component	B+	M+
23.27	Dehydroabietic acid, methyl ester	239	-

Sample 5, SM31, was analysed by GC-MS. The results from the GC-MS show that this sample is composed of oil and natural resin belonging to the Pinaceae family, probably pine resin. The oil was determined as linseed oil based on the palmitate to stearate ratio of 1.64. The azelate to suberate ratio of 4.93 suggests the oil may be partially heat-bodied. The chromatogram included a noticeable peak for methyl oleate (from monounsaturated oleic acid).

The sample was predominantly oil with the resin occurring only in trace amounts.

Peaks associated with oil: Fatty acid methyl esters.

R_T (min)	Component	B+	M+	Peak Area
10.62	Octanedioic acid, dimethyl ester (Suberate)	55	-	1.43×10^{11}
11.96	Nonanedioic acid, dimethyl ester (Azelate)	55	-	7.06×10^{11}
13.02	Decanedioic acid, dimethyl ester	55	-	8.70×10^{10}
13.81	Tetradecanoic acid, methyl ester	74	242	-
16.72	Hexadecanoic acid, methyl ester (Palmitate)	74	270	6.18×10^{11}
19.59	Octadecenoic acid, methyl ester (Oleate)	55	296	1.13×10^{11}
20.10	Octadecanoic acid, methyl ester (Stearate)	74	298	3.76×10^{11}

Fatty acid ratios: P/S = 1.64; A/P = 1.14; A/Su = 4.93.
The peak areas for the fatty acids were measured and the ratio of one fatty acid to another was calculated. The palmitate to stearate ratio is 1.64 which is consistent with linseed oil. The azelate/suberate ratio suggests the oil may be partially heat-bodied.

Peaks associated with Pinaceae resins.

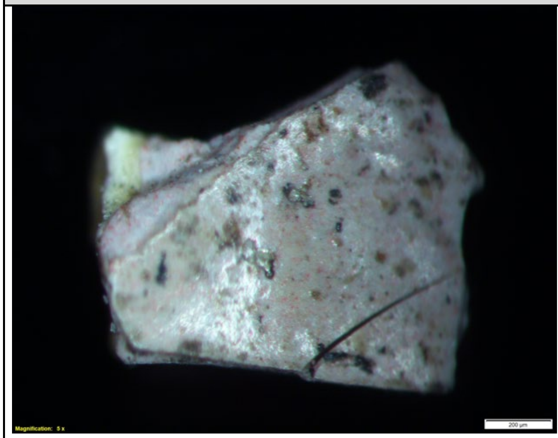
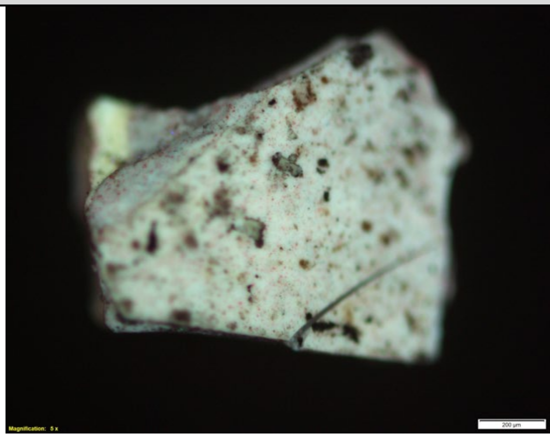
R_T (min)	Component	B+	M+
23.23	Dehydroabietic acid, methyl ester	239	-
24.65	Dehydroabietic acid, dimethylated derivative	358	-
26.30	7-oxo-dehydroabietic acid, methyl ester	253	328
28.37	15-hydroxy-7-oxo-deydroabietic acid, methyl ester	329	-

Appendices

A.1 Gas Chromatography-Mass Spectrometry (GC-MS)

3-(Trifluoromethyl)phenyl trimethylammonium hydroxide (TMTFTH) (20 µl) was added to the sample, which was heated (70 °C for four hours) and then vortex-mixed. The sample was then injected (1 µl) into a Varian 450-GC gas chromatograph coupled with a Varian 320-MS mass spectrometer. An VF-5ms capillary column (30 m length x 0.25 mm internal diameter x 0.25 µm film thickness) was used to provide separation of the components under a constant flow of helium gas (1.0 ml/min). The GC injector temperature was set at 270 °C. The analyses was performed in splitless mode with chromatographic conditions as follows: initial temperature 80 °C held for 2 min, increased at 10 °C/min to 200 °C, held for 3 min, increased at 7 °C/min to 280 °C, held for 3 min, then increased at 20 °C/min to 300 °C, held for 20 min. There was a 5 minute solvent delay. The transfer line was set to 280 °C, with the MS source temperature as 200 °C. Mass spectra were recorded under electron impact ionisation (70 eV) in the range of m/z 45 to 650.

9.3.4.2 III.4.2 GC/MS samples documentation

<table>
<tr><td colspan="6">Table III.33 Micrographs of paint sample TS19</td></tr>
<tr><td>BANNER</td><td colspan="5">The Glasgow Typographical Society</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning</td><td>YEAR</td><td>1883</td><td>SAMPLE</td><td>TS19</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="2">Dark field-crossed polarisers</td><td colspan="4">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="2"></td><td colspan="4"></td></tr>
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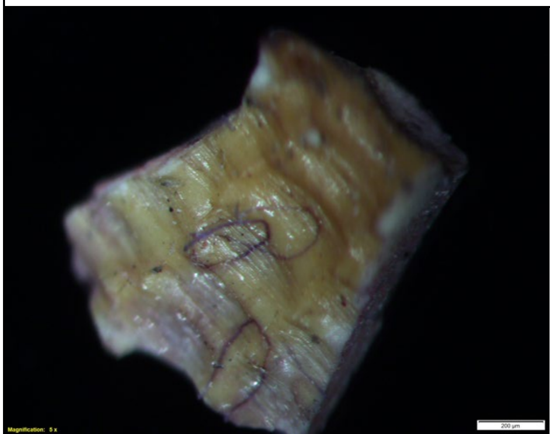
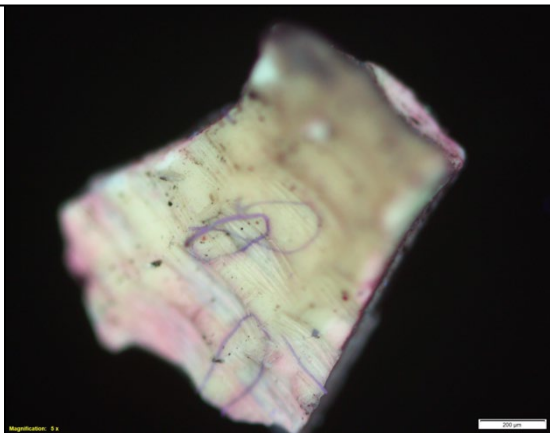
<tr><td colspan="2"></td><td colspan="4"></td></tr>
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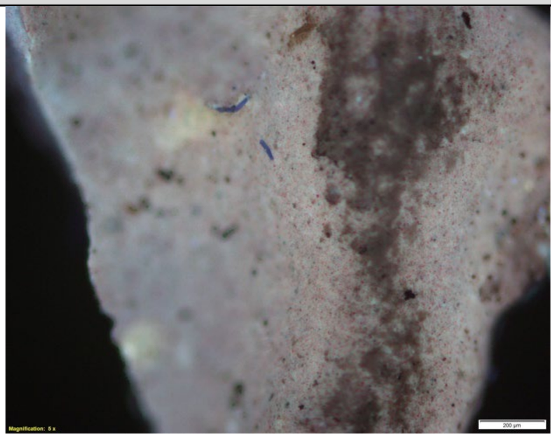
<tr><td colspan="6">Table III.34 Micrographs of paint sample GU29</td></tr>
<tr><td>BANNER</td><td colspan="5">The Glasgow Upholsterers Society</td></tr>
<tr><td>MANUFACTURER</td><td>George Kenning</td><td>YEAR</td><td>1884</td><td>SAMPLE</td><td>GU29</td></tr>
<tr><td colspan="6">Micrographs acquired under Olympus BX41 microscope at 50×</td></tr>
<tr><td colspan="3">Dark field-crossed polarisers</td><td colspan="3">UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)</td></tr>
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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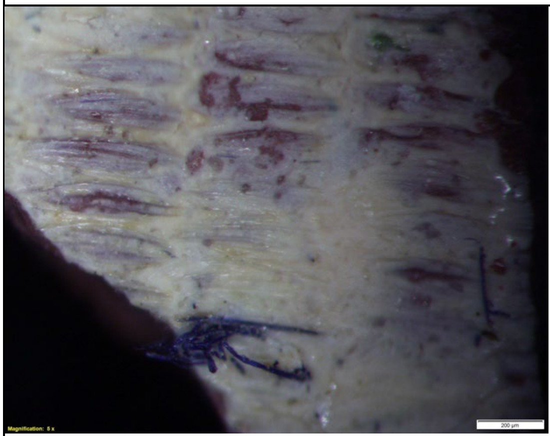
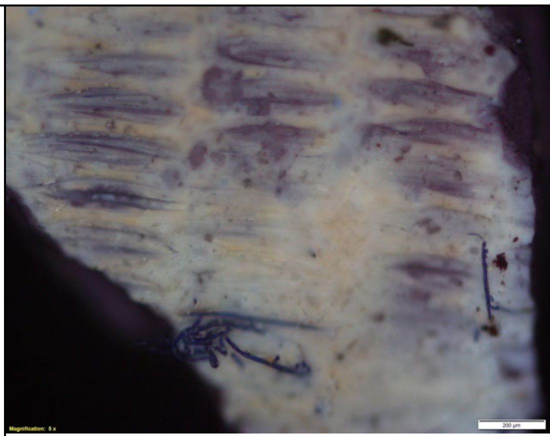
<tr><td colspan="3"></td><td colspan="3"></td></tr>
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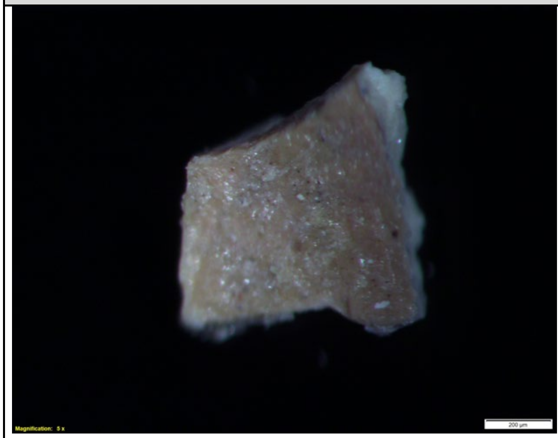
Table III.35 Micrographs of paint sample VB30					
BANNER	The National Union of Vehicle Builders, Glasgow Branch				
MANUFACTURER	George Kenning & Son	YEAR	1914	SAMPLE	VB30
Micrographs acquired under Olympus BX41 microscope at 50×					
Dark field-crossed polarisers			UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)		
					
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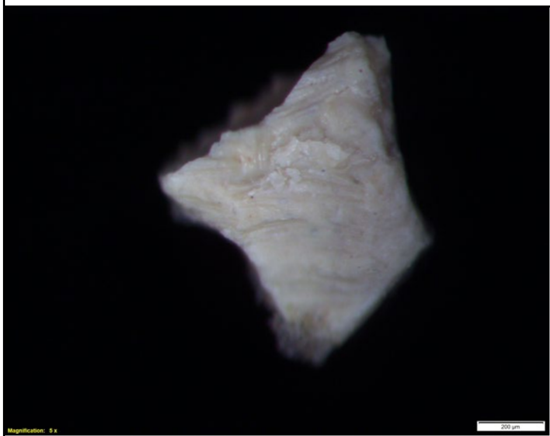			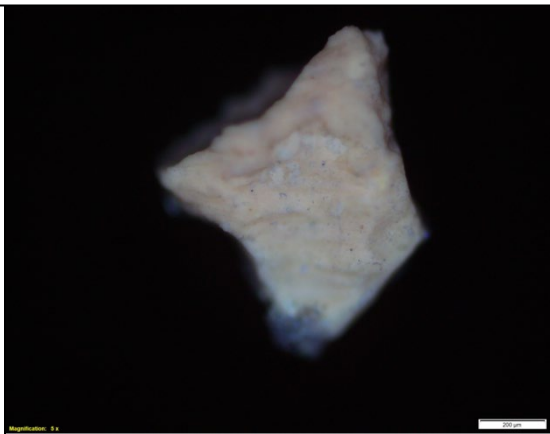		
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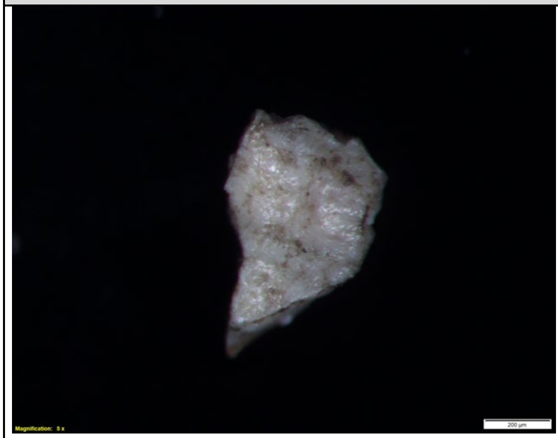
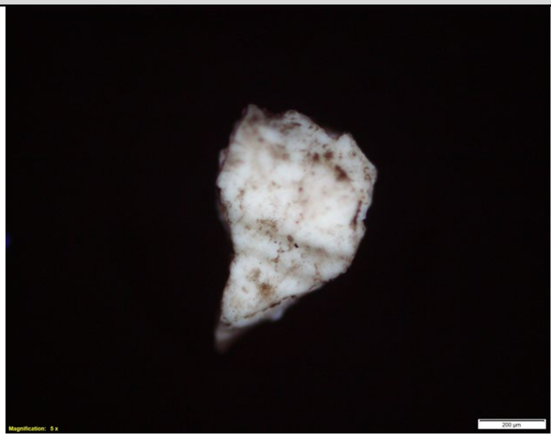
Table III.36 Micrographs of paint sample SM31

