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PNEUMOCONIOSIS OF COAL-MINERS IN SCOTLAND

Thesis for the Degree of Doctor of Medicine

presented by

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CONTENTS

INTRODUCTION

The purpose of this thesis is to present a comprehensive review of pneumoconiosis of coal-miners in Scotland at the present time. As will appear in the historical review, much of the early investigation into the subject of occupational diseases of the lungs in coal-miners was carried out in Scotland during the nineteenth century and was extensively discussed in contributions to medical journals at that time. Since then, however, information on the occurrence of pneumoconiosis in coal-miners in the British Coalfields has been scanty and incomplete in areas other than South Wales where, owing to the great prevalence of pulmonary disability in colliery workers, considerable research into the various aspects of the disease has been carried out in recent years. These investigations have been undertaken by the Medical Research Council, pathological departments in South Wales and members of the Silicosis Medical Boards as well as by others interested in the problem.

It was this lack of recorded information about the disease in the Scottish Coalfields which prompted the present study, the basis of which is data derived from the records of the Pneumoconiosis Medical Panel (previously the Medical Board for Silicosis and Asbestosis) covering that area. The records were compiled from examinations of persons claiming benefit in respect of disability due to pneumoconiosis contracted in coal-

mines. The cases, which are the subject of study, are men examined during the six years 1944-1949.

The work has been completed by me during the last four years while I have been a full-time member of the Pneumoconiosis Medical Panel for the Scottish area. Previous to that I was similarly engaged in the South Wales area at the Swansea centre.

It will be noted that in the discussion of the age distribution of pneumoconiosis the age groups selected are specified as 31-40, 41-50 and so on as opposed to the age grouping normally employed by the Registrar-General in official Reports. This choice of age groups is not made because of any inherent advantage but merely because these groupings are used by various authors, (e.g.) Fletcher (1948), McVittie (1949) and Jenkins (1949) in regard to South Wales, and with whose findings comparison may be required.

It is not claimed that this investigation represents a complete or exhaustive survey of coal-miners' pneumoconiosis in Scotland, for this is not possible by an individual in such a complex and many-sided problem involving engineering, sociological, economic, and medical considerations. Rather it is put forward as a beginning to indicate the nature of the problem of pneumoconiosis of coal-miners in the Scottish Coalfields as revealed by applications and certifications in respect of the disease. Even

so, it is hoped that it will provide a body of authoritative facts concerning the general problem of the disease in another area besides South Wales.

ACKNOWLEDGMENTS

I wish to record my sincere gratitude to all my colleagues and friends who have assisted me in any way during the course of this work and particularly to

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CHAPTER I

HISTORICAL REVIEW

It is not intended here to present a detailed review of the literature on chronic pulmonary diseases in coal-miners, but rather to emphasise the important contributions to the subject, which have been made by Scottish physicians and surgeons.

Commencing with Hippocrates medical writers have frequently recorded that miners as a class are peculiarly liable to suffer from chest diseases. In the main these allusions are indefinite and probably relate to workmen engaged in metal mines (Collis, 1915). Early in the 19th century, however, French pathologists directed attention to black discolouration of the lungs observed at necropsy and to this they attached the name melanosis of the lungs. Among them considerable discussion arose as to the origin of this pigmentation and various hypothesis were advanced. No specific mention of work in coal-mines as a possible cause of some cases was made until Dr.J.C.Gregory of Edinburgh (1831) published a paper entitled, "Case of peculiar Black Infiltration of the whole Lungs resembling Melanosis".

Gregory wrote: "I am inclined to publish the following case, partly because I have not hitherto met with the record of any other similar affection; and partly with the view of

calling the attention of those practitioners who reside in the vicinity of the great coal-mines, and who may have charge of the health of the miners, to the existence of a disease, to which that numerous class of the community would appear to be particularly exposed". He then described the case of a man, John Hogg, who, after serving as a regular soldier, worked for ten or twelve years in collieries in the Dalkeith district. This man had been unable to work for about sixteen months before admission to hospital on account of chest symptoms. His condition gradually deteriorated and after several weeks in hospital death resulted from progressive heart failure.

A post-mortem examination was carried out and following a detailed description of the appearances observed in the lungs, Gregory discussed whether the pathological condition observed should be considered as "a case of infiltration of the substance of the lungs by the peculiar matter of melanosis? - or whether the black colour of those organs depended mainly upon the habitual inhalation of a quantity of the coal dust with which the atmosphere of a coal-mine must be constantly charged, and which remaining unabsorbed and acting as a foreign body, had led ultimately to disintegration of the pulmonary tissue? - in like manner as one form of phthisis is found to

be particularly prevalent among those who by their occupations are most exposed to the inhalation of small irritating particles such as stone cutters, millers and needle grinders". He concluded that the second interpretation was the more probable, (i.e.) that the pigmentation resulted from the inhalation of coal dust. Washings of the lungs were examined by Dr.Christison who found that the black matter differed greatly in its chemical composition from the matter of melanosis,and indicated that the black pigment was probably coal.

Three years later Dr.William Marshall (1833) of Cambuslang, near Glasgow, recorded the cases of three miners aged 58, 62 and 57, who had been employed in collieries since boyhood, and who suffered from chest symptoms which they themselves attributed to bad air in the mines. During the latter part of their illness the first two had expectorated black sputum. Necropsy was performed in all three cases, and reference was made also to two others seen in 1825 and 1827 who showed similar symptoms during life but in which no post-mortem examination was carried out. Marshall described four pathological stages and expressed the opinion that the disease in collieries was caused by the inhalation of fine coal dust and its deposition in the lungs, especially if the bronchial tubes or the lungs were previously diseased. He suggested that hard dry seams with much pick work favoured the development of the disease and felt that

there was an individual predisposition.

A letter critical of Dr.Marshall's observations appeared in the Lancet from Matthew Gibson, surgeon of Govan Haugh, Glasgow (1833) who considered that Marshall's cases were "pure simple, everyday phthisis". Gibson also averred that black expectoration was not a disease but, on the contrary, very common in coal-miners. In support of this he cited two cases of coal-miners who, although they had no chest symptoms during life showed similar appearances of the lungs at necropsy following accidental death, and a third case of a miner seventy years of age who expectorated black matter when he had influenza but otherwise gave no indication of the symptoms described by Marshall.

Mr.Thomas Graham, Lecturer in Chemistry, Anderson's Institution, Glasgow (1834), and Dr.William Craig (1834) after examination of specimens of lungs sent to them supported the view that the condition found in the lungs resulted from the inhalation of foreign matter. Craig further stated, "I believe that in all extreme cases which have occurred in colliers and moulders there must have existed some previous disease of the lungs which prevented the foreign substance from being thrown off – May not a tuberculous or excavated state of the lung favour the retention of black matter? – It is only in the case of colliers, moulders or others who inhale large quantities of

black matter that the lungs are rendered perfectly solid".

Interesting contributions by Dr.William Thomson of Edinburgh (1837,1838) appeared in the Medico-Chirurgical Transactions, London. In these are described a number of fatal pulmonary cases from Scottish coal-mines and, in addition, the views of doctors practising in various coal-mining localities, which had been obtained as the result of a questionnaire prepared by his father, John Thomson. Reports, including necropsy findings, are given of nine Scottish coal-miners who had shown symptoms of pulmonary affection during life,and of six other cases with no definite symptoms, as well as some cases with "black spit" during life, but in whom no post-mortem examination had been performed. The replies from the doctors indicated that pulmonary consumption and black spit were very common among persons employed in coal-mines. The opinion seemed to be that lung disease was more common in those engaged in stone work in the coal-mines particularly when gunpowder was employed for blasting.

Although Thomson's contribution appeared in 1837, it is apparent that his interest in the subject had been aroused in 1824 when he had seen a specimen of lung removed from the body of a man at Edinburgh Royal Infirmary. The occupation of this particular case was not given. Then in 1826 he and his brother Allen Thomson carried out a post-mortem examination on a miner

from Tranent. Thomson's article is probably the earliest example of a survey into the question of pulmonary disease among coal-miners.

Thomas Stratton (1838) recorded the clinical history and necropsy findings in a coal-miner and suggested the name "anthracosis" for the condition of the lungs resulting from the inhalation of coal dust.

Evidence was given by medical witnesses to the Commission on Mines in 1842 to the effect that "Spurious Melanosis" or "Black Spit" was fairly prevalent among workers in Scottish coal-mines at that time. As a result of the investigations of this Commission Lord Ashley introduced a Bill in 1842, one of the main objects of which was improvement of working conditions in coal-mines. MacKellar (1845) dealing with lung disease in coal-miners regretted" that his Lordship did not embody in his measure provisions enforcing the free ventilation of mines under government inspection for nothing would tend more to improve the health of those employed in them".

Further Scottish contributions to the literature were made by Calder (1851), J.B.Thomson (1858) and Sanders (1864). Warburton Begbie (1866) wrote that "the disease now threatens to become rare in its occurrence; there are indeed indications of its happily altogether disappearing", while Dr.William Sneddon of Beith (1875) expressed a similar opinion. They

were supported in this view by Dr.W.T. (later Sir William) Gairdner (1876), Professor of Medicine at Glasgow University who, speaking at the Forty-Fourth Annual Meeting of the British Medical Association at Sheffield, said that he had been unable to obtain sufficient information on the subject and this he ascribed to the fact that this special form of pathological lesion had so much diminished of late years, in consequence of improved sanitary precautions, as to be almost quite extinct.

It is apparent from the foregoing that occupational pulmonary disease of coal-miners was prevalent in the Scottish Coalfields in the first half of the nineteenth century. The disease was variously designated Spurious Melanosis, Phthisis Melanotica, Black Phthisis, Black Spit, Anthracosis, Coal-Miners' Phthisis and Carbonaceous Lungs and attributed by different authors to the inhalation of soot, lamp black, gunpowder or coal dust. Following the improved working conditions in the coal-mines after Lord Ashley's Bill of 1842 the disease would seem to have become much less common.

This diminished prevalence of the disease among coal-miners throughout Great Britain was apparently sufficiently remarkable as to warrant record by such acknowledged experts as Oliver (1908), Shufflebotham (1914) and Collis (1915).

Since about 1930, however, pneumoconiosis of coal-miners has constituted a major medical and social problem in Great Britain, particularly in South Wales, from which area practically all the recent literature on the subject in this country has emanated. The only contribution on recent experience of the disease in Scotland would seem to be the article by Dr.Moore Hall (1937) of Shotts, Lanarkshire, in which he discussed chronic pulmonary disease in a series of sixty-four coal-miners observed by him in this area.

CHAPTER II

DESCRIPTION OF THE SCOTTISH COALFIELDS

It is now generally accepted that pneumoconiosis in coal-miners is due to the inhalation of respirable airborne dust arising from the various processes of development, winning of coal, repairing, conveying and the handling of coal and related minerals, whether these operations are carried out underground or on the surface. This mine dust is a highly complex mixture of minerals derived from the disintegration of the coal itself and the strata in which it occurs. As these minerals are not uniform in composition throughout the coal-measures of Great Britain the miners in different areas and even in individual coal-pits are exposed to the inhalation of dust of varying composition. This fact in itself may have an important bearing on the incidence and type of pneumoconiosis, both in the individual workman and in the group, and in individual collieries and coalfields. As these matters so far as they appertain to the Scottish coalfields are the subject of study and discussion in this thesis it is necessary at this stage to present a brief general description of the geographical and geological features of the area. The facts, in the main, have been derived from the Report of the Scottish Coalfields Committee (1944).

Practically all the workable coals in Scotland occur in the Carboniferous Formation within an area known as the Midland

Valley (Central Scotland) and in the Sanquhar-Kirkconnel Basin in Dumfriesshire. In addition small areas of workable coals are found at Machrihanish, in the Canonbie district on the Solway Firth, and at Brora in Sutherlandshire, but as no cases of pneumoconiosis from these isolated areas have arisen in the present series they can be dismissed from further consideration.

For the present purpose the coalfields of Scotland have been grouped into certain broad divisions slightly modified from the Coalfields Report. These divisions are as follows and the letters accorded to them and to the sub-divisions later defined will be used in all subsequent references.

A. The Central Coalfield - comprising the broad Lanarkshire Basin, the Douglas Valley Coalfield and the North-East Stirlingshire Coalfield.