BANNER	The Scottish Tin Plate Braziers and Sheet Metal Workers’ Society				
MANUFACTURER	George Kenning & Son	YEAR	c. 1916	SAMPLE	SM31

Micrographs acquired under Olympus BX41 microscope at 50×

Dark field-crossed polarisers	UV filter U-M11011v2 (BP 355-425nm, BS 455nm, LP 520nm)
	
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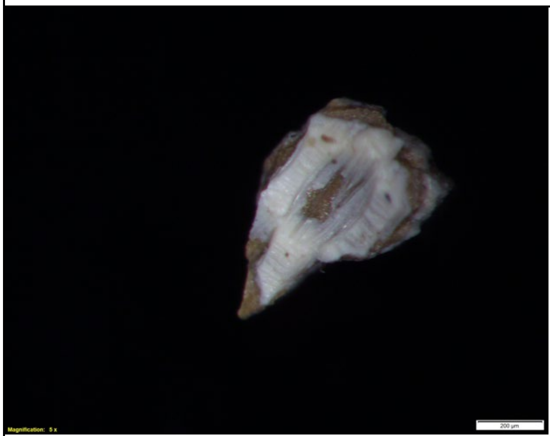	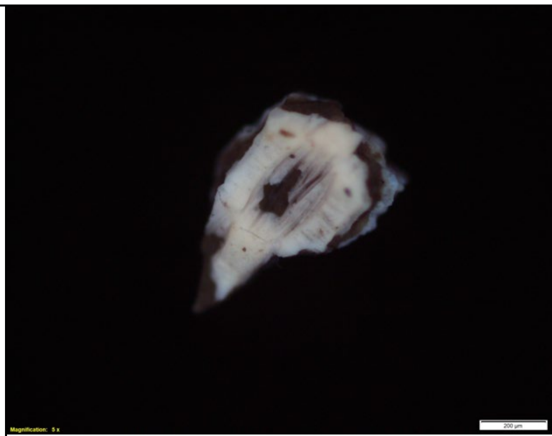
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9.4 Appendix IV. Historically informed banner reconstructions

9.4.1 IV.1 Banner Reconstruction 1

The materials and processes described in this section were selected from the literature review of Chapter 3, the analytical results of Chapter 6 and the sign painting sources reviewed in Table IV.24 at the end of this appendix.

9.4.1.1 IV.1.1 Size layer

9.4.1.1.1 IV.1.1.1 Materials

For the preparation of the size layer for Reconstruction 1, a solution was made of rabbit skin glue (No. LC27485J, J. Cornelissen & Son) in tap water at a concentration of 10% weight/volume. 10g of rabbit skin glue were weighted and mixed with sufficient cold water to make 100ml of size. It was left overnight to swollen inside a glass jar covered with parafilm to prevent evaporation of the liquid and access of foreign matter. The next day the gelled solution was melted at bain-marie at a temperature of 60˚C. Once molten, the size was ready to be applied.

9.4.1.1.2 IV.1.1.2 Process

Table IV.1 Application of size layer on *Reconstruction 1*	
Photographic record	Description and experimental conditions
	A strip of undyed silk rep was cut symmetrically along the wefts and warps and stretched by hand until achieve a drum-like sound. It was secured with staples making sure that all yarns were fixed to the stretcher. The tension was applied to the wefts and the warps remained un-tensioned due to the lack of material to do so. Conditions of application: 20°C, 55% RH Date: 14/10/19.

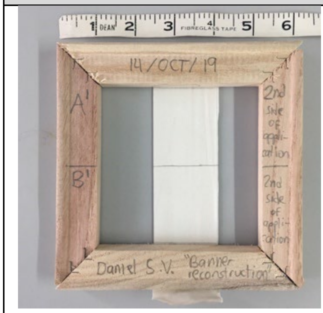
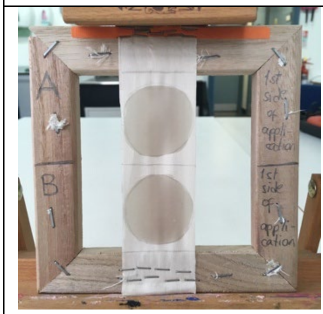
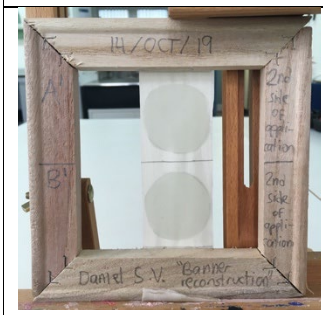
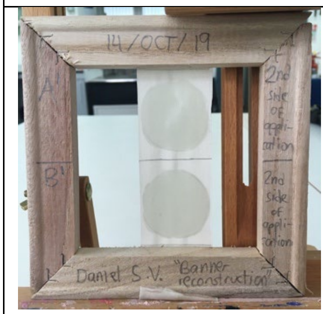
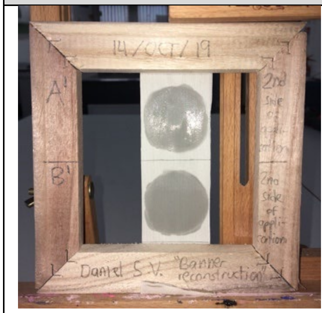
Table IV.1 (continued) Application of size layer on *Reconstruction 1*	
Photographic record	Description and experimental conditions
	Same as above, viewed from the back (sides A' and B'). As both images were photographed horizontally there is no raking light produced, thus showing an apparently flat fabric, which was not the case. Conditions of application: 20°C, 55% RH Date: 14/10/19.
	Areas for the application of materials were marked with pencil on sides A and B. Areas A and A' will have a raw linseed oil ground and areas B and B' will have a stand linseed oil ground, both with a ratio of 1:1 v/v lead white and calcium carbonate. Oils provided by Kremer, powders by Cornelissen. The raking light shows a slight distortion on the fabric after being stretched along the wefts' direction. Conditions of application: 20°C, 55% RH Date: 14/10/19.
	One layer of rabbit skin glue size was applied with a flat hog brush following the circular shape. Size was prepared at 10% w/v and applied hot (70° C). The application was done with the stretcher placed vertically and it was easy and smooth to apply. No drips or gloss were noticed, and the fabric got impregnated immediately with the hot size. The raking light shows an increase in distortion along the wefts after the application of size, more evident on the unsized areas. Conditions of application: 20°C, 55% RH Date: 14/10/19. Time: 3:17 pm
	View of sides A' and B' after the first application, not seeing an accumulation of material (seeping or gloss) to the back of the fabric. Conditions of application: 20°C, 55% RH Date: 14/10/19.
	One layer of rabbit skin glue size was applied with a flat hog brush following the circular shape on sides A' and B'. Size was prepared at 10% w/v and applied hot (70° C). The application was done with the stretcher placed vertically. The brush slide smoother over the fabric but the size was not absorbed as fast as on sides A and B, leaving accumulations of material and a glossy and wet appearance at the end. Still no drippings were achieved, neither during nor after the application. The excessive size left by the second/reverse application could explain the thicker layer of size seen in some of the paint samples and/or could determine the side that shows more paint detachment given the hygroscopicity of the glue. Conditions of application: 20°C, 55% RH Date: 14/10/19. Time: 3:19 pm.

Table IV.1 (continued) Application of size layer on *Reconstruction 1*

Photographic record	Description and experimental conditions
	Same image taken with flash to evidence the glossiness achieved and the heterogenous accumulation of size over the fabric. Note how the reflected light fails in record the deformation of the textile. Conditions of application: 20°C, 55% RH Date: 14/10/19.
	Image of sides A and B after the application of size on their reverse photographed with direct light. It shows that some of the size seeped from the back, coinciding with the areas of accumulation highlighted on the other side with the flashlight. This side of the reconstruction was not glossy after the first application; it became glossy in the accumulated areas from the back after the second size application. Conditions of application: 20°C, 55% RH Date: 14/10/19. Time: 3:20 pm.
	Image showing the drying of the size, which happened from the outer perimeter to the centre, following the shape in which it was applied (circle). The areas with accumulation of size took longer to dry. Conditions of application: 20°C, 55% RH Date: 14/10/19. Time: 3:58 pm.
	Size fully dried. Note how the deformation persists, only slightly less pronounced than after the application of size on sides A and B. Notice also the slight change of colour in the impregnated areas. Every step was applied and let to dry vertically as seen in historical photographs of banner production. Conditions of application: 20°C, 55% RH Date: 14/10/19. Time: 4:17 pm. TOTAL DRYING TIME: 1 hour.

*Temperature and relative humidity at the TAH were measured with an analogue thermohydrometer.

9.4.1.2 IV.1.2 Ground layer

9.4.1.2.1 IV.1.2.1 Materials

1 part of lead white weighting 16g (No. LC18004H, L. Cornelissen & Son) was mixed with 1 part of calcium carbonate weighting 7.3g (No. LC23165J, L. Cornelissen & Son) (Figure IV.1). From the mixture weighting 23.3g, 1 half was taken weighting 11.65g and divided subsequently into two parts weighting 5.825g each.

For the making of the raw linseed oil ground (Raw linseed oil No. 73054, Kremer Pigmente), one of the halves of lead and calcium carbonates weighting 5.825g was mixed with 2ml of raw linseed oil. Since the mixture was too runny, more lead and calcium carbonate mixture was slowly added until accomplish a richer texture, like that of commercial paint tubes, adding in total further 5.825g to the mixture. The resulting raw linseed oil ground thus had 11.65g of lead and calcium carbonate mixture, plus 2ml raw linseed oil.

For the making of the stand linseed oil ground (Stand linseed oil No. 73200, Kremer Pigmente), the other half of the lead and calcium carbonates mixture weighting 5.825g was mixed with 2ml of stand linseed oil. Since the mixture was too stiff (similar to putty), more linseed oil was slowly added until accomplish a slightly runnier texture, like that of commercial paint tubes, adding in total further 2ml of stand oil. The resulting stand linseed oil ground thus had 5.825g of lead and calcium carbonates mixture, plus 4ml of stand linseed oil.

From the outset it was evident that raw linseed oil ground required double the amount of pigment mixture than stand linseed oil ground to form a similarly viscous paste and stand linseed oil ground required double the amount of oil than raw linseed oil ground to form a similarly viscous paste. The conditions of preparation on the 15th October 2019 were 20 Celsius, 57% RH, measured with an *in-situ* analogue thermohydrometer.

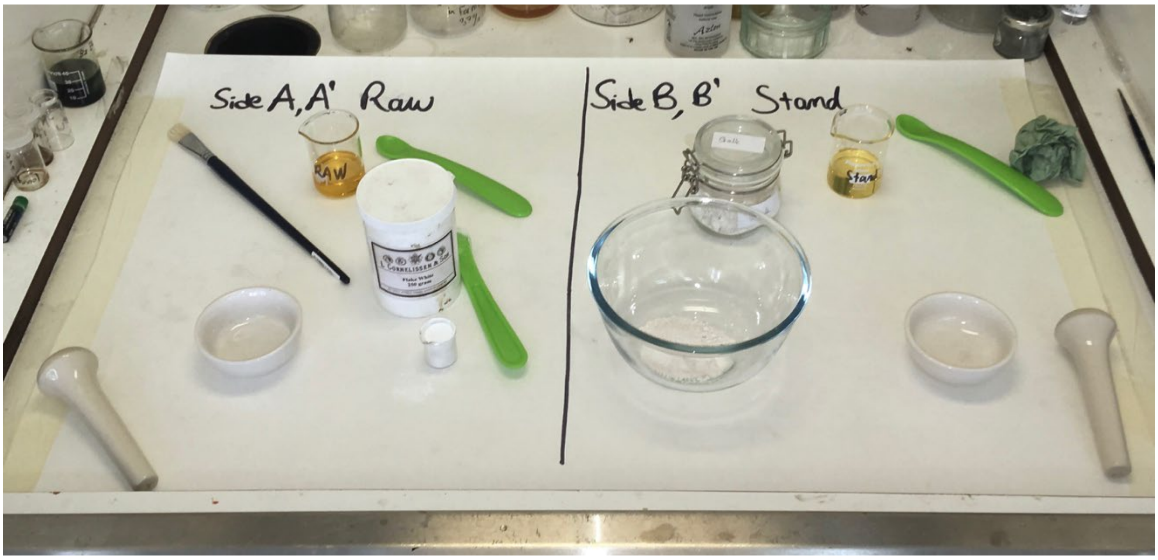


Figure IV.1 Workspace and overview of materials and utensils.

9.4.1.2.2 IV.1.2.2 Process

Table IV.2 Application of ground layer on *Reconstruction 1*		
Photographic record	Photographic record (with flash)	Description and experimental conditions
		One layer of the raw linseed oil ground was applied with a No 8 white hog bristle flat brush (one for each type of oil ground). The ground was easy to manipulate and spread/extend but it seemed to have some problems in adhering to the sized silk, as some of the brushstrokes dragged the previous layer slightly. The brushstrokes are very evident and remained as they were applied (the texture is more evident in the flash photograph). Seems that some of the oil oozed from the mixture and started to spread slightly towards the unsized area. Conditions of application: 20° C, 57% RH Date: 15/10/19. Time: 1:06 pm.

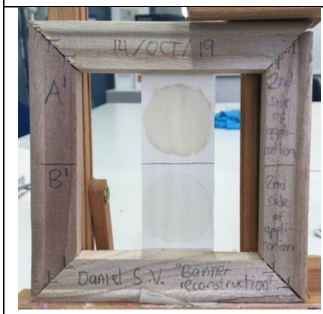
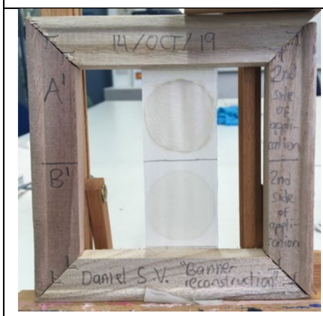
Table IV.2 (continued) Application of ground layer on *Reconstruction 1*		
Photographic record	Photographic record (with flash)	Description and experimental conditions
		The layer was immediately scrapped with a paint knife to smooth down the texture and thin down the layer, trying only to fill the interstices of the weave. Practically was difficult to accomplish due to the uneven tension of the silk (only stretched in the wefts), which produced an undulating distortion, causing the knife to leave accumulations of ground in the valleys. For future reconstructions it will be crucial to achieve an even tension on both directions of the weave to produce a flat workable surface. Conditions of application: 20° C, 57% RH Date: 15/10/19.
		The stretcher was turned around to see if any ground or binder had seeped into the back. The change in colour indicates that indeed a small part of it seemed to have passed through. Conditions of application: 20° C, 57% RH Date: 15/10/19.
		The background layer was applied slightly easier than on the front, the brush sliding more smoothly through the surface and the ground slightly easier to form a film. A larger accumulation of material was noticed, probably related to the easier application of the ground (better adherence, more material left). The brushstrokes were very evident after the application, seemingly more evident than the side A, probably due to a higher accumulation of ground due to the previous seeping of the oil from side A (more compatible). It seems that some oil from this ground is also extending towards the unsized areas. Conditions of application: 20° C, 57% RH Date: 15/10/19.

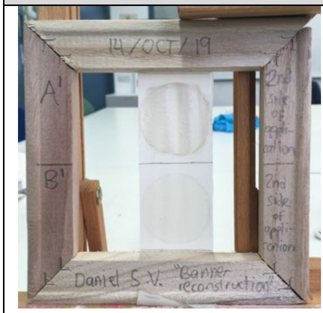
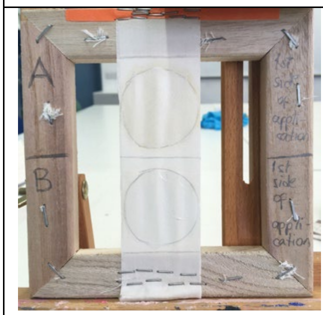
Table IV.2 (continued) Application of ground layer on *Reconstruction 1*		
Photographic record	Photographic record (with flash)	Description and experimental conditions
		The layer was immediately scrapped down with a paint knife, but the stretcher interfered with the access of the knife to the surface, resulting in an uneven flatting of the ground and evident lines from the tip of the knife. Also, the wavey surface of the unevenly stretched silk difficulted the smoothing of the layer, leaving accumulations of ground in the concave areas. Silk textile needs to be evenly stretched for future reconstructions. Every step was applied and let to dry vertically. Conditions of application: 20° C, 57% RH Date: 15/10/19. Time: 1:11 pm.
		One layer of the stand oil ground was applied with a No 8 white hog bristle flat brush. It was very difficult to manipulate given its sticky texture and lack of fluidity. The ground had to be physically dragged across the surface with the brush, applying much more pressure than with the other type of ground. It was particularly difficult to reach a neat border towards the edge of the marked area. The brushstrokes were evident while applying the ground but got flattened right after the application (reduced brushstroke retention). The appearance was very glossy at all times and the final effect resembles enamel. Conditions of application: 20° C, 57% RH Date: 15/10/19. Time: 1:15 pm
		The layer was immediately scrapped down with a paint knife, removing much more paint in comparison with the raw linseed oil ground. The smoothing also enhanced the glossiness of the layer. Due to the waviness of the unevenly stretched textile there were accumulations of ground left in the concave areas. The surface was harder to smooth down than the raw linseed oil ground. Conditions of application: 20° C, 57% RH Date: 15/10/19.

Table IV.2 (continued) Application of ground layer on *Reconstruction 1*

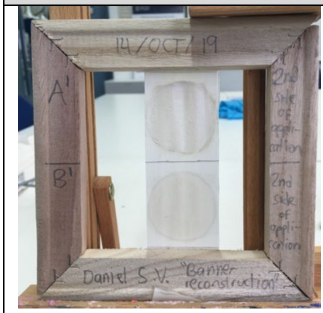
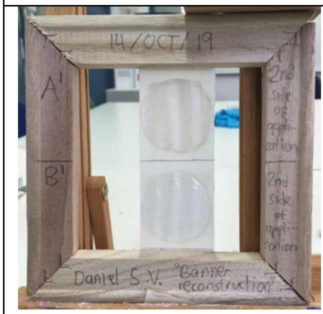
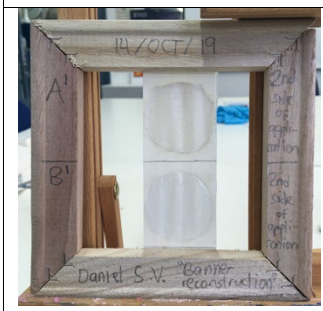
Photographic record	Photographic record (with flash)	Description and experimental conditions
		The stretcher was turned over to see if any of the ground or binder had seeped into the back but there was no evidence of that happening, unlike side A'. This can be due to the high viscosity of the mixture and the lesser amount of oil in comparison to the raw linseed oil ground. Conditions of application: 20° C, 57% RH Date: 15/10/19.
		One layer of the stand oil ground was applied with a No 8 white hog bristle flat brush. It was very difficult to manipulate given its sticky texture and lack of fluidity. The ground had to be physically dragged across the surface with the brush, but it was slightly easier than side B (probably due to a smoother surface given by the accumulation of animal glue size). The border was also slightly easier to work with (neat line) but could be due to the slightly larger accumulation of paint in comparison. The brushstrokes were evident while applying the ground but got flattened right after the application (reduced brushstroke retention). The appearance was very glossy at all times and the final effect resembled enamel. Conditions of application: 20° C, 57% RH Date: 15/10/19. Time: 1:19pm.
		The layer was immediately scrapped down with a paint knife, removing much more paint in comparison with the raw linseed oil ground and the side B of the stand oil ground. The smoothing also enhanced the glossiness of the layer. Due to the waviness of the unevenly stretched textile there were accumulations of ground left in the concave areas. The surface was harder to smooth down than the raw linseed oil ground. The stretcher interfered with the access of the knife to the surface, resulting in an uneven flatting of the ground and evident lines from the tip of the knife that got flattened after the scraping was done. Every step was applied and let to dry vertically. Conditions of application: 20° C, 57% RH Date: 15/10/19. Time: 1:21pm.

Table IV.2 (continued) Application of ground layer on *Reconstruction 1*

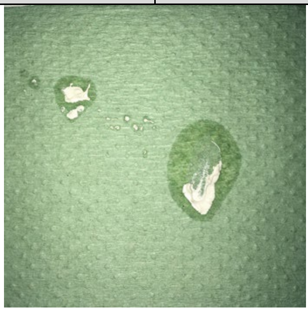
Photographic record	Photographic record (with flash)	Description and experimental conditions
		Spillages of the raw linseed oil ground (left image) were left during the time of application of the reconstruction and photographed at the end (between 1:06 pm and 1:11 pm). A significant amount of oil was adsorbed into the paper towel, leaving the remaining mixture slightly less glossy in appearance. The same was done with the stand linseed oil ground (left between 1:15 pm and 1:21pm) and there was no evidence of oil adsorption into the paper towel, not even from the back, within the same time frame. The appearance of the mixture was at all times very glossy (as an enamel). Images were only taken with flash to evidence presence or absence of gloss. Conditions of application: 20° C, 57% RH Date: 15/10/19.
		

Table IV.3 Drying monitoring of ground layer of *Reconstruction 1*

Date/Time	Temperature /Relative Humidity	Comments
15/10/19/5:42 pm	20°C/57%	Sections A and A' felt almost dry to touch (not tacky) after about 4 hours of application, although some ground got adhered to the glove when testing. Sections B and B' felt quite tacky and not at all dry to touch after about 4 hours, but a large amount of ground got adhered to the glove when testing.
16/10/19/11:00 am	20°C/57%	Same as the day before; A and A' felt almost dry to touch, not tacky, with some ground getting adhered to the tip of the glove. B and B' felt quite tacky, not dried to touch and plenty of ground adhered to the tip of the glove. The area of testing in sections B and B' leave a mark that disappears over time, as the mark from the previous day was not seen. The marks on sections A and A' are not that evident as the amount of paint attached to the glove was not as large to begin with.
17/10/19/1:25 pm	20°C/57%	Sections A and A' behaved similarly to the two previous days, not tacky at all, almost dry to touch, with just a little ground adhered to the tip of the glove. Sections B and B' felt very tacky to touch, with a little of the ground sticked to the tip of the glove, but significantly less than the previous two days. None of the testing marks remain in their surface.

Table IV.3 (continued) Drying monitoring of ground layer of *Reconstruction 1*		
Date/Time	Temperature /Relative Humidity	Comments
18/10/19/12:24 pm	20°C/54%	Sections A and A' are not tacky at all; ground seems dry to touch but still a little white is seen in the tip of the glove after testing. Sections B and B' feel tacky but not as much as the day before, however no ground was retrieved withe glove after testing. The surface remains slightly fluid, as it moves when pressure is applied, regaining its flatness after the pressure has been released.
23/10/19/1:55 pm	22°C/50%	Both sections A, A' and B, B' are completely dried to touch. No ground or pigment was retrieved in any case during testing and neither felt tacky or fluid. However, since testing was resumed until the 23 November, individual drying times (dried to touch) for each section could not be established. Seems that the raw linseed oil ground dries twice as faster, but it will have to be monitored again to confirm. TOTAL DRYING TIME: 8 DAYS (seemingly 4 for raw oil mixture and 8 for stand oil mixture).
*Temperature and relative humidity at the TAH were measured with an analogue thermohydrometer.		

9.4.1.3 IV.1.3 Paint layers

9.4.1.3.1 IV.1.3.1 Materials

Two sets of oil paints were purposely prepared for this reconstruction, in accordance with the two types of oil used for the ground: raw linseed oil and stand linseed oil, both from Kremer (Raw linseed oil No. 73054 and Stand linseed oil No. 73200, Kremer Pigmente). Two pigments were selected to distinguish each side of the reconstruction (front and back), chosen for being equally fast-drying pigments, non-toxic and likely to be found in painted banners: raw umber (side A) and yellow ochre (side B), both from Cornelissen (No. LC16071C and No. LC16141C, L. Cornelissen & Son) (Figure IV.2).

For the raw umber and stand oil mixture, 0.25 g of pigment were mixed with 0.3 ml of oil. For the raw umber and raw oil mixture a similar amount was used. Seemingly, due to the small size and porosity of raw umber particles, both oils were equally capable of easily forming a paste with the same oil ratio.

For the yellow ochre and stand oil mixture, 0.25 g of pigment were mixed with 0.2 ml of oil. For the yellow ochre and raw oil mixture, 0.25 g of pigment were mixed with 0.15 ml of oil. For the case of the yellow ochre-raw oil paint, less amount of binder was required, similarly to the ground layer preparation. For the case of the yellow ochre-stand oil paint, more amount of binder was required, similarly to the ground layer preparation. In comparison with the stand oil paints, the yellow ochre raw linseed oil mixture was too liquid to form a paste, thus needed twice the amount of pigment.

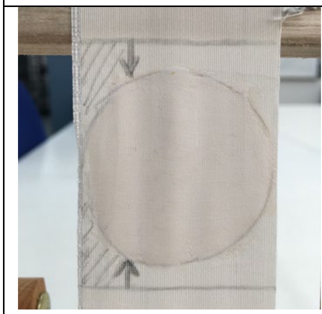
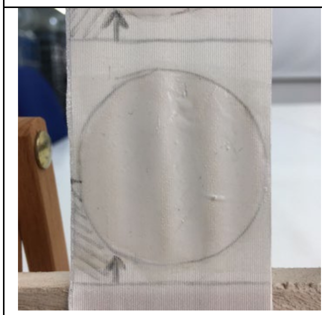
Overall, the preparation with raw linseed oil required twice as much pigment than the preparation with stand linseed oil. This varied slightly depending on the particle size and weight (density) of the pigment, as yellow ochre was twice as heavy than raw umber (half the volume of pigment with the same weight). The conditions of preparation and application on the 24th October 2019 were 22°C/52% RH, measured with an *in-situ* analogue thermohydrometer.

a)  b)

Figure IV.2 Overview of materials and utensils before mixing; a) raw linseed oil mixtures, b) stand linseed oil mixtures.

9.4.1.3.2 IV.1.3.2 Process

Table IV.4 Application of paint layers on *Reconstruction 1*

Photographic record	Photographic record (with flash)	Description and experimental conditions
		Areas for potential cross sectioning were selected from both sections on both sides, marked accordingly to the homogeneity of their ground layers. Other areas were either too thick or too thin. This precaution was taken due to the subsequent covering of the paint that would obstruct the distinction and selection of the most homogeneous areas.
		Detail of section A with sampling area marked with the arrows.
		Detail of section B with sampling area marked with the arrows.
		Areas for potential sampling marked also on side B of the reconstruction.
		Detail of section A' with sampling area marked with the arrows.