B. The Fife and Clackmannan Coalfield.

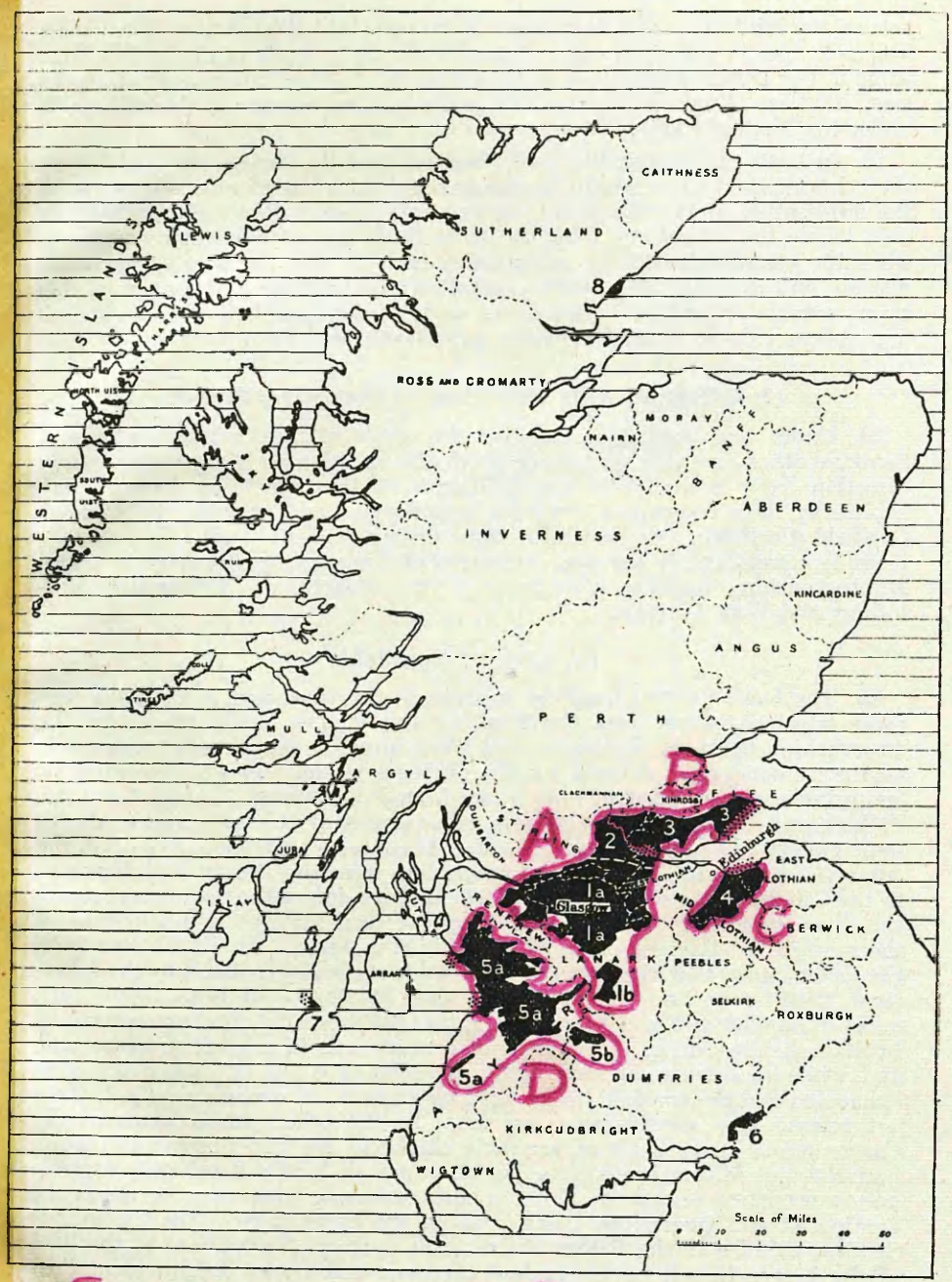
C. The Lothians Coalfield - Mid and East Lothian.

D. The Ayrshire Coalfield - including the Sanquhar-Kirkconnel Basin in Dumfriesshire.

These four main divisions, and their subdivisions into districts referred to below, have been so defined as they are natural geographical units of reasonable size and conform closely to the arrangement in the Scottish Coalfields Report. The coalfields and their subdivision into areas are as now described and illustrated by the accompanying maps which have been ex-

tracted from the Coalfields Report. All boundaries and symbols as used by us are inscribed in red ink.

(Map overleaf)



A.	1a	Central Coalfield	D.	5a	Ayrshire Coalfields
	1b	Douglas Valley		5b	Sanquhar Coalfield
	2	North-East Stirlingshire Coalfield		6	Canonbie Coalfield
B.	3	Fife and Clackmannan Coalfields		7	Machrihanish Coalfield
C.	4	Lothians Coalfield		8	Brora Coalfield

(Undersea Extensions shown thus ⟨)

FIG. 1.—INDEX MAP TO SHOW DISTRIBUTION OF SCOTTISH COALFIELDS

A. THE CENTRAL COALFIELD

This includes all the coal workings in Lanarkshire, Renfrewshire, Dunbartonshire and Stirlingshire with the resources of West Lothian and the west part of Midlothian. The main part of this coal area extends from Barrhead near Glasgow in the west to Bathgate and Wilsontown in the east, and from Stirlingshire in the north to Auchenheath in the south.

In the Coalfields Report the N.E.Stirlingshire coalfield is separately designated, but as it appears to represent an extension of the Lanarkshire basin and as persons employed in collieries in the neighbourhood of the arbitrary dividing line through Bonnybridge and Falkirk would be difficult to place satisfactorily, it has been included here in the Central Coalfield.

The Douglas Coalfield is separate lying in South Lanarkshire to the south of Lesmahagow and comprises the coal measures in the region of Douglas, Douglas Water and Coalburn.

For the purpose of this survey the Central Coalfield has been further sub-divided into four areas as follows.

A 1. The Northern Part covering the following districts - Cadder, Chryston, Kilsyth, Twechar, Falkirk, Denny, Larbert, Stirling, Bannockburn and Bo'ness.

A 2. The Central Lanarkshire area - Airdrie, Coatbridge, Bellshill, Cambuslang, Uddingston, Hamilton, Motherwell and Wishaw, and Larkhall districts - and the Douglas district.

A 3. Shotts and Wilsontown area.

A 4. West Lothian (and West Midlothian) area - Bathgate, Armadale, and Whitburn districts.

(Maps overleaf)

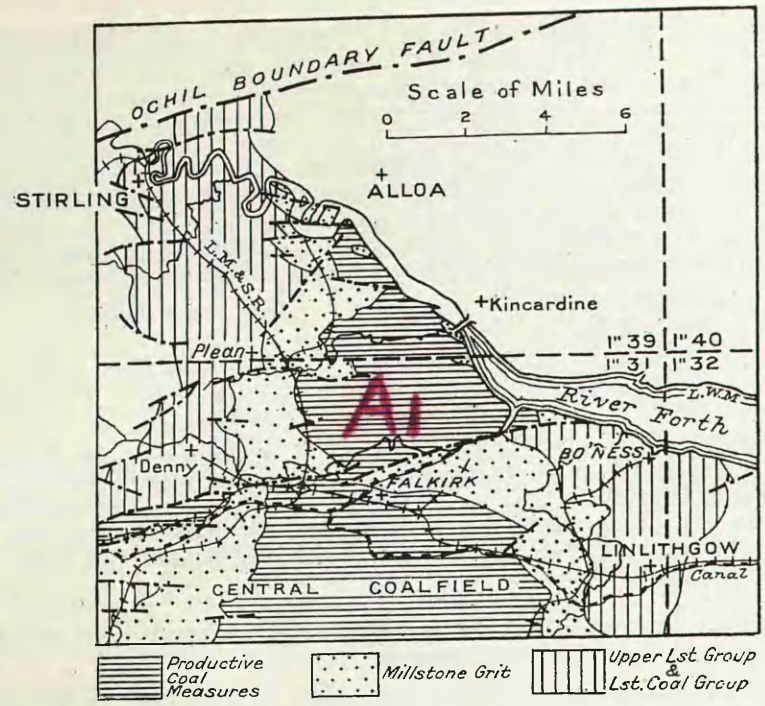


FIG. 5.—DISTRIBUTION OF COAL-BEARING STRATA IN THE NORTH-EAST STIRLINGSHIRE COALFIELD

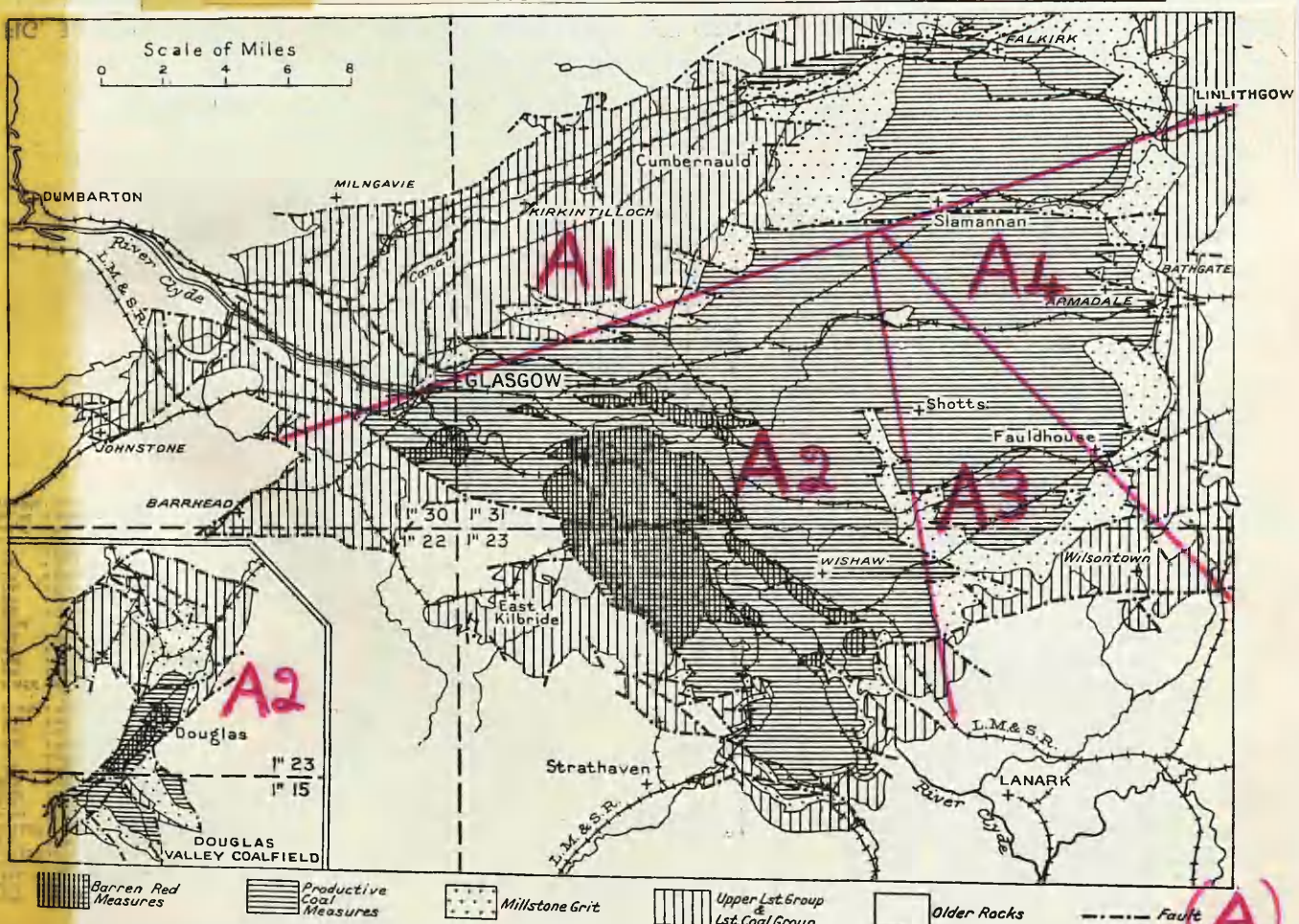


FIG. 2.—DISTRIBUTION OF COAL-BEARING STRATA IN THE CENTRAL AND DOUGLAS VALLEY COALFIELDS

B. FIFE AND CLACKMANNAN COALFIELD

As the name implies this covers the coal workings in Fife and Clackmannan and may be conveniently divided into three areas.

B 1. Clackmannan and West Fife - Clackmannan, Comrie and Valleyfield districts.

B 2. Central Fife - Dunfermline, Cowdenbeath and Lochgelly districts.