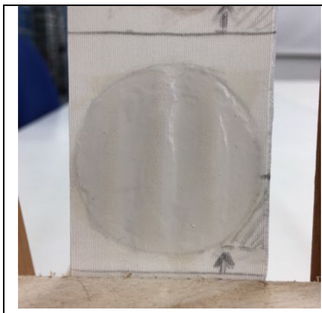
		Detail of section B' with sampling area marked with the arrows.
		One layer of raw umber oil paint was applied with a new No. 4 rounded natural-hair brush. One layer of stand umber oil paint was applied with another new No. 4 rounded natural-hair brush. Every step was applied and let to dry vertically. Conditions of application: 22° C, 52% RH Date: 24/10/19. Time: 12:39pm.
		Detail of section A after painting with sampling area marked with the arrows. Evident brushstrokes that remain after application. The paint has very good handling properties, covering power and film formation with the raw umber pigment ratio. It is possible to extend homogeneously. Conditions of application: 22° C, 52% RH Date: 24/10/19
		Detail of section B after painting with sampling area marked with the arrows. Evident brushstrokes that get flattened after application. The paint has terrible handling properties as it is impossible to extend (texture similar to golden syrup). Hairs from the brush got adhered after application as the paint had to be dragged across the surface to form a film. Conditions of application: 22° C, 52% RH Date: 24/10/19
		One layer of raw ochre oil paint was applied with a new No. 4 rounded natural-hair brush. One layer of stand ochre oil paint was applied with another new No. 4 rounded natural-hair brush. Every step was applied and let to dry vertically. Conditions of application: 22° C, 52% RH Date: 24/10/19. Time: 12:41pm.

Table IV.4 (continued) Application of paint layers on *Reconstruction 1*

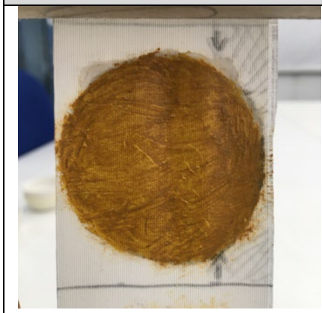
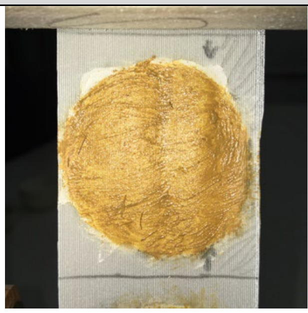
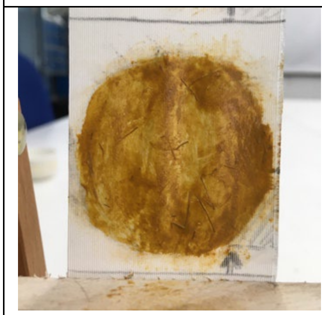
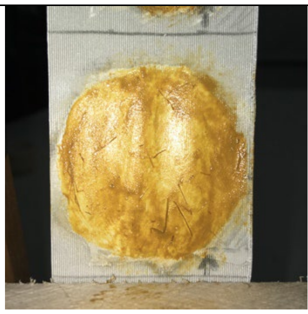
Photographic record	Photographic record (with flash)	Description and experimental conditions
		Detail of section A' after painting with sampling area marked with the arrows. Similarly, brushstrokes are evident and remained after application. However, the paint is too transparent and more difficult to obtain a homogeneous film. Conditions of application: 22° C, 52% RH Date: 24/10/19
		Detail of section B' after painting with sampling area marked with the arrows. Similarly, brushstrokes disappear after application and the paint has terrible handling properties (same consistency as golden syrup). It is also harder to manipulate than its raw umber equivalent. Conditions of application: 22° C, 52% RH Date: 24/10/19

Table IV.5 Drying monitoring of paint layers of *Reconstruction 1*

Date/Time	Temperature /Relative Humidity	Comments
25/10/19/12:00 pm	18°C/49%	All paints remain wet.
28/10/19/11:00 am	17°C/48%	As no monitoring was done over the weekend the length of the paint drying to touch is not exact. Sections A and B both feel dried to touch, although B is slightly tacky with no paint coming off. Sections A' and B' also feel dried to touch but yellow paint comes from A' if slightly rubbed and B' is as tacky as B with no paint coming off.
29/10/19/11:00 am	17°C/48%	All paints are dried to touch. TOTAL DRYING TIME: 5 DAYS
*Temperature and relative humidity at the TAH were measured with an analogue thermohydrometer.		

9.4.2 IV.2 Banner Reconstruction 2

The materials and processes described in this section were selected from the literature review of Chapter 3, the analytical results of Chapter 6 and the sign painting sources reviewed in Table IV.24 at the end of this appendix.

9.4.2.1 IV.2.1 Stretching

9.4.2.1.1 IV.2.1.1 Materials

Due to the restricted access caused by the COVID-19 restrictions, the materials for mounting and stretching the banner had to be improvised with was available at the TAH laboratory. Two squared-shaped stretchers were sectioned and reused to form a rectangular stretcher measuring 16” by 6” (40.64cm by 15.24cm). Stainless-steel staples and a staple gun were used to assemble the parts. A canvas plier was used to stretch the silk textile by hand, holding it in place at the side of the stretcher with a single line of stainless-steel staples also applied with a staple gun. The mounting process was done symmetrically along the sides of the stretcher, starting with the centres on the narrow end, followed by the wide end and closing towards the four corners in an alternated manner.

9.4.2.1.2 IV.2.1.2 Process

Table IV.6 Stretching of *Reconstruction 2*

Photographic record	Description and experimental conditions
	A wooden strainer measuring 16 by 6 inches was assembled squared from two picture frames with stainless steel staples. Conditions of application: 23° C, 50% RH Date: 11/09/20.

Table IV.6 (continued) Stretching of *Reconstruction 2*

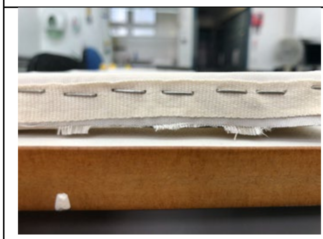
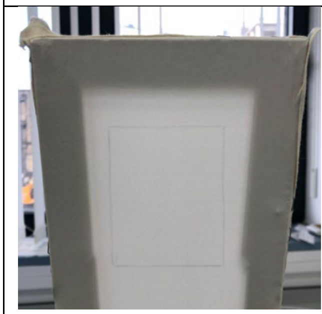
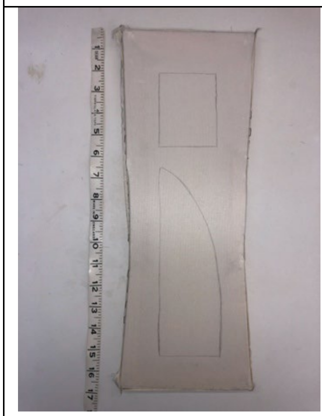
Photographic record	Description and experimental conditions
	A strip of silk grosgrain was cut along the wefts keeping one of the selvages and the start of the warps, measuring slightly over the strainer's measurements. The textile was used just as provided by the manufacturer without any washing. Conditions of application: 23° C, 50% RH Date: 11/09/20.
	The textile was stretched as taut as a drum using canvas pliers and electric staple gun with stainless staples. The stretching started on the four centres and symmetrically towards the corners. Given the lack of crossbar and taut stretching, the longer segments of the strainer suffered buckling. Conditions of application: 23° C, 50% RH Date: 11/09/20.
	The textile was left completely flat after the stretching and fixing.
	A strip of cotton tape was added all along the borders as an interface between silk textile and fixing elements (staples), as indicated by Kelly (1901). The spacing of the staples was maintained even throughout.

Table IV.6 (continued) Stretching of *Reconstruction 2*

Photographic record	Description and experimental conditions
	General areas of the design were traced with a 2B pencil on the back side, henceforth designated as side A.
	Using the transmitted light coming from the window, the same design was traced onto the opposite side with ease, as recommended by Cennino (c. 1450).
	The front side of the strainer was henceforth designated as side B.

9.4.2.2 IV.2.2 Size layer

9.4.2.2.1 IV.2.2.1 Materials

A similar preparation as the size for *Reconstruction 1* was followed for *Reconstruction 2* (see previous section IV.1.1.1) (Figure IV.3). The remaining size was left to cooldown and stored in the TAH laboratory fridge until further use. The size was kept inside the glass container tightly sealed with parafilm.

Figure IV.3 Rabbit skin glue heated in a bain-marie with applying brush.

9.4.2.2.2 IV.2.2.2 Process

Table IV.7 Application of size layer on *Reconstruction 2*

Photographic record	Description and experimental conditions
	One layer of rabbit skin glue size was applied with a flat hog brush exceeding the outline of the shapes by ¼ of an inch as suggested by Kelly (1901). Size was prepared at 10% w/v and applied hot (70° C). The application was done with the stretcher placed vertically and it was easy and smooth to apply. No drips or gloss were noticed, and the fabric got impregnated immediately with the hot size. The raking light shows a distortion along the warps after the application of size. Conditions of application: 24° C, 55% RH Date: 11/09/20.
	The strainer was turned around and one layer of rabbit skin glue size was applied with a flat hog brush also exceeding the shapes by ¼ inch. No drips were noticed but an increased gloss appeared in comparison, denoting the sealing of the opposite layer. The raking light shows a distortion along the warps after the application of size. Conditions of application: 24° C, 55% RH Date: 11/09/20.

Table IV.7 (continued) Application of size layer on *Reconstruction 2*

Photographic record	Description and experimental conditions
	After 1 hour both sides of the reconstruction appeared totally dried and the distortion disappeared almost completely. Conditions of application: 24° C, 55% RH Date: 11/09/20.
	The strainer was left vertically in the same space for a week, until it was convenient to apply the subsequent layers. Conditions of application: 24° C, 55% RH Date: 11/09/20.

9.4.2.3 IV.2.3 Ground layer

9.4.2.3.1 IV.2.3.1 Materials

A similar mixture as that described for the raw linseed oil ground of *Reconstruction 1* was prepared with the leftover mixture of lead and calcium carbonates (see section IV.1.2.1). The resulting mixture for *Reconstruction 2* was equally unctuous as said ground of *Reconstruction 1* (Figure IV.4).

Figure IV.4 Ground layer with applying brush.

9.4.2.3.2 IV.2.3.2 Process

Table IV.8 Application of ground layer on *Reconstruction 2*, side A

Photographic record	Description and experimental conditions
	One layer of the raw linseed oil ground was applied with a No 8 white hog bristle flat brush. The ground was easy to manipulate and spread/extend. In comparison with the first reconstruction, it did not have problems in adhering to the sized silk. The brushstrokes were very evident and remained as that after application. There was no oil oozed from the mixture, seemingly contained by the exceeding size application that restricts the capillarity of the silk fibres. Conditions of application: 23° C, 50% RH Date: 17/09/20. Time: 1:40 pm.
	The layer was immediately scrapped with a paint knife to smooth down the texture and thin down the layer, trying only to fill the interstices of the weave. It was very easy to accomplish due to the even tension of the silk. Only a slight distortion towards the edges of the shapes caused accumulations of ground in the valleys. Conditions of application: 23° C, 50% RH Date: 17/09/20.
	Similarly to the upper square, a slight distortion towards the top and bottom borders of the mixed shaped area resulted in an accumulation of ground in the concavities. Although the ground showed a pearly lustre in the mortar, the general appearance after application and scraping was semi-matt. Conditions of application: 23° C, 50% RH Date: 17/09/20.

Table IV.9 Drying monitoring of ground layer of *Reconstruction 2*, side A		
Date/Time	Temperature /Relative Humidity	Comments
17/09/20/1:40 pm.	23° C, 50% RH	The square shape was left to dry for 1 hour to become tacky for silver leaf application (time registered for the first reconstruction until earliest tackiness achievement).
17/09/20/2:40 pm.	23° C, 50% RH	Ground is wet and tacky with paint coming off.
17/09/20/3:40 pm.	23° C, 50% RH	Mixed-shape ground remains wet and tacky with paint coming off.
17/09/20/4:40 pm.	23° C, 50% RH	Mixed-shape ground remains wet and tacky with paint coming off.
18/09/20/10:12 am.	25° C, 50% RH	Mixed-shape ground is still wet but not tacky. Paint still comes off.
18/09/20/2:40 pm.	25° C, 50% RH	Mixed-shape ground is still wet but not tacky. Paint still comes off. It was left over the weekend to dry.
21/09/20/12:00 pm.	23° C, 52% RH	Mixed-shape ground is dried to touch. TOTAL TIME PAST: 4 days (not total drying time as weekend got in the way).
*Temperature and relative humidity at the TAH were measured with an analogue thermohydrometer.		

Table IV.10 Application of ground layer on *Reconstruction 2*, side B	
Photographic record	Description and experimental conditions
	There was no seeping of the previous ground layer noticed on the textile on side B. However, the translucency of the size impregnated textile made it evident that the application of the ground on side A was heterogeneous. Areas distorted by cusping had less or apparently none ground on the corresponding valleys, and in the outmost areas the scraping left almost no ground. This could possibly account for the previously detected areas with apparent no ground on commercially produced banners by Tutill and Kenning & Son (Macdonald et al. 2004; Smith et al. 2017). Conditions of application: 19° C, 45% RH Date: 30/09/20.

Table IV.10 (continued) Application of ground layer on *Reconstruction 2*, side B

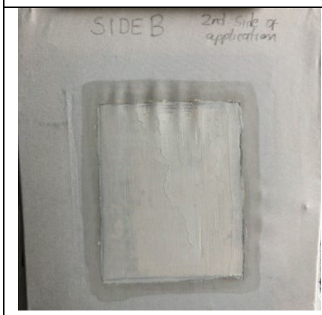
Photographic record	Description and experimental conditions
	Detail showing the cusping towards the top and right-hand side of the strainer, as well as the areas with accumulations and apparent lacking ground. Side A was fully covered with ground, thus the apparent lack seen on the back must indicate that the layer stayed on the surface of the textile. The apparent accumulated areas must be due to the full adsorption of the ground around the yarns, but not seeping to the back (side B).
	Same observations as squared shape. In both cases a slight oozing of oil from the other side was noticed just passing the limit of application, however contained by the exceeding size that prevented the spreading towards the unsized silk. This was not achieved with the first reconstruction as the limits of both size layer and ground/paint layers coincided with each other (no exceeding size left). As a consequence, the sections with the raw linseed oil mixtures got impregnated with the oozing of its oil and got stiff. This did not happen with the stand linseed oil sections (no oozing of oil), which textile remained supple.
	One layer of the raw linseed oil ground was applied with a No 8 white hog bristle flat brush. The ground was even easier to manipulate and spread/extend, seemingly due to the much smoother surface caused by multiple layers applied on the opposite side (metal leaves and paint layers). Conditions of application: 19° C, 45% RH Date: 30/09/20. Time: 12:00 pm.
	The layer was immediately scrapped with a paint knife to smooth down the texture and thin down the layer, trying only to fill the interstices of the weave. It was very easy to accomplish due to the even tension of the silk. Only a slight distortion towards the top and bottom edges of the shapes caused accumulations of ground in the valleys. Conditions of application: 19° C, 45% RH Date: 30/09/20.

Table IV.10 (continued) Application of ground layer on *Reconstruction 2*, side B	
Photographic record	Description and experimental conditions
	Same observations as squared shape. In both cases a slight oozing of oil from the other side was noticed just passing the limit of application, however contained by the exceeding size that prevented the spreading towards the unsized silk. Conditions of application: 19° C, 45% RH Date: 30/09/20.
	Detail showing the huge amount of ground that was retired with the glass spatula/scrapper. Glass was used and no metal as its dimension fit the drawn areas better on both sides A and B.

Table IV.11 Drying monitoring of ground layer of *Reconstruction 2*, side B		
Date/Time	Temperature /Relative Humidity	Comments
30/09/20/1:00 pm.	19° C, 45% RH	The square shape was left to dry for 1 hour to become tacky for silver leaf application (time registered for the first reconstruction until earliest tackiness achievement).
30/09/20/2:00 pm.	19° C, 45% RH	The ground is wet and tacky with paint coming off.
30/09/20/3:00 pm.	19° C, 45% RH	The mixed-shape ground remains wet and tacky with paint coming off.
30/09/20/4:00 pm.	19° C, 45% RH	The mixed-shape ground remains wet and tacky with paint coming off.
1/09/20/11:00 am.	19° C, 45% RH	The mixed-shape ground remains wet and tacky with some paint coming off. It proves Kelly's recommended 12 hrs for gilding are attainable. However, this was not followed in practice in squared shape for fear of not achieving its metal leaf adherence. The time followed was that of the first proved reconstruction of 1 hour after application.
1/09/20/3:00 pm.	19° C, 45% RH	The mixed-shape ground feels less tacky and there is almost no paint stripping. There is also hardly any surface marking left. However, it remains wet.
2/09/20/10:00 am.	19° C, 45% RH	The mixed-shape ground is dried to touch. TOTAL DRYING TIME: 3 days
*Temperature and relative humidity at the TAH were measured with an analogue thermohydrometer.		

9.4.2.4 IV.2.4 Metal leaves

9.4.2.4.1 IV.2.4.1 Materials

Transfer silver leaf and transfer aluminium leaf were acquired from Gold Leaf Supplies, UK. They were selected instead of loose leaves for being seen in historical footage of banner painters (Pathé, 1958) and recommended by Kelly (1911). Gold-size used for adhesion was Japan Oil Gold Size (3-hour setting) from Wrights of Lymm Ltd (Figure IV.5), also recommended by Kelly (1911). 24k gold leaf was supplied by the TAH laboratory, acquired from Gold Leaf Supplies, UK.

Figure IV.5 Wrights of Lymm Ltd 3-hour Japan Oil Gold Size, a) packing, b) appearance.

9.4.2.4.2 IV.2.4.2 Process

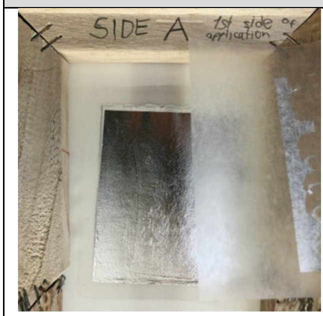
Table IV.12 Application of metal leaves on *Reconstruction 2*, side A	
Photographic record	Description and experimental conditions
	A transfer silver leaf cut out to the exact size of the squared shape was laid over the tacky white ground. It immediately adhered to the sticky surface and stripped clean from the greased paper. Hardly any wrinkles were formed and there was zero waste from the silver leaf. The overall process was surprisingly easy and straightforward. Conditions of application: 23° C, 50% RH Date: 17/09/20. Time: 2:40 pm.
	Following the recommendations of Kelly (1901), a cotton wool was used to further press the silver leaf over the ground and increase its adherence. This action did create wrinkles as possibly the ground was still too wet for applying the leaf (the 12 hours recommended by Kelly were not awaited in the fear that it would not work). Rubbing the silver leaf with the cotton wool cleaned the excess leaf on the borders, which was caught as dust into the fibres.

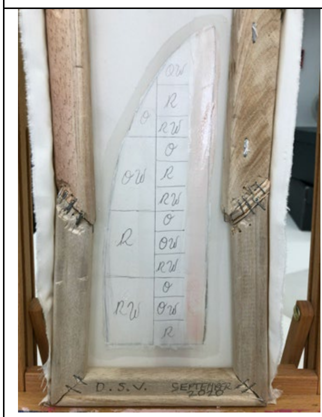
Table IV.12 (continued) Application of metal leaves on *Reconstruction 2*, side A	
Photographic record	Description and experimental conditions
	Appearance of side A after application of silver leaf. Note how the distortion caused by cusping becomes more noticeable with the metal leaf. Conditions of application: 23° C, 50% RH Date: 30/09/20.
	Following Kelly's recommendations (Kelly 1901), a layer of diluted rabbit skin glue was applied as an isolation layer to prevent the tarnishing of the silver leaf. To have a comparison standard, a strip of the silver leaf was reserved with paper and left un-coated. The rabbit skin glue was diluted in half from the 10% size layer mixture, resulting in a 5% concentration. It was applied hot (70°C) with a new camel-hair brush of ½ inch wide. Unexpectedly, the application was very smooth, even and did not seem to split form the surface.
	The coated silver leaf after drying. There was no stripping of the metal leaf caused by the shrinkage of the proteinaceous layer. However, a mottled appearance of a slightly yellowish colour was seen under the coating, similar to that observed in the original banners made by George Kenning (i.e. Typographers, Upholsterers and Millers banners). This could be an indication of a surface reaction between the coating and silver leaf as it dries. In contrast, the un-coated side started to develop a slight yellowish tarnishing. The overall wrinkling of the silver leaf diminished considerably as the bottom layer continued to dry. Conditions of application: 25° C, 50% RH Date: 18/09/20.
	Over the dried-to-touch ground a thin layer of Japan Oil Gold Size was applied with a rounded synthetic-hair brush to test the other type of metal leaf adhesion. As the brush had been previously used with a red paint, some residues stained the gold size making it appear redder than its original tone. Conditions of application: 23° C, 52% RH Date: 21/09/20. Time: 1:00 pm.

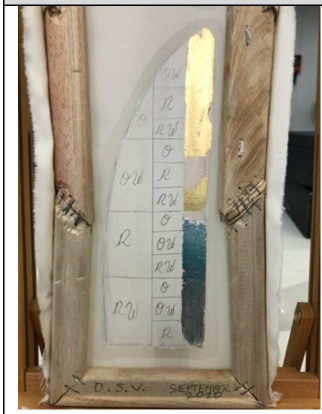
Table IV.12 (continued) Application of metal leaves on *Reconstruction 2*, side A	
Photographic record	Description and experimental conditions
	After 1 hour the surface of the gold-size was tested for tacking point and after having found it tacky but not wet, it was decided to apply the metal leaves (likewise, the 3 hours recommended by the manufacturer were not awaited for fear of them being too much). A full-size transfer gold leaf was carefully aligned to the upper section of the sized strip and pressed onto it with the back of the fingers, releasing and adhering perfectly to the surface. Immediately a cotton wool was pressed against it to increase adhesion but some of the fibres fell over the remaining areas and obstructed the adherence of the lower gilding sections. The same was done with the transfer silver leaf. Conditions of application: 23° C, 52% RH Date: 21/09/20. Time: 2:00 pm.
	Detail showing the cotton fibres adhered to sections of the gold-size preventing the adhesion of the metal leaves. After removal, another layer of gold-size was locally applied and left to dry for half an hour before re-applying the gold and silver leaves.
	Appearance of the gilded and silvered areas after patching. Accidentally, the upper silvered square was rubbed against with the hand, damaging and lifting a small area which was either not adequately adhered or remained still wet underneath. An important observation is that many defects seen in naturally aged banners could have been caused from the moment of application as part of the technique (i.e. mottled appearance of the silver leaf, wrinkling and detachment of silver leaf, textured leaf in patching areas). Surprisingly, the drying of the ground under the squared leaf flattened significantly the distortion caused by cusping (seems to stretch similarly to a paper facing in painting conservation). Conditions of application: 23° C, 52% RH Date: 21/09/20. Time: 2:30 pm.

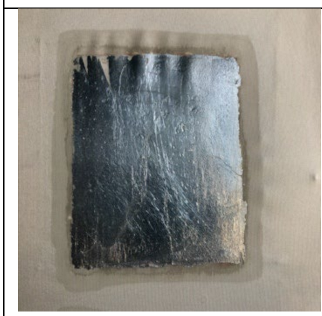
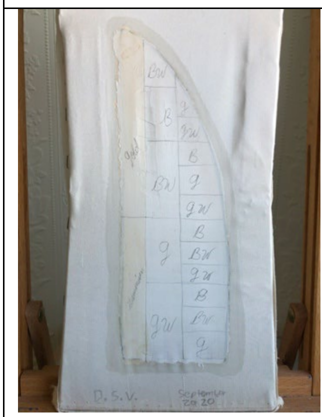
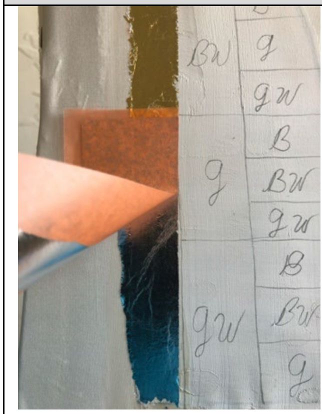
Table IV.13 Application of metal leaves on *Reconstruction 2*, side B	
Photographic record	Description and experimental conditions
	The transfer aluminium leaf was applied directly from the greased paper without cutting to shape, which immediately made it harder to release from the paper. Although the ground had left to dry for an hour like side A, aluminium leaf was at least twice the thickness of the silver one and the tackiness of the ground seemed not enough to pulled it off. It was required to use the cotton wool to hold it down while the paper was being peeled off. It developed a multitude of wrinkles not seen during the application of sliver leaf. Furthermore, the leaf was already wrinkled from the soft packaging for shipping. Conditions of application: 19° C, 45% RH Date: 30/09/20. Time: 1:00 pm.
	A fingerprint was intentionally pressed over the freshly laid out leaf to see if it reproduced the effect seen in Kenning's banners. However, no deformation was registered. Most of the excess leaf had to be left in place, as the cotton wool was not enough to remove it and trying to pull it oof ended up peeling the leaf. Additionally, the previous wrinkles and cracks of the aluminium leaf allowed the surpassing of the wet ground, smearing it over the leaf while passing the cotton wool over the surface. This is a sign that the leaf was laid out before time, as probably waiting for the recommended 12 hours by Kelly would have had a better bond. Conditions of application: 19° C, 45% RH Date: 30/09/20.
	Although aluminium does not tarnish like silver, Kelly still suggested the coating with diluted size, so the same 5% rabbit skin glue size was laid over hot (70° C) with the same camel-hair brush. However, this time the formation of a homogeneous coating was more difficult to achieve as the surface was greasy due to the surpassing of the wet ground and the surface dust. This caused the formation of islands while wet that diminished after drying, although still visible as accumulation spots. This showed the importance of applying the layer right after adhering the leaf, as recommended by Kelly (1901). A strip on the right side was left uncoated for comparison. Conditions of application: 19° C, 45% RH Date: 30/09/20.
	A fingerprint was intentionally left over the fresh ground during tacking-point testing (using cling-film as interface for safety), located in the upper part of the gilding area. Over the dried-to-touch ground a thin layer of Japan Oil Gold Size was applied with a rounded synthetic-hair brush to test the other type of metal leaf adhesion. This time the brush was clean, thus leaving the actual appearance of the gold size. Conditions of application: 19° C, 45% RH Date: 2/10/20. Time: 1:30 pm.