B 3. East Fife - Kirkcaldy, Thornton, Wemyss and Leven districts.

(Map overleaf)

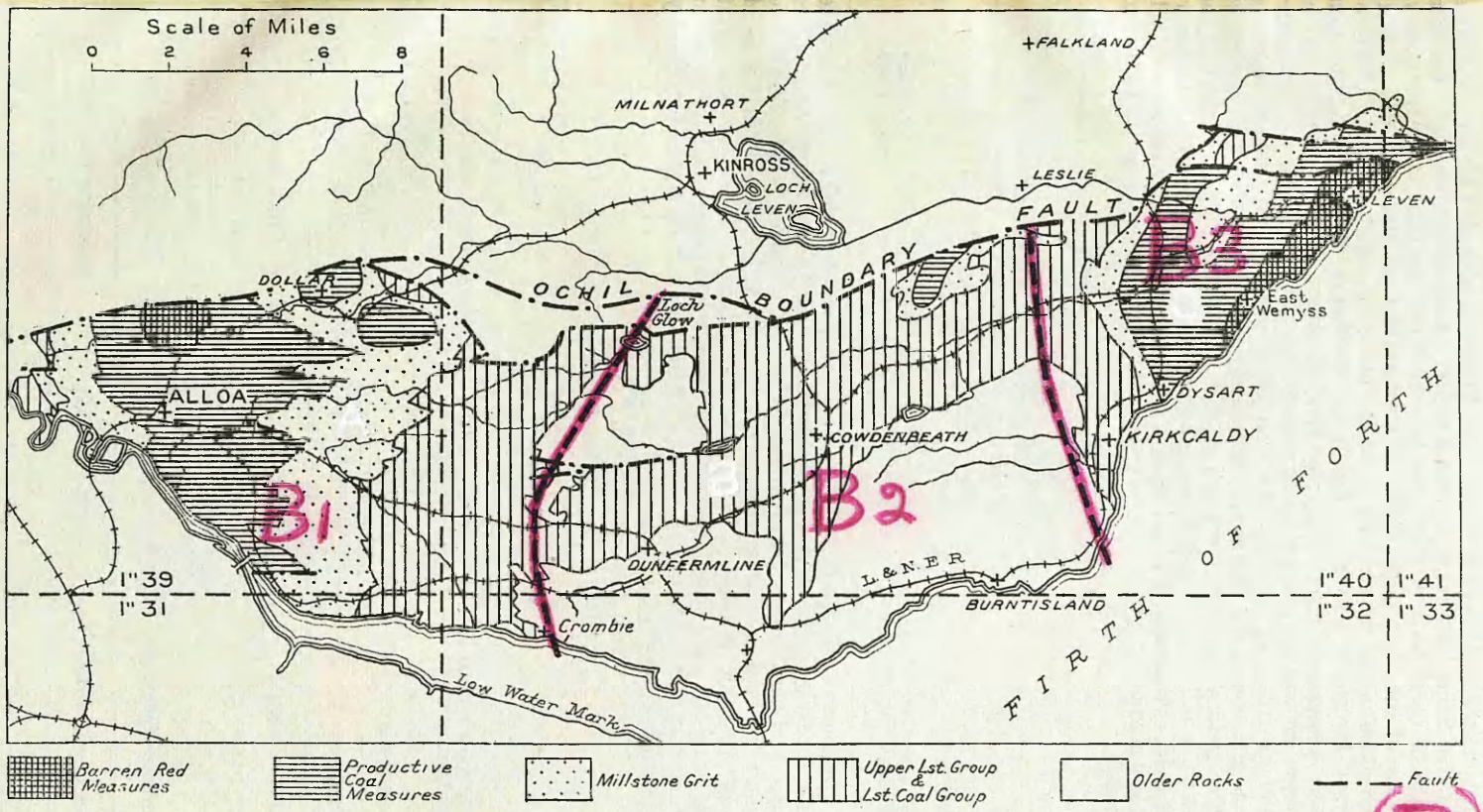


FIG. 7.—DISTRIBUTION OF COAL-BEARING STRATA IN THE FIFE AND CLACKMANNAN COALFIELDS (B)

C. LOTHIANS COALFIELD

This is contained in Midlothian and East Lothian stretching inland from the south shore of the Firth of Forth and may be regarded as consisting of two roughly parallel basins or troughs.

C 1. Midlothian - this is the deeper comprising the Musselburgh-Dalkeith and Roslin-Loanhead districts.

C 2. East Lothian (including the extreme east of Midlothian). This basin is much shallower and is based on Prestonpans, Tranent and Ormiston districts.

(Map overleaf)

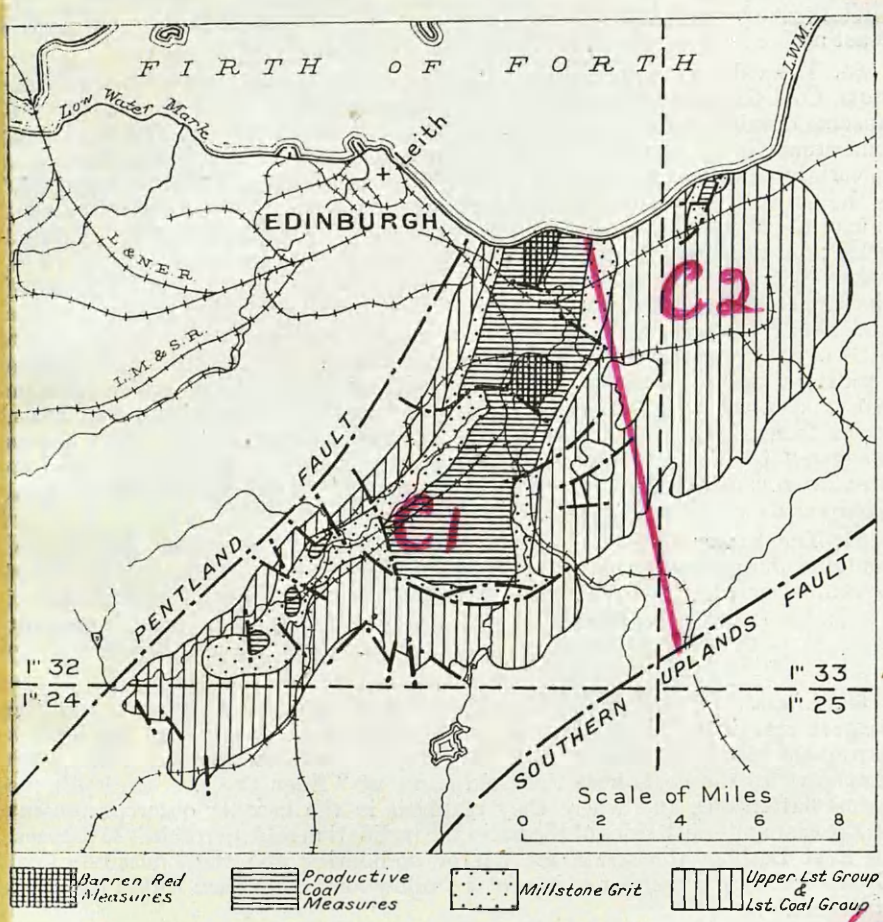


FIG. 9.—DISTRIBUTION OF COAL-BEARING STRATA IN THE LOTHIANS COALFIELD

D. AYRSHIRE AND DUMFRIESSHIRE COALFIELD

Two areas may be defined in this coalfield.

D 1. Central Ayrshire - the larger and economically the more important. It covers the coal workings in Mauchline, Cumnock, New Cumnock, Annbank and Dalmellington districts.

D 2. Other Ayrshire coal workings - comprising North Ayrshire (Dreghorn and Kilmarnock districts), South Ayrshire (Dailly district) and Dumfriesshire (Kirkconnel and Sanquhar districts). These lie in different directions on the periphery of the Central Ayrshire area and are included in one area as individually they do not employ a sufficient number of workers to provide units of reasonable size for analysis.

(Map overleaf)

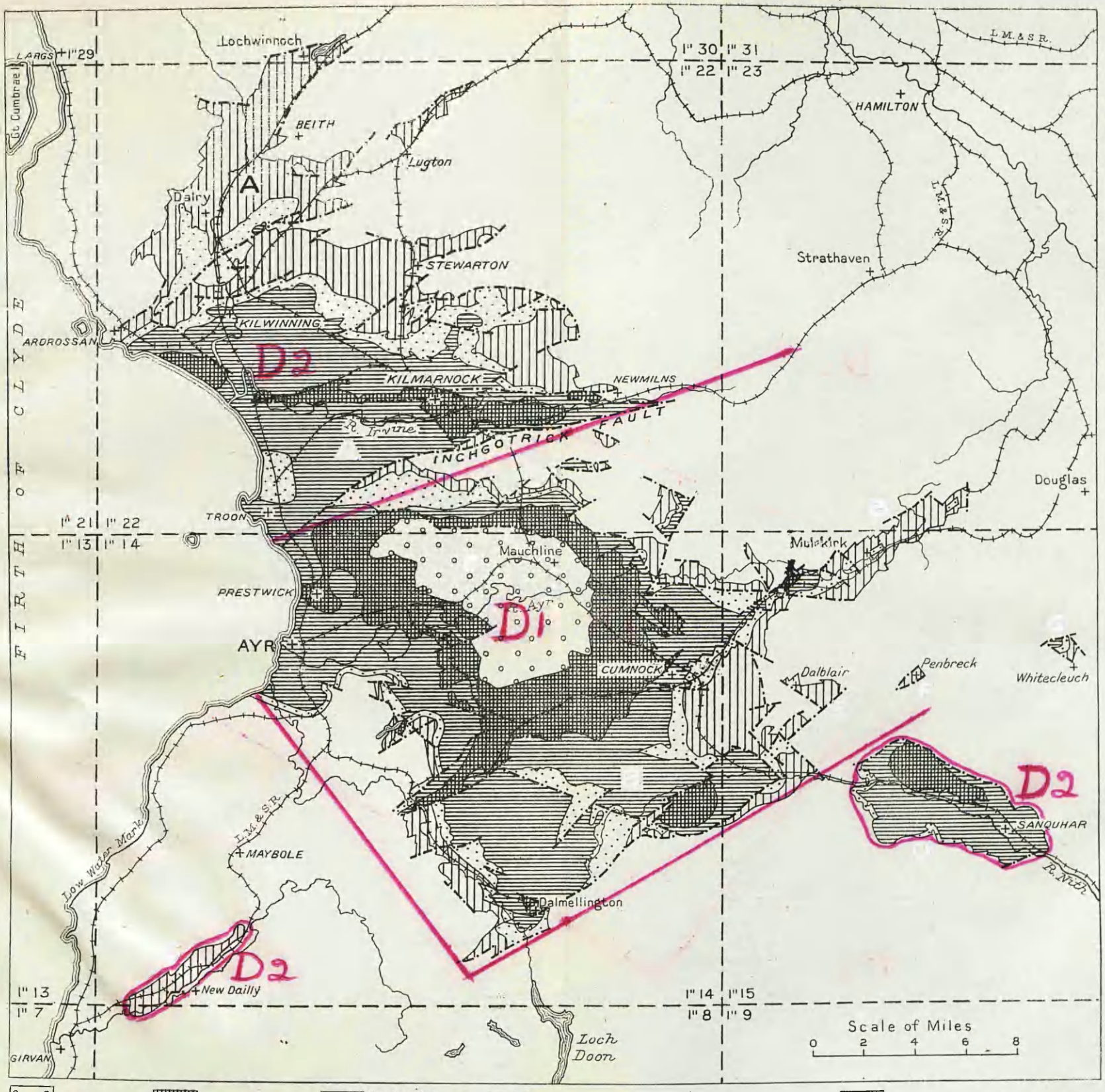


FIG. 11.—DISTRIBUTION OF COAL-BEARING STRATA IN THE AYRSHIRE AND DUMFRIESSHIRE COALFIELDS (D)