Table IV.13 (continued) Application of metal leaves on *Reconstruction 2*, side B	
Photographic record	Description and experimental conditions
	After an hour of drying the metal leaves were applied, although it seemed as if the gold size was drier than the side A example and not as tacky. Nevertheless, both leaves were easily adhered, even better than the side A example, which suggests that a longer drying time as indicated (3 hours) might be indeed more adequate (less wrinkling caused by the wet surface). The wrinkles in the aluminium leaf were from packing/shipping. Both leaves were left very smooth and even resembled metallic paints. Conditions of application: 19° C, 45% RH Date: 2/10/20. Time: 2:30 pm.
	After gilding the fingerprint was revealed, suggesting that the fingerprints seen on Kenning's banners were likely formed while checking the tacking point of the ground before gilding. Fingerprint deformations were not produced while pushing the metal leaf into place (if anything they leave a proteinaceous and greasy material that can tarnish the metal leaf if it is prone to like silver). As the surface remained clean of cotton fibres, the patching was done without any problem over the exposed and still partly tacky areas with gold size.
	The metal leaf laid out directly over the ground better reveals the weave of the fabric, whilst the metal leaf laid out over the gold size better resembles a metallic paint; it dries over the brushstroke left with the application of gold size, thus acquiring its texture. The overly wrinkled leaf of the squared section flattened after the full drying of the ground (to touch). Some of the perimetral excesses were removed with cotton wool and others remained adhered to the textile, even without having any adhesive. These were not possible to be removed. It is better to previously cut the metal leaf to the exact dimensions of the area (lesser waste, easier handling, better adherence, fastest production). Conditions of application: 19° C, 45% RH Date: 2/10/20. Time: 2:40 pm.
*Temperature and relative humidity at the TAH were measured with an analogue thermohydrometer. ** Temperature and relative humidity at home during COVID lockdown were measured with a digital thermohydrometer of the brand RadioShack.	

9.4.2.5 IV.2.5 Paint layers

9.4.2.5.1 IV.2.5.1 Materials

Four tubes of commercially produced oil paint of the brand Michael Harding were purchased for *Reconstruction 2* in four different colours: yellow ochre, Indian red, ultramarine blue (synthetic), and *terre verte*. Besides the last pigment, the other three were selected for having been identified in the five Kenning banners of Glasgow Museums Collection. The green *terre verte* was selected as a cheaper substitute for chrome green, which was also identified in one of the banners and available in the same brand but was too expensive to purchase. A further tube of lead white from the same manufacturer was supplied by Dr Christina Young (Figure IV.6). Each of the colours was applied in two ways: straight form the tube and mixed with the lead white paint in a 1:1 ratio (Figures IV.7 and IV.8).

Figure IV.6 Michael Harding paints used for *Reconstruction 2*.

a) b)

Figure IV.7 Side A paint mixtures from the tube; a) yellow ochre with lead white, b) Indian red with lead white.

Figure IV.8 Side B paint mixtures; ultramarine blue with lead white and green earth with lead white.

9.4.2.5.2 IV.2.5.2 Process

Table IV.14 Application of paint layers on *Reconstruction 2*, side A	
Photographic record	Description and experimental conditions
	A layer of red and ochre colour was applied directly from the tube with a "cat's tongue" synthetic-hair brush, trying to achieve a homogeneous layer throughout the designated areas with a single brush application. Both paints were very smooth to apply, needing very little paint to cover the surface, achieving a neat line around the border. Equal parts of each paint and lead white were mixed in the palette with a spatula and immediately applied in the same manner on their designated areas. The lead white-paints felt even "creamier" or "butterier" and their handling/covering properties improved even more. This coincided with Carlyle's team observations (Bonaduce 2011). Conditions of application: 23° C, 52% RH Date: 21/09/20. Time: 4:20 pm.
	As mentioned by Townsend (2020), paint applied straight from the tube leaves an evident brushstroke, just as seen in the five research banners. Some translucency was seen in the ochre paint, but a full covering power was seen in the remaining colours. The mixture of Indian red and lead white felt comparably "drier" to handle than the other three colours, but still no dilution was needed for spreading it evenly. Conditions of application: 23° C, 52% RH Date: 21/09/20. Time: 4:20 pm.
	A second layer of each colour was subsequently applied onto the designated areas, once the first layer was dried to touch. The paint texture "from the tube" allowed a very smooth paint application and required very little to form a covering coating, particularly in the lead white mixtures. This was aided by the smoothness and non-absorbance of the subjacent layers (paint, ground, sized silk), which facilitated the achievement of a very thin and continuous layer of paint in each case. Conditions of application: 21° C, 43% RH Date: 25/09/20. Time: 11:40 am.
	Seems that the possibility of laying very thin layers of paint due to the lack of absorbance and smoothness of the surface, is one of the big achievements of banner's technique. This economises the materials needed and speed up the production due to the fastest drying of thinner layers in comparison to thicker *impasti* (Christina Young commented that Mike Harding paints took weeks to dry as they lack of additives, yet the tests dried to touch in less than a week). The latter is even more so having lead-white in the mixture. Ochre over ochre took one day more to dry than ochre over lead-white, showing the role of the subjacent layer in the speed or delay in drying. Conditions of application: 21° C, 43% RH Date: 25/09/20.

Table IV.15 Drying monitoring of paint layers of *Reconstruction 2*, side A		
Date/Time	Temperature /Relative Humidity	Comments
22/09/20/11:30 am	21° C, 45% RH	All four colours of the first layer remain wet, with ochre+lead white being the driest (it even feels tacky, but much paint comes off) and red being the wettest.
23/09/20/12:00 pm	21° C, 45% RH	The lead-white mixtures are starting to feel dry to touch, with red+lead white being the driest (still some paint comes off). Both single mixtures remain equally wet.
24/09/20/12:00 pm	21° C, 45% RH	Both lead-white mixtures feel dry to touch. Ochre feels slightly wet (some paint comes off) and red is almost dry to touch (only a little paint comes off).
25/09/20/11:00 am	21° C, 43% RH	All four paints are dried to touch. TOTAL DRYING TIME: 4 days
26/09/20/1:00 pm	21° C, 43% RH	All four colours of the second layer remain wet, although the lead-white mixtures are both tacky (red+lead white has less paint coming off than ochre+lead white). Ochre feels wetter than red.
27/09/20/12:00 pm	21° C, 45% RH	Both lead-white mixtures are dried to touch. Both ochre and red feel equally wet.
28/09/20/11:00 am	21° C, 45% RH	Both lead-white mixtures are dry, ochre is still wet, and red has gone tacky.
29/09/20/11:00 am	21° C, 45% RH	All colours but ochre are dried to touch. Ochre feels tacky and lots of paint comes off while testing).
30/09/20/12:00 pm	21° C, 45% RH	All four paints are dried to touch. TOTAL DRYING TIME: 5 days
*Temperature and relative humidity at the TAH were measured with an analogue thermohydrometer. ** Temperature and relative humidity at home during COVID lockdown were measured with a digital thermohydrometer of the brand RadioShack.		

Table IV.16 Application of paint layers on *Reconstruction 2*, side B

Photographic record	Description and experimental conditions
	A layer of blue and green colour was applied directly from the tube with a “cat’s tongue” synthetic-hair brush, trying to achieve a homogeneous layer throughout the designated areas with a single brush application. The blue paint was very smooth to apply, needing very little paint to cover the surface, achieving a neat line around the border. The colour appeared translucent in the thinner areas. Contrarily, green earth paint was hard to spread evenly as it lacked unctuosity (felt like dragging clay). It is too translucent and unable to form a homogeneous layer, therefore is not deemed fit for banner paint (the colour was only selected for resembling some of the greens in the research banners, but clearly is highly unlikely to have been used). Conditions of application: 19° C, 45% RH Date: 02/10/20. Time: 4:40 pm.
	Equal parts of each paint and lead white were mixed in the palette with a spatula and immediately applied in the same manner on their designated areas. The lead white-paints felt even “creamier” or “butterier” and their handling/covering properties improved in both cases. This coincided with Carlyle’s team observations (Bonaduce 2011) and the side A paints. Conditions of application: 19° C, 45% RH Date: 02/10/20. Time: 4:40 pm.
	A second layer of each colour was subsequently applied onto the designated areas, once the first layer was dried to touch. The paint texture “from the tube” allowed a very smooth paint application and required very little to form a covering coating, particularly in the lead white mixtures. This was aided by the smoothness and non-absorbance of the subjacent layers (paint, ground, sized silk), which facilitated the achievement of a very thin and continuous layer of paint in each case. Conditions of application: 22° C, 50% RH Date: 06/10/20. Time: 11:30 pm.
	After applying these second layers it was noticed that not all paints are suitable for banner painting. They need to be able to apply smoothly, preferably in one coat and fluidly, for achieving neat lines and thin coats with a single brushstroke (this also applies for sign painting). They also need to have a good covering power. Although not intentionally, having selected green earth for the tests provided a good comparison of a non-suitable paint for banner painting, resulting translucent and non-spreadable/extendable. All lead-white mixtures worked perfectly well in comparison. Conditions of application: 22° C, 50% RH Date: 06/10/20. Time: 11:30 pm.

Table IV.17 Drying monitoring of paint layers of *Reconstruction 2*, side B		
Date/Time	Temperature /Relative Humidity	Comments
03/10/20/11:00 am	22° C, 50% RH	Both lead-white mixtures are almost dried to touch with just a little paint coming off and feeling tacky. The other two paints remain wet although the green earth feels more like a clay than a paint layer.
5/10/20/3:30 pm	22° C, 50% RH	All paints but blue ultramarine feel dried to touch. That last one feels tacky and has some paint coming off during testing.
6/10/20/11:00 am	22° C, 50% RH	All paints of first layer are dried to touch. TOTAL DRYING TIME: 4 days.
6/10/20/4:00 pm	22° C, 50% RH	Blue+lead white mixture feels tacky and almost dried to touch (little paint comes off while testing). The remaining paints are wet.
7/10/20/11:00 am	22° C, 50% RH	All lead white mixtures feel dried to touch. The remaining paints still feel wet although blue over blue+lead white feels drier.
8/10/20/10:30 am	20° C, 50% RH	Green over blue feels tacky (no paint coming off); blue over green+lead white feels wet; blue over blue+lead white feels wetter.
9/10/20/11:00 am	20° C, 50% RH	All but blue over blue+lead white feel dried to touch.
10/10/20/11:00 am	20° C, 50% RH	All paints feel dried to touch. TOTAL DRYING TIME: 4 days.
*Temperature and relative humidity at home during COVID lockdown were measured with a digital thermohydrometer of the brand RadioShack.		

9.4.2.6 IV.2.6 Glazes and lettering

9.4.2.6.1 IV.2.6.1 Materials

Two sets of dry pigments were supplied by the TAH laboratory for recreating the glazes and lettering paint seen in the five Kenning banners of Glasgow Museums Collection: two reds, alum-tin based madder lake (made by TAH student Clara Gonzalez in 2019 from a nineteenth century recipe) and alizarin crimson (Kremer Pigmente), plus two blacks, ivory black (L. Cornelissen & Son, London) and lamp black (pigment PBK 7.77266/47250, TAH pigment collection) (Figures IV.10 and IV.11). These materials were selected from the sign painting sources included in Table IV.24 at the end of this appendix. Madder lake was chosen based on the EDX results of sample TS08 (see Chapter 6 section 6.6.5), as well as its characteristic hue, transparency and fluorescence colour that was seen in all the inspected Kenning banners with a red glaze. Alizarin was selected for comparison. Additionally, yellow ochre of the brand Michael Harding was selected to imitate the yellow glazes seen in the five Glasgow Museums Collection banners.

Figure IV.10 Pigments and binder for glazes and lettering of side A; madder lake and Japan gold-size, ivory black and Japan gold-size, Michael Harding's yellow ochre.

a) 

b)

Figure IV.11 Pigments and binder for glazes and lettering of side B; a) alizarin and Japan gold-size, b) lamp black and Japan gold-size.

9.4.2.6.2 IV.2.6.2 Process

Table IV.18 Application of glazes and lettering on *Reconstruction 2*, side A

Photographic record	Description and experimental conditions
	A tip of spatula was mixed in with 0.4 ml of Japan oil gold-size over a glass slide until integrate. The lake was easy to mix in the medium (only a little lumpy). The consistency achieved was that of honey, so it was deemed necessary to further dilute it for application. Genuine English rectified turpentine was used to wet a “cat’s tongue” synthetic-hair brush and dilute the glaze for application. Conditions of application: 21° C, 45% RH Date: 30/09/20. Time: 11:00 am.
	A volume equivalent to that of a tip of a spatula was squeezed from the ochre paint tube and mixed in with 0.4 ml of Japan oil gold-size until integrate. The mixture was easily accomplished but less viscous than the red glaze. Nevertheless, the brush was equally wet with rectified turpentine for application, to maintain the same variables in all three paints. Conditions of application: 21° C, 45% RH Date: 30/09/20. Time: 11:12 am.
	A tip of spatula was mixed in with 0.4 ml of Japan oil gold-size over a glass slide until integrate. The paint was easy to mix in the medium (only a little lumpy) with similar consistency as the red lake. It was similarly diluted in rectified turpentine. Conditions of application: 21° C, 45% RH Date: 30/09/20. Time: 11:29 am.
	The application of the red glaze in the size-isolated section was easy and smooth. The glaze adheres easily to the surface, achieving a homogeneous coating with a single brushstroke. This did not happen in the un-sized strip, where the application found it difficult to achieve a layer as the glaze tend to separate in lumps and did not seem to adhere to the metal leaf. The application of the yellow glaze was similar in both sized and un-sized sections. The mixture was too runny to apply and left a stringy appearance. The amount of paint was excessive to function as a glaze (too cloudy). This suggests that very little paint might have been used for such purpose, economising in the use of materials even further. The ivory black paint was easy and smooth to apply over the sized section, adhering immediately to the surface. Almost a single layer sufficed for total covering and the re-application did not remove the previous coating. The opposite happened in the un-sized strip as the paint did not adhered easily and left a stringy appearance. It required more than one coating to cover but the subsequent applications lifted the previous coat, making it less efficient.