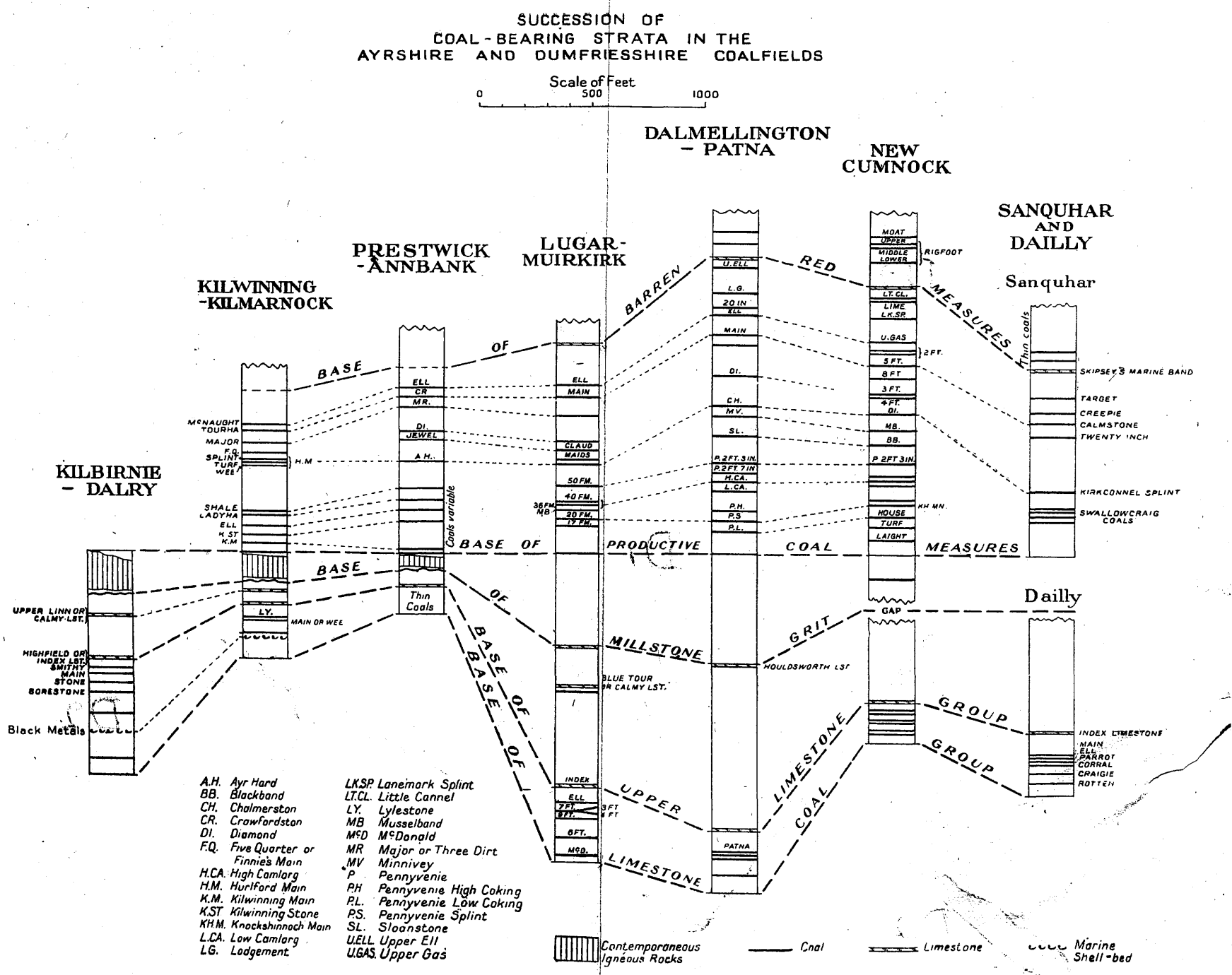

SUCCESSION OF
COAL-BEARING STRATA IN THE
AYRSHIRE AND DUMFRIESSHIRE COALFIELDS
Scale of Feet
0
500
1000
KILBIRNIE - DALRY
KILWINNING - KILMARNOCK
PRESTWICK - ANNBANK
LUGAR - MUIRKIRK
DALMELLINGTON - PATNA
NEW CUMNOCK
SANQUHAR AND DAILLY
Sanquhar
Dailly
BASE OF BARREN MEASURES
BASE OF PRODUCTIVE COAL MEASURES
BASE OF MILLSTONE GRIT
BASE OF UPPER LIMESTONE
BASE OF COAL
RED
Thin coals
Coals variable
Thin Coals
UPPER LINN OR CALMY LST.
HIGHFIELD OR INDEX LST. & MITHY MAIN STONE
SORESTONE
Black Metals
LY.
MAIN OR WEE
McNAUGHT
TOURHA
MAJOR
F.Q.
SPLINT
TURF
WEE
H.M
SHALE
LADYHA
ELL
K.ST
K.M
ELL
CR
MR.
DI.
JEWEL
A.H.
50 FM.
40 FM.
36 FM.
MB
20 FM.
17 FM.
CLAUD
MAIDS
INDEX
ELL
7 FT.
6 FT.
6FT.
McD.
BLUE TOUR OR CALMY LST.
U.ELL
L.G.
20 IN
ELL
MAIN
DI.
CH.
MV.
SL.
P. 2FT. 3 IN.
P. 2FT. 7 IN.
H.CA.
L.CA.
P.H.
P.S.
P.L.
PATNA
MOULDSWORTH LST
MOAT
UPPER
MIDDLE
LOWER
RIGFOOT
LT. CL.
LIME
LK. SP.
U. GAS
2 FT.
5 FT.
8 FT
3 FT.
4 FT.
DI.
MB.
BB.
P. 2FT 3 IN.
KH MN.
HOUSE
TURF
LAIGHT
GAP
GROUP
GROUP
LIMESTONE
COAL
SKIPSEY'S MARINE BAND
TARGET
CREEPIE
CALMSTONE
TWENTY INCH
KIRKCONNEL SPLINT
SWALLOWCRAIG COALS
INDEX LIMESTONE
MAIN
ELL
PARROT
CORRAL
CRAIGIE
ROTTEN
A.H. Ayr Hard
BB. Blackband
CH. Chalmerston
CR. Crawfordston
DI. Diamond
F.Q. Five Quarter or Finnie's Main
H.CA. High Camlarg
H.M. Hurlford Main
K.M. Kilwinning Main
K.ST Kilwinning Stone
KH.M. Knockshinnoch Main
L.CA. Low Camlarg
LG. Ladgement
LK.SP Lanemark Splint
LT.CL. Little Cannel
LY. Lylestone
MB Musselband
McD McDonald
MR Major or Three Dirt
MV Minnivey
P Pennyvenie
P.H Pennyvenie High Coking
P.L. Pennyvenie Low Coking
P.S. Pennyvenie Splint
SL. Sloanstone
U.ELL Upper Ell
U.GAS. Upper Gas
Contemporaneous Igneous Rocks
Coal
Limestone
Marine Shell-bed

FIG. 12

CHAPTER III

BRIEF GEOLOGICAL DESCRIPTION OF SCOTTISH COALFIELDS

As already stated all the workable coals in the Coalfields under discussion occur in the Carboniferous Formation, the sub-divisions of which from the surface level downwards are as follows:-

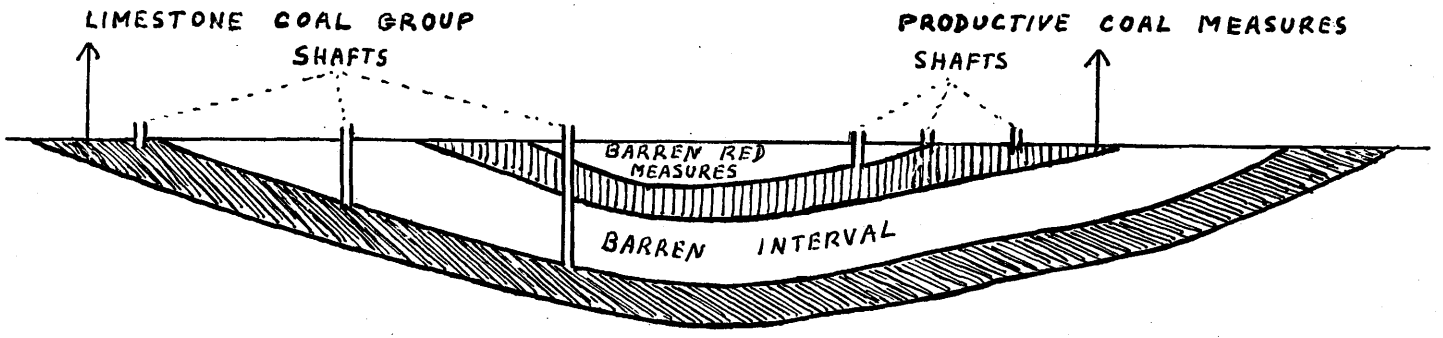
1.	Coal Measures	Barren red measures
		Productive coal measures
2.	Millstone Grit	
3.	Carboniferous Limestone Series	Upper Limestone Group
		Limestone Coal Group
		Lower Limestone Group

The valuable seams of coal occur in the Productive Coal Measures and in the Limestone Coal Group.

Some of the coalfields and areas contain both series of coal-bearing rocks. The major coalfields are in the form of 'broad basins underlain or flanked by older barren rocks'. This results from the folding to which the carboniferous rocks have been subjected as a result of crustal movements and of the denudation which has taken place subsequently. As a consequence the general distribution of the coal measures in the major coal-fields is as shown diagrammatically.

(Diagram overleaf)

DIAGRAMMATIC REPRESENTATION OF COAL BASIN



In areas where both Productive Coal Measures and the Limestone Coal Group are present it is necessary to sink shafts through the Productive Coal Measures and Millstone Grit to reach the coals in the Carboniferous Limestone Series. In areas where the Coal Measures have been removed by erosion only the Limestone Coal Group coals are present. Thus it is apparent that in some districts the workable seams lie at shallow depths while in other areas much greater depths have to be attained.

There is a marked variation in the number and thickness of workable seams in different districts both in the Productive Coal Measures and Limestone Coal Group, (e.g.) the Central Lanarkshire area is very deficient in seams of economic importance in the Limestone Coal Group. This fact, together with the fact that the coal-workings in the easily accessible Productive Coal Measures, which was one of the main factors leading to the early and extensive development of this area of the Central Coalfield, are now rapidly becoming exhausted, helps to explain the decline of coal-mining which has taken place in this area during the past twenty to thirty years.

It might be assumed from the terms Productive Coal Measures and Limestone Coal Group that some significant geological differences in rock formation would be encountered in extracting coal from these measures. However, according to Dr.Murray Macgregor

(personal communication), an authority on the geology of the Scottish Coalfield, this is not so. It would appear that the term Limestone Series is rather a misnomer as this is not really a limestone formation but is largely composed of sandstones as well as non-siliceous rocks. Consequently if comparable areas of reasonable size from the Productive Coal Measures and the Limestone Coal Group are taken, the mineral constitution of the rock formation is practically the same in each case, that is, roughly the same proportions of sandstones, shales, coals and other minerals are present. This being so workmen engaged in all these areas are exposed to the inhalation of airborne dust clouds which do not vary substantially in the quality of their mineral content.

Locally it may happen that in certain areas of limited extent more stone may be encountered from the thinness of the coal seams necessitating brushing of the roof or pavement, or from faults requiring more mine driving to follow the seams of coal. These factors might well create local differences in the quality of the dust to which workmen are exposed but, as has been indicated, there does not seem to be any significant difference in rock formation in the different coal-bearing measures to account for any varied incidence of pneumoconiosis. This question will be considered in a later section.

CHAPTER IV

LEGISLATION IN REGARD TO PNEUMOCONIOSIS OF COAL-MINERS

Although, as appears in the historical survey, pulmonary disease arising from the inhalation of dust has long been recognized as a cause of morbidity and mortality among coal-miners it was not until 1928 that the disease was recognized for the purposes of compensation under the Workmen's Compensation Acts. Sutherland (1949) has comprehensively reviewed the history and present status of compensation for pneumoconiosis in Great Britain. The following briefly represents the facts as they apply to the coal-mining industry.

Provision was originally made in the Various Industries (Silicosis) Scheme, 1928, but this applied only to a selected group of workers in coal-mines, namely, workmen engaged in 'drilling or blasting in silica rock'. For the purposes of the Scheme 'silica rock includes quartz, quartzite ganister, sandstone, gritstone and chert, but does not include natural sand or rotten rock or any rock containing less than 50% free silica'. The disease was restricted to the specific variety of pneumoconiosis, silicosis or silicosis accompanied by tuberculosis. Moreover, compensation was only payable in respect of total disablement or death by reason of the disease. Practical operation of the scheme quickly attracted much adverse criticism

from the workmen and the National Union of Mineworkers when it became generally recognized that the provisions of the scheme were too narrow. By the Various Industries (Silicosis) Scheme, 1931 - in conformity with other industries - compensation was extended to partial disablement by reason of the disease. It was still required, however, that the workman should prove that he had been engaged in operations in or in the handling of silica rock. This provision in turn was seriously criticised by judges in the Courts and eventually under the Various Industries (Silicosis) Amendment Scheme,1934, the provisions were extended to include all workmen employed in 'any operation underground in any coal-mine'.