Table IV.18 (continued) Application of glazes and lettering on *Reconstruction 2*, side A	
Photographic record	Description and experimental conditions
	Aspect of the silver leaf after application of the three types of paints. The red glaze and black paint resembled closely their equivalents on the three George Kenning banners. Conditions of application: 21° C, 45% RH Date: 30/09/20. Time: 11:40 am.

Table IV.19 Drying monitoring of glazes and letter of *Reconstruction 2*, side A		
Date/Time	Temperature /Relative Humidity	Comments
30/09/20/12:00 pm	21° C, 45% RH	Completely dried to touch after 1 hour.
30/09/20/12:15 pm	21° C, 45% RH	Still wet after 1 hour, slightly tacky with paint coming off.
30/09/20/12:30 pm	21° C, 45% RH	Completely dried to touch after 1 hour.
30/09/20/1:15 pm	21° C, 45% RH	All three paints are dried to touch. TOTAL DRYING TIME: 2 hours.
*Temperature and relative humidity at home during COVID lockdown were measured with a digital thermohydrometer of the brand RadioShack.		

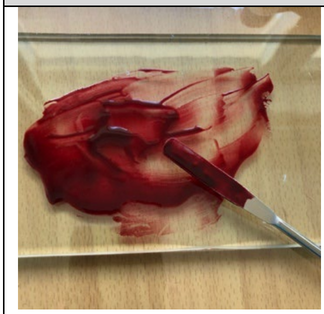
Table IV.20 Application of glazes and lettering on *Reconstruction 2*, side B	
Photographic record	Description and experimental conditions
	A tip of spatula was mixed in with 0.4 ml of Japan oil gold-size over a glass slide until integrate. The lake was similarly easy to mix as madder but less lumpy. The consistency achieved was that of runny honey, but it was still thinned with English rectified turpentine to compare with the madder lake. A “cat’s tongue” synthetic-hair brush was wet with the solvent and used for diluting the glaze prior application. Conditions of application: 20° C, 50% RH Date: 07/10/20. Time: 11:00 am.

Table IV.20 (continued) Application of glazes and lettering on *Reconstruction 2*, side B

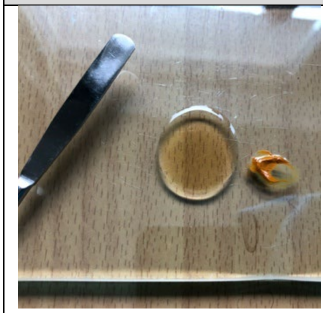
Photographic record	Description and experimental conditions
	Just a dash of ochre paint was mixed into 0.4 ml of Japan oil gold-size for trying to produce a translucent glaze. However, the resulting mixture still looked cloudy, so it is likely that a lake pigment or even colorant could have been added to the original yellow glazes (turmeric is repeatedly recommended in the sign painting sources reviewed). The mixture was too runny to be further diluted with turpentine, so it was applied without wetting the brush. Conditions of application: 20° C, 50% RH Date: 07/10/20. Time: 11:10 am.
	A tip of spatula was mixed in with 0.4 ml of Japan oil gold-size over a glass slide until integrate. The paint was the easiest to mix in the medium (particles wetted immediately), achieving a smooth and unctuous consistency. It did not need dilution or previous wetting of the brush. Conditions of application: 20° C, 50% RH Date: 07/10/20. Time: 11:20 am.
	Alizarin glaze showed twice the covering power achieved with the madder glaze, immediately forming a homogeneous coating with a single brushstroke on the previously sized section. Similar problems of adhesion as madder lake were seen in the un-sized strip (much less retention of material on surface), requiring two layers to achieve a similar coating (but still looking thinner than on the sized section). Ochre glaze was similarly applied on both sized and un-sized sections of the metal leaf. Lamp black paint was harder to form a homogeneous coat than ivory black, requiring more than one brushstroke and maintaining a translucency and intense gloss. The paint on the un-sized side had the same problems of adhesion and left a stringy appearance.
	Aspect of the aluminium leaf after application of the three types of paints. The red glaze and black paint only resembled those on the *Scottish Tin Plate, Braziers and Sheet Metal Workers* banner by George Kenning & Son. Conditions of application: 20° C, 50% RH Date: 07/10/20. Time: 11:23 am.

Table IV.21 Drying monitoring of glazes and letter of *Reconstruction 2*, side B		
Date/Time	Temperature /Relative Humidity	Comments
07/10/20/12:00 pm	20° C, 50% RH	Alizarin lake is almost dry to touch after an hour (it felt tacky with no paint coming off).
07/10/20/12:15 pm	20° C, 50% RH	Ochre glaze felt tacky with no paint coming off, but it stripped a section of the metal leaf while testing.
07/10/20/12:30 pm	20° C, 50% RH	Lamp black paint felt tacky just as ochre but glossier.
07/10/20/1:30 pm	20° C, 50% RH	All three paints are dried to touch. The testing on the un-sized strip was less evident due to the much lesser amount of material in the coating (it dried faster in comparison). TOTAL DRYING TIME: 2 hours
*Temperature and relative humidity were measured with a digital thermohydrometer of the brand RadioShack.		

9.4.2.7 IV.2.7 Trimming

9.4.2.7.1 IV.2.7.1 Materials

Gutermann brand cotton thread (navy blue dyed) and a straight stainless-steel needle were used for the hand-sewing trimming of the banner. Silk thread was unfortunately unable to acquire at the time due to COVID-19 restrictions.

9.4.2.7.2 IV.2.7.2 Process

Table IV.22 Hand trimming of *Reconstruction 2*	
Photographic record	Description and experimental conditions
	The silk textile got detached from the strainer and squared up by cutting any irregular fabric along the warps or wefts until a whole yarn came out from each of the four sides. There were immediately some fabric distortions noticed after the stretching was released, associated to the perimetral excess sizing and the un-sized fabric of the surroundings. In the sized and decorated areas, the fabric remained de-crimped and flat as when it was stretched in the strainer. The remaining areas showed crimping and wavy distortions in comparison. The whole of the fabric changed in texture (became stiffer) and in its draping capacity, resembling the properties felt in the five research banners. Stretching does have an irreversible repercussion in the fabric: plastic deformation. Conditions of application: 20° C, 50% RH Date: 09/10/20. Time: 12:30 pm.

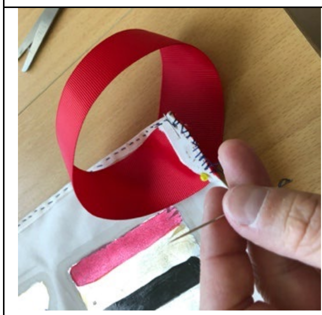
Table IV.22 (continued) Hand trimming of *Reconstruction 2*	
Photographic record	Description and experimental conditions
	On side A of the banner, the distortion appeared slightly convex in the decorated areas. This could be due to the shrinkage of the paint materials as they dry, pulling the fabric and applied materials from side B toward its center. In comparison, side B appeared slightly concave, possibly because it encompasses the shrinkage of side A that has been drying for the longest time. Conditions of application: 20° C, 50% RH Date: 09/10/20.
	Both left and right edges were folded towards side B similarly to the construction of Kenning's banners (only difference was that no hemming was done due to the scale of the reconstruction and limited amount of free/excessive fabric). Both edges were hand sewn with a running stitch, similarly to Kenning's banners. Conditions of application: 20° C, 50% RH Date: 09/10/20. Time: 1:30 pm.
	One end of a pre-cut grosgrain ribbon was tucked inside the upper edge of the banner on side B, whilst the other end was folded towards itself and aligned in the corresponding area on side A. The four layers of ribbon (two folded inside and two external) and the two layers of banner fabric (the folded edge and the other side) were pinned down with a sewing pin and sewn altogether with a whip stitch at the edge. Once secured, two rows of running stitches were added to the top and bottom of the hem on both sides for securing and flatting the loops. Hemming is required for preventing any fraying. The same was done for the opposite loop. Conditions of application: 20° C, 50% RH Date: 09/10/20. Time: 1:45 pm.
	The top row of running stitches were sewn first, keeping the lower edge of the loop pinned down with a sewing pin. Given the multiple layers of overlapped fabric the sewing was hard, but at the same time it added much strength and stability to the top edge. To save time and ease the process, the stitches were limited to the ribbon area. On the original banners, each row of stitches run along the top edge, securing every loop and the hemmed edge at the same time. This adds on the stability of the banner for hanging from the top pole. After the top edge was secured, the bottom edge followed, and then the same for the opposite loop. Conditions of application: 20° C, 50% RH Date: 09/10/20. Time: 2:06 pm.

Table IV.22 (continued) Hand trimming of *Reconstruction 2*

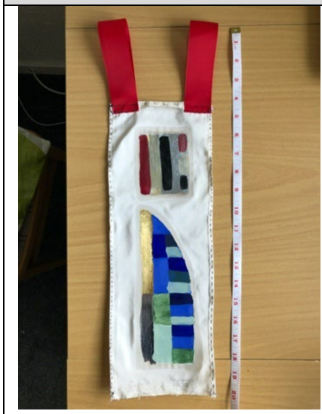
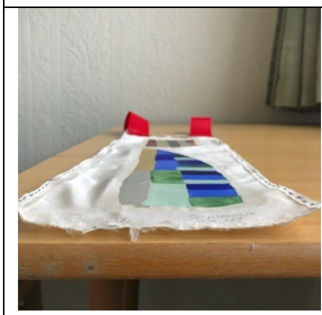
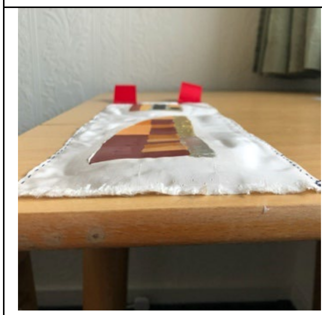
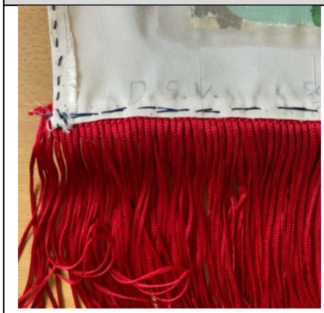
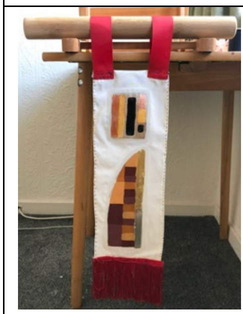
Photographic record	Description and experimental conditions
	The left, right and top edge of the reconstruction were folded and sewn towards side B (or back side as designated by the opposite side of the fringe attachment), similarly as the five research banners. The trimming gave the fabric a tactile structure, whilst adding to the apparent concavity of side B. It was perceived that the type of weave and orientation made it easy to sew straight, which might be the one of the reasons why it was selected by banner-making companies like Kenning's. Conditions of application: 20° C, 50% RH Date: 09/10/20. Time: 2:32 pm.
	Side A continued to look convex and the distortions surrounding the painted sections were also maintained. It is evident that the fabric elongated in the unpainted sections surpassing its elastic limit, thus incapable of returning to its initial state and deforming permanently. This was only appraised visually as no measurements or technical tests were conducted (i.e. tensile tester). For future reference it will be beneficial to conduct proper testing.
	Another view showing the perceived concavity of the whole. Conditions of application: 20° C, 50% RH Date: 09/10/20. Time: 2:35 pm.
	Side A showing the perceived convexity of the whole. Conditions of application: 20° C, 50% RH Date: 09/10/20.

Table IV.22 (continued) Hand trimming of *Reconstruction 2*	
Photographic record	Description and experimental conditions
	The bottom edge was folded to the opposite side similarly as the research banners. It was seen that this prevents the left and right-side edges from fraying, getting enclosed within the hemmed edge. As it was not possible to get a thick silk bullion fringe, a single synthetic fringe was folded onto itself three times to simulate the weight as close as possible. This fringe was sewn from side A using a basting stitch for swiftness. Conditions of application: 20° C, 50% RH Date: 09/10/20. Time: 3:00 pm.
	With all the trimming done, the reconstruction banner was hung from a wooden pole that had a similar width as those of the research banners (1 ½ inches). Conditions of application: 20° C, 50% RH Date: 09/10/20. Time: 3:05 pm.
	The weight of the fringe straightened the fabric, diminishing the distortion seen whilst unhanged. However, the concavity of side B and convexity of side A were still noticed. TOTAL SEWING TIME: 3 and a half hours.
*Temperature and relative humidity were measured with a digital thermohydrometer of the brand RadioShack.	

9.4.2.8 IV.2.8 Rolling, packing, and unrolling

9.4.2.8.1 IV.2.8.1 Materials

A wooden rolling pin with a similar width as the original banner poles (6cm) was used for rolling *Reconstruction 2*. A carboard box was adapted to the inner measurements of the original banner box of the Metal Workers banner (see Appendix I) and a Kraft paper was used as interface to prevent the adhesion of one side of the banner with the other whilst rolling.

9.4.2.8.2 IV.2.8.2 Process

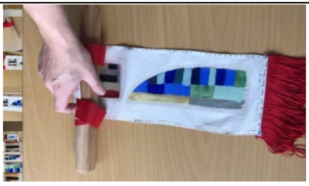
Table IV.23 Rolling, packing, and unrolling of *Reconstruction 2*

Photographic record	Description and experimental conditions
	Trials for determining which side was easier to roll were conducted on both sides. Due to the higher weight of the pole in comparison to the reconstruction, it was similarly easy to roll it onto one side than the other. Thus, it was decided to roll it with the side B (back side) facing inwards.
	To protect any possible self-adhesion onto side A, an interface of paper was laid on top of side B prior to rolling, following the recommendations of Tutill's label on his surviving banner boxes.
	The rolling was done encompassing the pole's girth but without further stretching of the fabric. Immediately some fabric distortions in the unpainted areas were noticed, similarly to those seen whilst rolling several banners of Glasgow Museums collection (including the 5 of the research). This shows that some of the distortions seen in old banners may have been originated from their making. It is unlikely that banners were completely flat.
	The fringe was kept aligned by holding it with the exceeding paper until complete covering.
	The rolled banner was inserted in an adapted carboard box to the similar dimensions of the surviving Kenning banner boxes. To try to simulate the inside of the original box, which would have contained the carrying poles, ropes, etc., two wooden strips were also added.