Despite these extensions and amendments there was still considerable dissatisfaction,for it was observed that many underground workers, while obviously incapacitated by chest disease, which was confirmed by abnormal radiographic appearances, failed to obtain from the Medical Board for Silicosis the certificate necessary to enable them to recover compensation from the employers. The difficulty derived mainly from the radiographic criteria for the diagnosis of the earliest stage of the disease, namely, 'radiographic appearances not less than the presence of nodular shadows together with an increase of the hilum shadows, linear shadows and pulmonary reticulum ' (Report of Departmental Committee, 1928). Keating and Thomas

(1936), members of the Medical Board for Silicosis at Cardiff, from their experience among South Wales coal-miners, were convinced that there existed among these workmen a type of occupational chronic pulmonary disease which clinically was indistinguishable from silicosis, but which did not present a radiographic picture characterised by nodular shadows.

With a view to elucidating the problem, the Industrial Pulmonary Diseases Committee of the Medical Research Council instituted a special inquiry among South Wales coal-miners. The inquiry was comprehensive of all aspects of the problem and the results were presented in two reports.

Chronic Pulmonary Disease in South Wales Coal-miners.

I - Medical Studies (1942).

II - Environmental Studies (1943).

The conclusion was that there exists in coal-miners a form of pneumoconiosis distinguishable radiologically and pathologically from "classical" silicosis. This condition they designated dust reticulation.

As a result of these investigations and reports the Coal Mining Industry (Pneumoconiosis) Compensation Scheme, 1943, was enacted, the provisions of which applied to all underground colliery workers as well as to certain categories of surface workers who had been so employed on or after 1st July, 1943. In this Scheme the definition of pneumoconiosis is:- "Fibrosis of

the lungs due to silica dust, asbestos dust or other dust and includes the condition of the lungs known as dust reticulation". Compensation was payable in respect of partial disablement, total disablement or death arising from the disease. At the same time the Pneumoconiosis (Benefit) Scheme, 1943, made provision for a benefit payment to workmen who had been employed in or about any coal-mine on or after 22nd October,1934, but not after 30th June,1943, and who were not eligible under any of the compensation schemes. Benefit under this scheme was restricted to those certified to be totally disabled and there was also a death benefit payable to dependants

With the advent of Social Insurance on 5th July,1948, all schemes made under the Workmen's Compensation Acts were superseded by the National Insurance (Industrial Injuries) Act,1946. While the existing provisions were re-enacted a new outlook on disablement resulting from the disease was introduced. The main change is that disablement is not merely assessed on the loss of physical faculty but also on the loss of mental faculty - that is the power of the workman to enjoy life in like manner to a person of similar age and social state.

The group, which is the subject of this study, comprises workmen examined during the six years 1944 - 1949, so it is possible to summarise the legislative provisions, which apply to them, thus:

1. Pneumoconiosis means 'fibrosis of the lungs due to silica dust or other dust, and includes the condition of the lungs known as dust reticulation'.
2. "The disease" means pneumoconiosis or pneumoconiosis accompanied by tuberculosis of the lungs.
3. The term workman includes all men engaged in 'work underground in any coal-mine and in the working or handling above ground at any coal-mine of any minerals extracted therefrom, or any operation incidental thereto' and who have been so employed on or after 1st July, 1943.

In all the enactments mentioned above for the purpose of assessing disability or death the effects of tuberculosis accompanying pneumoconiosis are reckoned as those of pneumoconiosis.

CHAPTER V

DEFINITIONS

From the preceding it will be apparent to readers that at various dates since the original scheme in 1928 alterations have been made in the definition of the disease and of the conditions under which the workman was entitled to proceed to obtain a certificate enabling him to recover compensation. This being so it was necessary for the purposes of this study to ensure that all workmen included in the analyses were subject to the same diagnostic criteria and the same mode of assessment.

Accordingly the disease was recognized as pneumoconiosis, that is to say, 'fibrosis of the lungs due to silica dust or other dust and including the condition of the lungs known as dust reticulation' or pneumoconiosis accompanied by tuberculosis of the lungs. This, in effect, means all coal-mining applications made in pursuance of either the Coal Mining Industry (Pneumoconiosis) Compensation Scheme, 1943 or the National Insurance (Industrial Injuries) Act,1946.

Under these two schemes the disposal of cases by the Medical Board is slightly different, though in fact it is simply a matter of procedure. Thus under schemes (e.g.) the Coal Mining Industry (Pneumoconiosis) Compensation Scheme,1943, made in pursuance of powers conferred by Section 47 of the Workmen's Compensation Act,1925, as extended by the Workmen's Compensation (Silicosis and Asbestosis) Act,1930, the Medical Board either

granted or refused to grant a certificate to the workman. Such a certificate, if granted, was prima facie evidence of the disease and was final and conclusive of the matters therein certified (Meiklejohn,1942). The procedure under the National Insurance (Industrial Injuries) Act,1946, is that the Medical Board, after examination of the claimant, report their decision on the medical facts to the Local Insurance Officer of the Ministry of National Insurance, who decides whether or not the Ministry of National Insurance accepts liability for the payment of disablement benefit (Ministry of National Insurance Leaflet N.I.3,1948). This, of course, does not involve review of the medical findings but only of legal provisions under the National Insurance (Industrial Injuries) Act,1946. In the present investigation the essential consideration is the diagnosis of the disease, so we may disregard the procedure following medical examination of the workman and for convenience adopt a uniform formula, certificate granted or certificate refused. While the Coal Mining Industry (Pneumoconiosis) Compensation Scheme,1943, became effective on 1st July,1943, it was decided to exclude the first six months of operation during which the scheme was in process of achieving smooth working. The survey embraces the six full years 1944 - 1949.

As recorded the purpose of this research is to study the

problems of pneumoconiosis of coal-miners in the Scottish area. This being so it was necessary to ensure that all men included in the survey could rightly be assigned to this area. The records showed that in the specified six year period 1953 claimants were examined by the Medical Board. A few of these had substantial exposure to dust in such industries or occupations as stone quarrying, foundry work and shale mining, while others had been employed for considerable periods in coal-mines outside Scotland. It was considered that such groups could not rightly be included and this resulted in the discarding of 39 claimants, thus reducing the total number for study to 1914 persons. These workmen, so far as occupational dust risk is involved, have been entirely employed in Scottish coal-mines and have not been employed in any other recognized pneumoconiosis-producing industry. It is further emphasised that while some had been employed temporarily in surface occupations at the mines, all had engaged mainly in underground work. No selection of cases within the group was made but certain decisions had to be made to restrict the analyses to persons and not to examinations. In the case of workmen who had been examined once only, the decision was simple, person and examination constituted one unit. During the period, however, some workmen made two or more applications and had a corresponding number of examinations. The reason for this was either previous refusal by the Medical Board to grant a certificate or

or for re-assessment of the degree of disablement. As already stated the medical disposal of any individual case is either certificate granted or certificate refused. When a certificate has been granted at the first or any subsequent examination in the material period the case is allocated according to the year of such certificate, whereas in these cases where a certificate has consistently been refused the year taken is that of the first examination. For example:-

1. J.A. examined for first time in 1945 - certificate granted - allocated to year 1945.
2. T.M. one examination only in 1944 - certificate refused - allocated to year 1944.
3. W.W. examined 1945 certificate refused
   1946 certificate refused } allocated to year 1945
   1949 certificate refused
4. T.T. examined 1945 certificate refused
   1948 certificate granted } allocated to year 1948
5. H.B. examined 1946 certificate granted - partially disabled
   1949 totally disabled } allocated to year 1946

Cases at first refused and subsequently certified are, as will appear later, the subject of special investigation.

CHAPTER VI

CLINICAL, RADIOLOGICAL AND PATHOLOGICAL FEATURES OF COAL MINERS' PNEUMOCONIOSIS

It is not the purpose of this thesis to discuss these aspects of the subject, but a brief recapitulation of the main features is necessary, if only to elucidate certain descriptive terms in current use.

The clinical manifestations of silicosis and other forms of pneumoconiosis which affect coal-miners have been recorded by many authors in recent years (Hart and Aslett, 1942, Meiklejohn, 1949 a, and McVittie, 1949).

INDUSTRIAL HISTORY

Keating (1930) submitted that the diagnosis of silicosis was dependent on the critical assessment of three main factors; (1) the occupational history with special reference to the nature of the dust exposure; (2) the clinical examination of the whole patient; (3) the radiographic examination of the lungs. These methods of investigation apply equally to pneumoconiosis of coal-miners. All the men concerned in the present study had engaged in underground work, but underground work in a colliery embraces a whole variety of operations, not all equally harmful either in quality or quantity of respirable dust produced. Meiklejohn (1949 b) has particularly emphasised the value of an accurate and detailed employment history and indicated that to be of real value the recording involves a definite technique.

This technique has now been followed by the Medical Board for Silicosis for many years and the employment histories in the present series have been recorded in this manner.

CLINICAL HISTORY

The clinical manifestations of silicosis, which apply equally to coal-miners' pneumoconiosis, have been admirably presented by Ferguson (1934). At the outset the patient complains of shortness of breath or a feeling of tightness of the chest. This is usually accompanied by a harassing dry unproductive cough, which once established persists and is not readily relieved by medicines.

The dyspnoea is at first only apparent on exertion such as running or cycling, especially uphill, but as the disease advances it is induced by progressively less effort until the patient is distressed even by walking slowly on the level. The affected miner, in his own words, records that he gets out of wind travelling up the dips and on roads over which he could formerly travel without discomfort he is unable to keep up with his mates and often has to rest to catch his breath.

Cough is almost invariably an accompaniment of breathlessness. It is usually worse in the mornings until 'he gets something up'; a little tough mucus. Sometimes it is so violent as to cause vomiting. Bouts of coughing are often brought on by undressing for bed and very frequently interfere

with sleep. The result is that in the morning the workman feels tired and not fit to turn out for his shift.

Expectoration is at first scanty and composed of viscid mucus. When infection is superimposed the sputum becomes more copious, often muco-purulent and more easily expectorated, so that the patient may feel less distressed. As would be expected the sputum is streaked with coal dust. When the disease is advanced some cases develop a persistent uniformly black spit which is indicative of breaking down fibrotic tissue in the lungs; a fact which is confirmed at necropsy. It will be recalled that this feature of the disease led to considerable discussion among doctors over one hundred years ago. While blood-streaked sputum is not infrequently recorded by patients frank haemoptysis is rare and when it does occur usually denotes complicating tuberculosis (Meiklejohn,1949 c). In particular cases, however, it may be due to associated bronchiectasis, malignant disease of the lungs or cardiac disease. Weakness or exhaustion is a common complaint but is difficult to dissociate from shortness of breath. When infection - particularly tuberculosis - supervenes the patient feels ill. Meiklejohn (1949 a) has admirably summed up thus:

> "In simple silicosis (pneumoconiosis) the patient is fit but distressed, in silicosis accompanied by tuberculosis (and in some cases of complicated pneumoconiosis)he is sick and in declining health".

Physical Signs

Even in the presence of extensive involvement of the lungs physical signs are often very slight. Obvious loss of weight is usually indicative of associated infection, notably tuberculosis, and cyanosis and clubbing of the fingers are seldom evident.

In most cases the chest is of normal configuration although when extensive emphysema is present it may become barrel-shaped. Chest expansion, however, is usually restricted and in advanced cases may result in 'en bloc movement' (Hart and Aslett,1942).

Clinical examination of the lungs by percussion and auscultation are of very little help in assessing, with any real accuracy, the extent and nature of the disease. In simple pneumoconiosis it is seldom possible to elicit any change in resonance of the chest. In cases of advanced disease, in which there are areas of massive fibrosis, dulness may be detected mainly over the apices, but even then in many cases the dulness is masked by hyperresonance due to emphysema. On auscultation the chest both in simple and complicated pneumoconiosis may be almost silent. Most frequently in simple pneumoconiosis the respiratory murmur is weak, increased in pitch with the expiratory phase prolonged. In complicated pneumoconiosis even with massive areas of consolidation, bronchial or tubular breathing is uncommon. Adventitiae are

very variable in type and are most commonly related to associated bronchitis. Where active tuberculosis supervenes the clinical features are modified accordingly.