Table IV.23 (continued) Rolling, packing, and unrolling of *Reconstruction 2*	
Photographic record	Description and experimental conditions
	Opposite view of the above image showing the convex/concave distortion while hung.
	The banner also showed repetitive horizontal distortions about the same width as the pole, similarly to those seen in the five research banners caused by the tight rolling around the pole. There was some horizontal cracking perceived in the large area of Indian red paint as well as in both metal leaves (although slightly more acutely on the silver leaf).
	The silver leaf on side A showed horizontal cracks that were not seen before the rolling, thus caused by it. These cracks were more evident than those seen in the strip of the irregular shape, possibly for having more surface to oppose the force of the rolling. However, the cracks feel stable and there is no detachment coming from the ground nor the textile. Tarnishing was evident before the rolling, and it did not seem to increase afterwards. It is more evident in the uncoated strip where it looks iridescent and slightly bronze coloured. Both red and ochre glazes show discolouration (darkening), possibly caused by the oxidation of the medium. This was also noticed before the rolling. Black paint seemed unaffected.
	Side B showed in comparison much more cracks along the aluminium leaf strip. Although horizontal, the spacing between the cracks was very reduced giving the appearance of micro-cracking. The gold leaf showed much fewer cracks, and none were identified on any of the paints.
	The aluminium leaf on side B showed much more horizontal cracks than side A. These cracks were much more spaced than those on the aluminium strip of the mixed shape. The black paint also showed a different pattern of horizontal cracks, slightly similar to those seen in the lower strip but independent from the aluminium leaf cracks. Their borders of seem rounded thus is likely that the cracks are caused by fast drying of the medium. However, all cracks feel stable and there was no detachment seen from the ground nor the textile (only the previously reported in table x-drying of side B glazes). Both glazes seemed unaltered. It is evident that the materials got compressed after being rolled inwards. Interestingly, the reduced area of aluminium leaf showed finer and more abundant cracks than the large area. The thickness of the aluminium leaf might also be responsible for that, given that gold leaf had a more similar behaviour as side A and silver leaf seemed to behave similarly on both large and reduced areas.

Table IV.23 (continued) Rolling, packing, and unrolling of *Reconstruction 2*

Photographic record	Description and experimental conditions
	The box was closed and left unopened for 5 days, which was the maximum duration of a trip from London to anywhere in Europe in 1914 (Bartholomew 1914). To try to simulate the variation in conditions and movement (vibration) that would happen on a train to Glasgow, the box was left outside in a dry but ventilated place and shaken 4 times a day for 5 days (the box was carried up and down a staircase twice a day). Conditions of application: 20° C, 50% RH Date: 10/10/20. Conditions of application: 11° C, 94% RH Date: 12/10/20. Conditions of application: 12° C, 61% RH Date: 13/10/20. Conditions of application: 12° C, 83% RH Date: 14/10/20.
	The first thing noticed on the unpacking/unrolling day was the looseness of the wrapped reconstruction, caused by the repeated vibration of the whole. Conditions of application: 21° C, 45% RH Date: 15/10/20. Time: 11:35 am.
	The fringe was no longer aligned but compressed in itself.
	After unrolling the reconstruction, the overall appearance of the fabric was much more flattened than before packing. Yet differences in stiffness and distortions were seen in the decorated and undecorated areas.
	The rolling intensified the concave/convex distortion of the banner, much more evidently in the decorated areas. This suggests a permanent deformation in the painting materials.

Table IV.23 (continued) Rolling, packing, and unrolling of *Reconstruction 2*	
Photographic record	Description and experimental conditions
	Trials were conducted to stablish whether or not the initial rolling determined the subsequent. Indeed, trying to roll the banner in the opposite direction as it was first rolled proved to be more difficult. An opposing force was felt, similar to that felt when a paper sheet is rolled against the direction of its fibres. Thus, it was decided to roll on the initial direction.
 	The rolling on the initial direction was as smooth as expected, thus it is likely that the banners could have been rolled in the same way as they got delivered, thus causing one side (the compressed side) to deteriorate greater than the other over time.

9.4.3 IV.3 Historical sources reviewed for selecting the reconstructions' materials

Table IV.24 Sign painting sources reviewed for selecting the historically informed reconstructions' materials

Author	Title	Publication date	Publication place(s)	Materials suggested for:
S. Gibson	*Haney's manual of sign, carriage, and decorative painting; containing Rules and Regulations in Everything Relating to the Arts of Gilding, Painting, Varnishing, preparing Grounds, etc.; together with Rules for making Drying Oils, Japans , and Other Requisites of The Art; also a Treatise upon Contrast, Harmony and Force of Colors, Theory of Composition, Groundwork, Tints, Shades and Shadows, with full instructions in practical Fresco and Decorative Painting, also complete system of Carriage Painting, with numerous useful and Valuable Recipes, some of them never before given to the public, including the secrets of the celebrated Birmingham Japanners*	1870	New York	Size
				Shellac in alcohol and egg white for indoor or fast use only (p. 30)
				Ground layer
				Not mentioned
				Gold-size
				Thickened linseed oil slightly thinned afterwards with turpentine for application, or a mixture of old drying oil with yellow ochre and red lead (for gold leaf), or a quick drying size of copal varnish and old drying oil, or pure drying oil with gum animi (not copal) thinned with turpentine for use (p. 21-22) Japanner's gold size: gum animi, sugar of lead, clarified drying oil and turpentine (p.31)
				Black lettering paint
				Lamp black previously calcined to promote drying but prefers the use of ivory black (p. 10-11)
				Coloured glazes
				Copal, clarified drying linseed oil, sugar of lead (acetate) and turpentine, said to be very flexible (p. 31)

Table IV.24 (continued) Sign painting sources reviewed for selecting the historically informed reconstructions' materials

Author	Title	Publication date	Publication place(s)	Materials suggested for:
James Callingham	*Sign writing and glass embossing: a complete practical illustrated manual of the art, to which are added numerous alphabets*	1871	London and Philadelphia	**Size** Mentions the wet rubbing of the surface to be painted with a dark leather chamois to prevent the "cissing" of the paint (p. 144)
				Ground layer Considers the use of white lead bound in oil as useful to cover the ground and all the ordinary purposes of signwriting. For thinning the white lead paint (prepared in the consistency of a thick paste), the recommended vehicle is turpentine and some colourless varnish (copal for instance) in the proportion of 2/3 of turpentine per 1 of varnish. He doesn't recommend the thinning of paint with neither boiled oil nor gold-size (p. 130-31)
				Gold-size Gilders' size prepared with fat oil and ground yellow ochre. Japanners' gold-size (preferred by sign writers for speed) mixed with oil varnish or a few drops of boiled oil, never linseed oil, to regulate its speed (p. 167)
				Black lettering paint Ivory black ground in turpentine and diluted for use with turpentine, gold-size and a little varnish (a sufficient quantity of them both, or if it requires drying very quickly, only gold-size is added)/needs varnish on top as it dries dull (p.131) Vegetable black (preferred for ease of work and low price) is rubbed up with oil, added patent dryers and diluted for working with turpentine and a little varnish (doesn't need varnish on top). Neither pigment is mixed with quick drying diluents (alcohol) (p. 132)
				Coloured glazes Only used as glaze -that is a transparent varnish to lay over - purchased commercially ground in oil, thinned with turpentine and a small quantity of varnish (p. 134-35)

Table IV.24 (continued) Sign painting sources reviewed for selecting the historically informed reconstructions' materials

Author	Title	Publication date	Publication place(s)	Materials suggested for:
James T. Gardiner	*The Sign Painters Guide, or Hints and Helps to Sign Painting, Glass Gilding, Pearl Work, etc., containing also many valuable receipts and methods, and much general information in the various branches of the business*	1871	Cincinnati	Size
				Japan varnish (p. 39)
				Ground layer
				Mixture of boiled oil with lead white, with added turpentine and a little dryer (not specifying type) depending on the needs. It also gives indication on the times needed for drying between layers (24 hrs for the first coat, further 4 hours after sanding, 15 hours for second coat and 24 for the third coat/about 3 days to start painting) (p. 24)
				Gold-size
				Fat oil or boiled linseed oil that has become fat from heat and exposure, with finely ground yellow ochre or chrome yellow, thinned with turpentine for usage and added liquid dryer (drying oil) (p. 26)
				Black lettering paint
				Not only for black but for every kind of paint, unless otherwise indicated in the text: pure boiled linseed oil is the best in all circumstances for mixing colours for all purposes of Sign Painting. Japan drier may be added for drying purposes only, in the quantity required by the urgency of the work. A substitute for boiled oil is raw oil with a larger proportion of drier (patent driers specified in page 67), but it is not so good (p. 22)
				Coloured glazes
				Golden glaze: asphaltum varnish "nearer to the natural shade of gold than any other colour known" or raw and burnt sienna and lake (p. 28) Japan size as binder for glazes (p. 40)

Table IV.24 (continued) Sign painting sources reviewed for selecting the historically informed reconstructions' materials

Author	Title	Publication date	Publication place(s)	Materials suggested for:
W. C. Warren	*The House & Sign Painters Recipe Book, containing many valuable recipes and methods, and general information in the various branches of the trade*	1890	Indianapolis	Size
				Japan varnish or shellac varnish (p. 66) Thin glue size and 2-3 coats of lead white (p. 98)
				Ground layer
				Mixture of boiled oil with lead white, with added turpentine and a little dryer (not specifying type) depending on the needs (p. 75)
				Gold-size
				Ochre, copal varnish, raw linseed oil, turpentine, and boiled linseed oil, diluted with turpentine if needed (p.61) English Japan gold-size (p. 68)
				Black lettering paint
				Shellac dissolved in alcohol with camphor and lamp black (p. 100)
				Coloured glazes
				Shellac, sandarac, and alcohol with transparent colours/gold lacquer with copal varnish (turpentine) coloured with turmeric and baked in an oven (p. 73)

Table IV.24 (continued) Sign painting sources reviewed for selecting the historically informed reconstructions' materials

Author	Title	Publication date	Publication place(s)	Materials suggested for:
C. J. Allen, I.C.S.	*Elements of lettering and sign painting; prepared for students of The International Correspondence Schools, Scranton, Pa.*	1899	Pennsylvania	**Size**
				Ordinary shellac, or a mixture of clear asphaltum, Japan gold-size and turpentine (judged better than the shellac, especially for closed grained silks) (p. 33)
				Ground layer
				White lead, boiled oil, turpentine, Japan gold-size (p. 16)
				Gold-size
				Slow size: boiled linseed oil with added coachmakers' Japan and chrome yellow (for gold). Quick size: Japan gold-size with added boiled linseed oil. Medium-slow size: coach finishing varnish with coachmaker's Japan (p. 19) White oil size for silvering: light coach varnish, lead white, Japan gold-size and turpentine (p. 20)
				Black lettering paint
				Outlines made with hard-drying colours and recipe for flexible colour: any oil colour to which 1/5 beeswax has been added (p. 33)
				Coloured glazes
				Medium drying varnish diluted with turpentine and added colours: carmine in tube, well ground black, Prussian blue, etc. (p. 30-1) Colours should be mixed with naphtha to prevent them from spreading (p. 33)

Table IV.24 (continued) Sign painting sources reviewed for selecting the historically informed reconstructions' materials

Author	Title	Publication date	Publication place(s)	Materials suggested for:
Albanis Ashmun Kelly	*The Expert Sign Painter: a book of reference designed for the use of practical sign painters and letterers*	1911	Pennsylvania	Size
				Parchment size applied hot, first coat a little dilute, second coat as strong as it can be worked, leaving an outline of 1/4 inch larger than the motif (p. 107) Options for sizing: 1) thin clear size 2) size with Chinese white and a little glycerine 3) coat of flatting colour made of white lead, varnish, and turpentine. Other recommended sizes for banner work: gelatine size, coach Japan thinned with turpentine, egg size, Russian isinglass with alum, shellac varnish (p. 109-10)
				Ground layer
				For wood signs consists of white lead in oil (not boiled) thinned with raw oil and turpentine adding very little dryers (p. 68) For silk banners consists of coat of oil white lead, no turpentine, very thin and rubbed out (p. 107-8)
				Gold-size
				Composed of pure fat oil and white lead, nothing else, bodily laid in both sides of the banner, silver in 12 hours and immediately clear sized with weak parchment glue (p. 108)
				Black lettering paint
				Ivory drop black is the purest and deepest, demanding grinding with turpentine, gold size and a little varnish to bind it. Lamp black is more durable and should be previously calcined to remove its grease, also requires addition of dryers, mixed with benzine or turpentine, raw oil added gradually (p. 57-8) Fast drying paint for muslin work: pigments bound in Japan or furniture varnish (p. 97)
				Coloured glazes
				Scroll must be varnished after gilding for shading and tube colours must be used: burnt sienna, asphaltum, gamboge, yellow lake, Dutch pink, verdigris, carmine, Vandyke brown and orpiment (p. 36) Pure crimson lake for red glaze (p. 59) Glazes bounded in Venice turpentine and turpentine (p. 60)

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