In short the clinical examination is of itself of very little real value in the diagnosis of the presence, extent and character of the disease. As has so often been emphasised 'radiographic examination of the chest still affords the best single piece of evidence in establishing the presence, extent and character of the disease' (British Journal of Radiology, August,1950). This, of course, does not indicate that the clinical examination can be dispensed with or minimised for it is of considerable value in assessing the general health of the patient, the effects of the disease and the presence and effects of extraneous conditions.

RADIOLOGICAL APPEARANCES

Hart and Aslett (1942) following their survey among coal-miners in South Wales recorded that in many cases abnormal radiological changes were present in the form of a 'fine network, sometimes sharp and lacelike in pattern, but much more often blurred in appearance'. This condition they considered to be of occupational origin and not infrequently it was accompanied by respiratory disability. It did not, however, have the nodular appearance required for the diagnosis of silicosis. For this abnormal radiographic appearance they suggested the

designation "reticulation". The pathologists recorded a similar morbid anatomical appearance which they in turn named "dust reticulation" (Belt and Ferris, 1942). As already explained, this condition was included in the definition of pneumoconiosis in the Coal Mining Industry (Pneumoconiosis) Compensation Scheme, 1943, and in the Pneumoconiosis (Benefit) Scheme,1943. Other radiological appearances in coal-miners' lungs were classified by Hart and Aslett under nodulation, coalescent nodulation, multiple fluffy shadows and massive fibrosis.

The term 'reticulation' has been criticised because various observers have used it to describe different appearances and attempts have been made by several workers to establish a generally acceptable classification of the various radiological appearances. So far the most satisfactory classification is that of Davies and Mann (1948), based on the appearances of the disease as observed by them among South Wales coal-miners. According to these authors the essential lesions are described as minute opacities of varying size, density and extent of distribution in the lung fields and they recognize two main types of the disease, namely, simple pneumoconiosis and complicated pneumoconiosis.

In simple pneumoconiosis the X-ray appearances are considered to represent actual dust accumulation in the lungs

together with localised foci of fibrosis; reticulation and nodulation. Four categories of increasing abnormality are defined according to the profusion of the opacities, the area of lung involved and the degree of masking of the normal lung markings.

In complicated pneumoconiosis the X-ray appearances are considered to represent dust accumulation plus massive fibrosis, due to the action of the dust alone or in association with tuberculous infection. Here again subdivision is made into four categories according to the extent of the shadows and their involvement of the thoracic structures. Evidence has been adduced by Fletcher (1948) and Gough (1949) to show that complicated pneumoconiosis appears only as a result of associated infection probably tuberculosis in lungs already occupied by dust. Our personal experience is that the radiological appearances of pneumoconiosis among coal-miners in the Scottish area conform closely to those described by Davies and Mann in South Wales coal-miners. Accordingly in all subsequent discussions in this thesis simple pneumoconiosis and complicated pneumoconiosis bear the meaning attached to them by these authors.

PATHOLOGY

Knowledge of the pathology of pneumoconiosis of coal-miners has been greatly advanced by Professor J.Gough and his co-workers in Cardiff. This work has been made possible by a new technique

developed by them for the cutting of large tissue sections of lungs. Gough (1949) has presented a comprehensive account of the present views on the subject.

A relatively small group of miners, hardheaders or stonemen are engaged in development work which involves drilling and blasting in silica rock and consequently exposure to dust of high silica content. In the course of years these workmen may develop "classical" nodular silicosis as revealed by the radiological and pathological appearances characteristic of that condition. More common, however, is the condition already described as dust reticulation. This, it would appear, is caused by the inhalation of airborne mine dust of low silica content. Mere mass of dust may be a factor, but on the other hand it may be due to some constituent element, although this has not yet been determined with certainty. It has been established that pneumoconiosis similar to that in coal-miners may occur in coal-trimmers engaged in loading coal into ships at the Cardiff and Swansea docks (Hart and Aslett,1942). King (1945) has further demonstrated that experimental injection of powdered coal into laboratory animals can produce the disease.

As observed in large lung sections and in histological preparations (see illustrations in Appendix II), in simple pneumoconiosis the dust appears as focal accumulations throughout the lungs, mainly around the terminal bronchioles and their

accompanying arteries. These coal nodules with the related reticulin fibrosis and peculiar focal emphysema constitute the characteristic lesion of the disease. The consequent respiratory disability, dyspnoea, appears to be related more closely to the extent of the emphysema rather than to the dust accumulation and fibrosis. By correlation of large lung sections with the corresponding radiographs Gough, James and Wentworth (1949) have concluded that the radiographic pattern of reticulation seen in coal-miners is due to coal nodules superimposed in depth as projected on a flat film.

Complicated pneumoconiosis occurs principally as massive fibrosis, most frequently localised in the upper part of the lung and in the apex of the lower lobe, but also as dense infective fibrotic nodules mainly around the massive fibrotic areas. Gough (1949),following post-mortem studies, asserts that tubercle bacilli can be demonstrated in about 40 per cent of cases of massive fibrosis, which is held to support the view that complicated pneumoconiosis results from the superimposition of tuberculous infection on simple pneumoconiosis. In a smaller percentage of cases specific tuberculous lesions have been identified.

Our own experience, derived from a considerable number of necropsies in coal-miners in Scotland, shows that the disease is similar to that described in South Wales.

The radiographic and pathological features of pneumoconiosis are illustrated by a representative series of exhibits in Appendix II at the end of this thesis.

CHAPTER VII

PATTERN OF EMPLOYMENT, APPLICATIONS AND CERTIFICATIONS IN THE SCOTTISH AREA AND ITS FOUR MAIN COALFIELDS

According to the Ministry of Fuel and Power List of Mines, 1944, 82,818 persons were employed at that time in the coal-mines of Scotland; of these 62,553 were engaged in underground work. In the latest published List of Mines,1948, the corresponding figures are 81,715 and 62,231 respectively. These figures were obtained by extracting and adding the number of employees as listed for each coal-mine in the Scottish Division. Similar estimates were made of the workers employed in the four main Scottish coal-fields as defined on page 10 .

TABLE 1.

DISTRIBUTION OF WORKERS IN SCOTTISH COAL-MINES

Year	Underground Workers	Surface Workers	Total
	Scottish Area		
1944	62,553	20,265	82,818
1948	62,231	19,484	81,715
	A. Central Coalfield		
1944	29,744	9,358	39,102
1948	27,742	8,624	36,366
	B. Fife and Clackmannan Coalfield		
1944	15,251	4,856	20,107
1948	16,180	4,782	20,962
	C. Lothians Coalfield		
1944	7,999	3,042	11,041
1948	8,547	3,175	11,722
	D. Ayrshire Coalfield		
1944	9,559	3,009	12,568
1948	9,762	2,893	12,655

The total population in the Scottish area has varied only slightly between 1944 and 1948 and so far as underground workers are concerned the difference during that period amounts only to a reduction of 322 among a population of over 62,000 workers. The variation in the individual coalfields is of a higher order, thus the number of underground workers in Coalfield A has diminished by 2,002 (6.7 per cent) whereas there has been an increase in each of coalfields B, C and D amounting to 829

(5.4 per cent), 548 (6.8 per cent), and 203 (2.1 per cent) respectively.

As our survey is concerned with workmen who have been employed in the industry on or after 1st July,1943, and who have been certified during the years 1944 to 1949 the population figures for 1944 would appear to be a satisfactory basis for any statistical analyses. Besides the shift of population between coalfields is a subject for discussion in relation to certifications in the separate coalfields.

As previously defined the number of applications examined in pursuance of the Coal Mining Industry (Pneumoconiosis) Compensation Scheme,1943, and the National Insurance (Industrial Injuries) Act,1946, for certificates of disablement by reason of pneumoconiosis or of pneumoconiosis accompanied by tuberculosis from this working population during the six years 1944-1949 aggregated 1914.

APPLICATIONS AND CERTIFICATIONS BY YEARS FOR THE SCOTTISH AREA

(Shaded areas represent certifications)

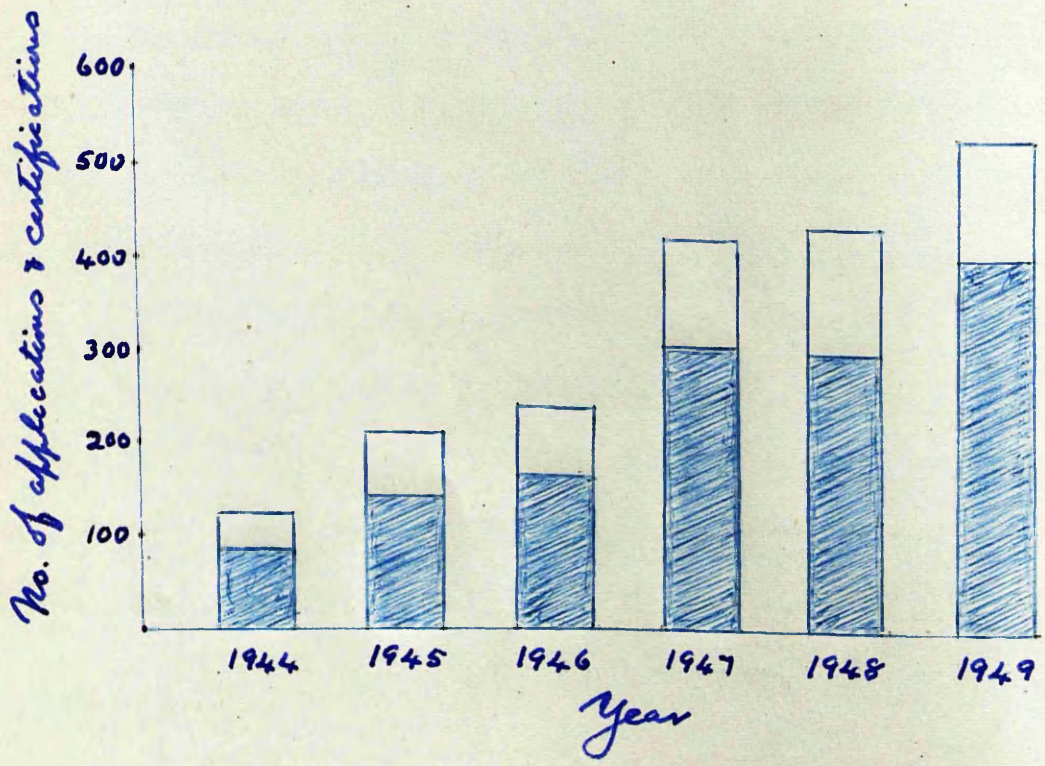


TABLE 2.

APPLICATIONS AND CERTIFICATIONS BY YEARS FOR THE SCOTTISH AREA

Year	Applications	Certificates granted		Certificates refused	
	No.	No.	%	No.	%
1944	116	76	66	40	34
1945	209	125	60	84	40
1946	234	154	66	80	34
1947	413	292	71	121	29
1948	424	289	68	135	32
1949	518	379	73	139	27
1944-1949	1914	1315	69	599	31

These certifications were distributed throughout the four Scottish Coalfields thus:

TABLE 3.

CERTIFICATIONS BY YEAR AND COALFIELD

Year	Coalfield			
	A	B	C	D
1944	40	15	9	12
1945	75	17	20	13
1946	96	24	26	8
1947	196	31	39	26
1948	171	48	38	32
1949	245	44	47	43
Totals	823	179	179	134

These statistics (tables 2 and 3) establish that during the period 1944 to 1949 a considerable increase in the absolute number of certificates granted has progressively taken place not only in the Scottish area as a whole but in each of the four main constituent coalfields. The increase,however, is not uniform in the separate coalfields for whereas the increase in the Central Coalfield (A) is 6 times and in the Lothians Coalfield (C) is 5¼ times, in the Fife Coalfield (B) and in the Ayrshire Coalfield (D) the respective increases are 3 and 3½ times. As these variations are capable of detailed analysis and are influenced by several factors yet to be considered,their discussion appears more appropriately in a later section (see p. 51).

DISCUSSION OF INCREASE IN CERTIFICATIONS

It has been demonstrated that the number of certifications in the Scottish area has progressively advanced from 76 in 1944 to 379 in 1949 and that this pattern is reflected,though not uniformly, in each of the four constituent coalfields. As previously explained it will be appreciated that these cases represent only those dealt with under the Coal Mining Industry (Pneumoconiosis) Compensation Scheme,1943, and the National Insurance (Industrial Injuries) Act, 1946, and so do not take account of cases dealt with during the same period under the Various Industries (Silicosis) Scheme,1931, and as amended, and

the Pneumoconiosis (Benefit) Scheme,1943. McVittie (1949), however, has recorded from official records the total certifications under all the schemes among coal-miners in Scotland for the years 1939 to 1947. These figures, with the addition of the appropriate figures for the years 1948 and 1949, are reproduced below.

TABLE 4.

ALL CERTIFICATIONS FOR THE SCOTTISH AREA FOR THE YEARS 1939 TO 1949

Year	1939	1940	1941	1942	1943	-	1939-43
Number of Certifications	7	2	3	6	10(6)	-	28
Year	1944	1945	1946	1947	1948	1949	1944-49
Number of Certifications	109	148	166	322	317	419	1481

(raised figure for 1943 represents cases of silicotic type.)

As the Coal Mining Industry (Pneumoconiosis) Compensation Scheme became effective on 1st July,1943, this year may be accepted as a natural division. Accordingly the above figures reveal that the mean annual number of certifications for the five years 1939-1943 was 5.6, whereas for the six years 1944-1949 the corresponding figure was 247, an increase of 44 times. Comparable figures for the other coalfields of Great Britain are

not available, but according to Fletcher (1948) among South Wales coal-miners 'the mean rate of certification since 1942 (i.e. to the end of 1946) has risen to 4 or 5 times the rate in that year'. From our data for the same years the corresponding increase for the Scottish area is 18 times. This tremendous increase in the Scottish area is noteworthy for the fact that it commenced suddenly in 1944 and has since continued. It is of interest and importance to consider possible reasons for such increase.

In the first place it must be emphasised that with the introduction of the Coal Mining Industry (Pneumoconiosis) Compensation Scheme,1943, an almost immediate increase in certifications was to be expected, because by definition the disease was not restricted to silicosis but was on the much wider basis of pneumoconiosis including the condition of the lungs known as dust-reticulation. In other words many workmen while suffering from disabling chronic pulmonary disease due to dust but not amounting to silicosis, and who prior to 1st July,1943 failed to obtain a certificate, now succeeded due to the wider definition of the disease.

That this increase was not entirely due to the recognition of dust reticulation in the scheme is suggested by taking account of those cases, occurring in the years 1944-1949, which fall into the category of silicosis.

TABLE 5. CASES OF SILICOSIS

Certifications in pursuance of	1944	1945	1946	1947	1948	1949	1944-49
Various Industries (Silicosis) Scheme, 1931	10	13	6	27	8	12	76
Pneumoconiosis (Benefit) Scheme, 1943	4	3	4	6	4	2	23
Coal Mining Industry (Pneumoconiosis) Compensation Scheme, 1943. National Insurance (Industrial Injuries) Act, 1946.	30	48	68	90	92	92	420
Total - all Schemes	44	64	78	123	104	106	519

This represents a mean annual number of certifications by reason of silicosis of 86.5 for the years 1944-1949 as against 4.8 for the years 1939-1943 (see Table 4), which is an increase of 18 times. Moreover, as, on first examination by the Medical Board, about one-half of all these cases were adjudged to be totally disabled by the disease and the remainder shewed definite impairment of physical capacity for work by reason of the disease, it is probable that the application for a certificate was determined by illness and not by any accidental discovery of the condition, such as by routine radiographic examination of the chest. Thus it would appear that 519 or 35.0% of the 1481 certifications among coal-miners in Scotland since 1943 can be accounted for by cases of silicosis, in which cases a certificate would have been granted even if the legislation

had not been extended to include dust reticulation. It should further be mentioned that the above numbers on which the calculations are based do not represent all possible cases of silicosis as doubtful or borderline cases were excluded. The significance of this is that the contribution of silicosis to the increased number of certifications has, if anything, been underestimated.

From these observations it seems reasonable to suggest that a measure of true increase in the occurrence of pneumoconiosis has taken place in the Scottish area during recent years. This compares with the opinion of Fletcher (1948) who, quoting Keating and McVittie of the Silicosis Medical Boards at Cardiff and Swansea, estimates 'that of the men certified since July,1943, in South Wales approximately 50% shewed a more advanced disease than dust reticulation and that there must have been a considerable increase in the number of applicants to the Board with this type of disease'. Several other factors, however, have undoubtedly contributed to the increase of applications and certifications, which, as already indicated, follow a closely similar pattern.

1. Changes in the relevant legislation undoubtedly played a material part. . The Coal Mining Industry (Pneumoconiosis) Compensation Scheme,1943, considerably extended the legal

connotation of pneumoconiosis for the purposes of compensation. By including dust reticulation the affected coal-miner more easily achieved certification. This is not a peculiar experience for it has frequently been observed that the introduction of new legislation in relation to workmen's compensation almost immediately leads to an increase in the number of applications. In recent years this is excellently illustrated by experience of compensation claims on account of occupational dermatitis. In the present instance, however, few new applications arose in the first six months of the operation of the scheme, due no doubt to the fact that workmen and doctors required some time to become fully aware of the new legislative provisions. Besides in order to proceed under the scheme it was necessary for the workman to have worked in or about a coal-mine on or after 1st July,1943. As knowledge of the scheme increased so the number of applicants advanced. The National Insurance (Industrial Injuries) Act,1946, which became effective as from 5th July, 1948, further facilitated applications by remitting all fees payable by the workman and by rescinding the provisions as to compulsory suspension from work on certification, except in cases in which the pneumoconiosis was accompanied by tuberculosis of the lungs. Thus the

affected workman was enabled to recover disablement benefit and, if fit, he could continue at his job. Again benefits were payable in respect of loss of faculty and were in the form of a pension assessed on a percentage basis - in which 45/- represents 100 per cent - and were not conditional, as hitherto, on loss of earnings.

2. There is no doubt that many old miners and others, whose physical capacity for work was impaired, patriotically carried on for the duration of the war. With the end of active hostilities in 1945 they began to leave the mines and in due course many made application for certification under the scheme.

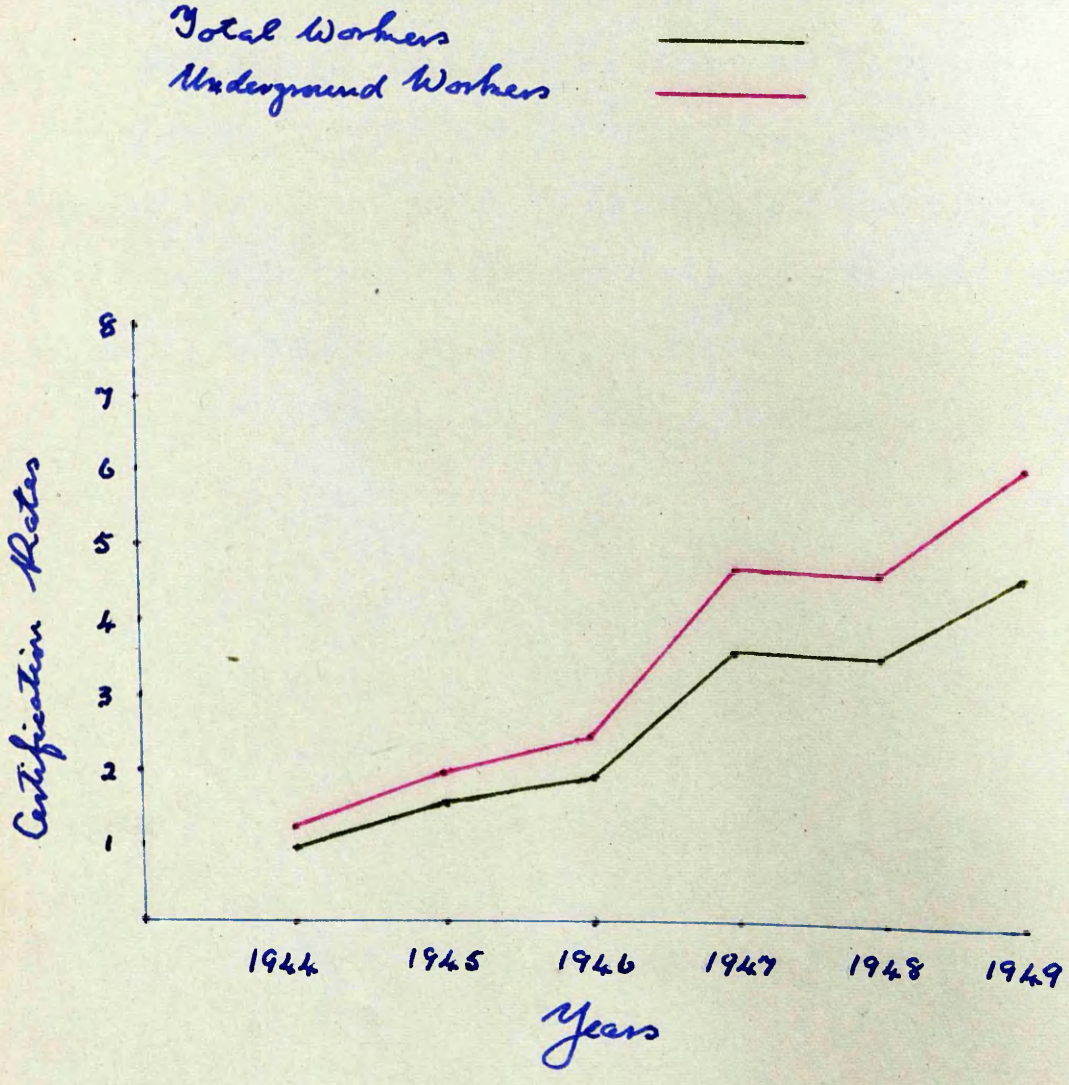
3. The exhaustion of economic coal workings, for example, in Central Lanarkshire, led to the closure of some pits with the result that many old miners and others in impaired health, when displaced, did not accept transfer to other pits. This also had the effect of stimulating applications for certification.

4. During the last few years facilities for radiological examination of the chest at hospitals and in the course of mass radiography surveys have been greatly extended. This has been the means of discovering some unsuspected cases of the disease, which have then presented for certification.

SUMMARY AND CONCLUSIONS

Since 1944 a very substantial increase in the number of certifications on account of pneumoconiosis has occurred throughout all the coalfields of the Scottish area. This accords with experience in South Wales. The increase in cases of the silicotic type suggests that there has been a real increase in the actual occurrence of the disease. Other factors, however, such as the broader scope of compensation provisions since 1943, retiral of old and unfit miners, closure of uneconomic pits and increased radiological facilities, have all contributed to the progressively higher number of applications and certifications during the six years 1944-1949.

CERTIFICATION RATES IN THE SCOTTISH AREA



CHAPTER VIII

INCIDENCE OF PNEUMOCONIOSIS IN SCOTTISH COAL-MINES

An accurate estimate of the true incidence of pneumoconiosis in the Scottish coal-mines could only be achieved by a complete survey of all colliery workers. Even this would not be entirely accurate for it would be liable to errors such as those of interpretation, as emphasised by the researches of Fletcher and his co-workers (1949) into the radiological diagnosis of pneumoconiosis. While no such survey has so far been carried out in Scotland or elsewhere some estimate of the extent of the occurrence of the disease in the whole area and its separate coalfields and districts within these is possible by an analysis of certifications. The following standard of measurement may be defined.

Certification Rate - the annual number of certifications per 1,000 workers.

The number of certifications by years are known, and figures are available (List of Mines,1944) of total workers and of underground workers, 82,818 and 62,553 respectively.

TABLE 6.

CERTIFICATION RATES IN THE SCOTTISH AREA

Year	1944	1945	1946	1947	1948	1949	Mean 1944-1949
Certification Rate							
(a) total workers	0.92	1.51	1.86	3.53	3.49	4.58	2.65
(b) underground workers	1.21	1.99	2.46	4.69	4.62	6.06	3.50

This table and accompanying graph demonstrate that the trend throughout the years is similar whether the basis be certifications in relation to total or underground workers. This being so and as all persons included in this study had spent the whole or major part of their working life in underground operations the certification rate in relation to underground workers will be adopted for discussion purposes.

It is not suggested that the certification rate reflects the total incidence of the disease for many patients may continue at work without even seeking examination. Still over a number of years, other factors remaining constant, it is, at least, a measure of incapacitating disease.

As shewn the mean annual certification rate for the Scottish area is 3.50. The question now arises whether or not this is uniform throughout the constituent coalfields.

TABLE 7.

CERTIFICATION RATE IN SEPARATE COALFIELDS
(1944-1949)

Coalfield	A	B	C	D	Scottish Area
Underground Workers	29,744	15,251	7,999	9,559	62,553
Number of Certificates	823	179	179	134	1,315
Certification Rate	4.61	1.96	3.73	2.34	3.50

It emerges that there is a considerable variation in certification rate between separate coalfields, ranging from 4.61 in A to 1.96 in B as against 3.50 for the Scottish area.

It is possible to break these figures down still further into districts within the separate coalfields, whereby it appears the variation in certification rate is even more striking.

TABLE 8.

CERTIFICATION RATE IN DISTRICTS OF COALFIELDS (1944-1949)

Coalfield	A				B		
Districts	1	2	3	4	1	2	3
Underground Workers	8,646	10,889	4,624	5,585	2,582	7,589	5,080
Number of Certificates	119	319	273	112	32	121	26
Certification Rate	2.29	4.88	9.84	3.34	2.06	2.66	0.85

Coalfield	C		D	
Districts	1	2	1	2
Underground Workers	5,226	2,773	2,103	7,456
Number of Certificates	77	102	43	91
Certification Rate	2.44	6.13	3.41	2.03

Compared with the mean annual certification rate of 3.50 for the Scottish area districts A3 and C2 have high rates of 9.84 and 6.13 respectively and B3 the lowest rate, 0.85. Such wide divergence in certification rates demands consideration. It is unlikely that any single factor is the determinant but several possible major influences may be considered separately. Omitting, for the time being, tuberculous infection which is a

topic of consideration later, these factors are:

1. Awareness of the disease and of the legislative provisions.
2. Age distribution of workers employed.
3. Exhaustion of coal workings.
4. Differences in geological formations.
5. Conditions of work with special reference to dust.

1. Awareness of the disease and of the legislative provisions on the part of claimants or their medical attendants is only likely to operate at the inception of a scheme. Inquiry on this question to officials of the National Union of Mineworkers reveals that there is a general awareness of the procedure in respect of claims throughout all the Scottish Coalfields.

2. Age distribution - an area with an older age distribution of workers at risk is likely to have a bigger incidence due to the correspondingly longer period of exposure.

3. Exhaustion of coal workings leads to the closure of pits and the necessity for men to transfer to other areas. This has been referred to generally in a previous section where it was suggested that the older age groups suffering some impairment of health would probably seek certification rather than transfer to other coalfields. This decline in mining and consequent closure of pits has been

most marked in district A2 where it has been occurring over the past twenty to thirty years and this may have served to increase the certification rate in that area. It is true that the highest certification rate is in district A3, but it is probable that this may have been influenced to an appreciable extent by the fact that many of these men now being certified from area A3 had previously worked in area A2,having transferred to area A3 when pits in their own district closed down. This suggested explanation may appear to conflict with the previous statement about unwillingness of the older men to transfer. There is no contradiction, the objection is to transfer from one coalfield to another, (e.g.) from Lanarkshire to Fife and this does not apply to the same extent between pits in neighbouring districts. For one thing this does not necessitate moving house, displacing the whole family and breaking family and social ties.

4. Geological. Attention has previously been drawn to the fact that the coal workings in Scotland occur in two geological formations - the Productive Coal Measures (P.C.M.) and the Limestone Coal Group (L.C.G.). In some areas the Productive Coal Measures are worked, in some the Limestone Coal Group, and in others both. An attempt has been made to ascertain whether this has been responsible in any way for the variation in certification

rates.

The Scottish Coalfields Report, 1944, gives a list of collieries in each area specifying the formation in which the coal is being worked. It was felt that by relating the proportion of underground workers (U.G.W.) in an area with the formations worked and comparing such data with that from other areas it might be possible to determine some relationship. As might be expected most areas are mixed, having coal workings in both geological formations, but fortunately in several areas one particular formation shows an overwhelming predominance, which for our purpose is taken as 90 per cent or over. This occurs in coalfield D and in separate districts in each of other three coalfields.

TABLE 9.

CERTIFICATION RATE IN RELATION TO GEOLOGICAL FORMATION

Area	U.G.W.	P.C.M. % employed	L.C.G. % employed	Certification rate
A1	8646	7.5	92.5	2.29
B2	7589	0.0	100.0	2.66
B3	5080	100.0	0.0	0.85
C2	2773	0.0	100.0	6.13
D	9559	93.2	6.8	2.34

Areas B3 and D are essentially Productive Coal Measures, yet the certification rates differ as between 0.85 and 2.34. In the same way in areas A1, B2 and C2 which are essentially Limestone Coal Group the respective certification rates are 2.29, 2.66 and 6.13. Then comparing area D which is 93.2 per cent Productive Coal Measures with area A1, which is 92.5 per cent Limestone Coal Group and both involving comparable numbers of workmen, the certification rates are almost identical.

Thus it seems that geological formation does not play any material part in the varying incidence of pneumoconiosis in the different areas of the Scottish Coalfields. This is in keeping with the information recorded earlier that there are no significant geological differences between the Productive Coal Measures and the Limestone Coal Group such as would result in any material difference in the quality of the airborne dust to which these separate groups of miners are exposed.

5. Conditions of work with special reference todust. Dust inhaled into the lungs is the essential causative agent in the production of pneumoconiosis. Sir Andrew Bryan, H.M. Chief Inspector of Mines, in his Annual Reports for 1947 and 1948 and in a lecture to the Institution of Mining Engineers in June,1949, when dealing with the problem of

pneumoconiosis among coal-miners emphasises the important part played by the increased production of dust which has resulted from greater mechanisation in mines. He strongly advocates the need for intensive anti-dust measures. Differences in the degree of mechanisation carried out in various areas would of course influence the amount of dust produced and likewise the development of the disease.

That this is not the only factor is suggested by Jenkins (1948), who states that the progress of mechanisation in the South Wales Coalfield has proceeded at a much slower rate than in other parts of Great Britain and he attributes the high incidence of pneumoconiosis in the South Wales coal-mines to the dry dusty conditions prevailing there. From this consideration and from the success of wet methods of dust suppression in reducing dust counts it seems reasonable to conclude that the condition of the workings as regards wetness is also an important point, dry workings favouring the production and dispersion of dust.

Other factors which probably affect the dustiness of a mine are thinness of seams and frequent faulting, these conditions being more common in some areas than others. Not only do these increase the quantity of airborne dust but they alter its quality by increasing the silica content.

On these topics of mechanisation and wetness or dryness the National Coal Board (Scottish Division) have provided the

following authoritative information. Part of this has already been published in the Ministry of Fuel and Power, Statistical Digests for the years 1945-1949 (H.M.S.O.)

MECHANISATION

In 1913 only 8 per cent of coal in Great Britain was machine cut. At this date the corresponding figure for Scotland was 22 per cent and most of this was in thin seams in the Lanarkshire coalfield. Indeed Lanarkshire is reputed to be the home of the coal cutter. During the ensuing fifteen years there was a general expansion but the relative positions recorded above were more or less maintained.

Conveyors of bigger capacity were brought into use while machine cutting was extended to thicker seams. In 1928, 12 per cent of coal in Great Britain was mechanically conveyed; in Scotland 25 per cent. Machine cutting was until about 1930 almost entirely confined to Lanarkshire and the particular machine was the disc cutter. It is recalled by old miners that about 30 years ago it used to be asked by miners in Muirkirk (Ayrshire), "Who is going to Shotts to be poisoned?" This apparently referred to the fact that men returning from Shotts where the disc cutter was used were noted to be short of breath when they got back to Muirkirk where the coal was hand got by stoop and room methods.

TABLE 10.

STATISTICS OF MACHINE CUT COAL
(per cent)

District	Year									
	1938	'39	'40	'41	'42	'43	'44	'45	'46	'47
Fife and Clackmannan	90	89	91	91	91	92	93	92	93	92
Lothians - Mid and East	62	65	65	65	68	66	69	72	74	74
Lanarkshire	84	84	84	86	85	85	90	89	88	90
Ayr and Dumfries	69	70	70	72	72	74	74	77	76	72
Great Britain	59	61	64	66	66	69	72	72	74	75

This emphasises that the mechanical cutting of coal in Lanarkshire and Fife and Clackmannan is substantially higher than in the other Scottish coalfields and in the rest of Great Britain. Nevertheless the certification rates do not appear to be parallel to degree of mechanisation as revealed by a comparison of Tables 7 and 10, for whereas the certification rate in Coalfield A (Lanarkshire) is 4.61 the certification rate in Coalfield B (Fife and Clackmannan) is 1.96. On the other hand in the less mechanised coalfields the certification rates are intermediate between these. This would suggest that mechanisation per se is not the only factor in determining the certification rate in individual areas.

Wetness and Dryness of Workings

Recognized wet areas are Armadale, Shotts and Ayrshire except the Annbank district. The Clyde valley, Kilsyth and

Stirling are dry. The Lothians pits are fairly dry and Fife on the average is not very dusty though some pits (e.g.) Valleyfield are dry and dusty. In N.E.Lanarkshire, especially in the Shotts area, for every ton of coal mined, more stone is handled than in other Scottish districts and generally the mechanical ventilation is not so good. This is related to the fact that there is no gas in the pits and naked lights can be used.

In Shotts particularly the coal seams are very thin and the machine cutting is done in the pavement which is of fire-clay.

PNEUMOCONIOSIS IN INDIVIDUAL COLLIERIES

The allegation is frequently made that certain collieries are "bad pits" implying that these collieries are much more liable to give rise to pneumoconiosis than are others. It is true that if certifications of the disease are related to the colliery at which the applicant last worked some collieries seem to produce a higher number, but all too often those who make such assertions ignore the size of the pit, (i.e.) number of men employed. It is also true that many of the cases so allocated have worked in that particular colliery for a comparatively short time, often much too short to justify attributing the disease to that colliery.

In an attempt to elucidate this point a review of the industrial histories of the 1914 applicants dealt with in the present study was carried out. Before any applicant was allocated to a particular colliery it was required that certain conditions be fulfilled, based on the findings recorded (p. 67) that practically all cases of pneumoconiosis in the present series had presented to the Medical Board only after at least 20 years' colliery work. These requirements were as follows:

(1) That all the colliery work had been carried out at one colliery,

or (2) That 30 years or more of the latest exposure had been at one colliery,

or (3) If less than 30 years that the latest exposure at one colliery had amounted to at least 75 per cent of the total exposure with a minimum of 20 years.

The Coalfields Report (1944) lists 221 collieries in the Scottish area and from these during the six years 1944-1949, 1315 workmen were granted certificates. Careful scrutiny of the industrial histories as given by these men at the time of examination reveals only 166 workmen who fulfilled the criteria defined for attachment to an individual colliery and these were derived from no less than 75 collieries.

TABLE 11

CERTIFICATIONS BY INDIVIDUAL COLLIERIES AND DISTRIBUTION IN COALFIELDS

Certifications number	Collieries number	Certifications total	Coalfield A	B	C	D
1	39	39	17	7	5	10
2	16	32	6	2	4	4
3	8	24	6	2	0	0
4	4	16	1	2	1	0
5	3	15	2	0	1	0
6	2	12	0	1	0	1
7	1	7	0	0	1	0
8	0	0	0	0	0	0
9	1	9	1	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	1	12	0	0	1	0
-	75	166	33	14	13	15
Total collieries	221	-	105	40	27	49

Thus over a period of six years it appears that only one certified case could reasonably be attributed to work in any one of 39 collieries; 12 collieries had more than three cases, but one had twelve cases. Altogether only 3 collieries had

more than an average of more than one certified case per annum. The numbers of underground workers at these three collieries were 214, 347 and 666, and the certifications over the six years numbered 7, 9 and 12 respectively.

It is submitted that it is not justifiable on these facts to attach to any individual colliery an undue liability in the production of pneumoconiosis.

SUMMARY AND DISCUSSION

On the available data an endeavour has been made to determine the incidence of pneumoconiosis among miners in the Scottish area. While not absolutely definitive it is suggested that the certification rate over a period of years is a measure. It emerges that compared with the certification rate for the Scottish area as a whole there is a substantial variation throughout the four main coalfields, which variation is even wider in the separate districts within these coalfields. Individual pits are often cited as being 'bad pits' but it appears that there is no reliable evidence to support this opinion. Certificationsfrom individual pits do not reflect the risk of these pits because comparatively few men spend their whole working lives in a single pit. All these cases have been collected but they are too few on which to base any conclusion. The reasons for the varying incidence of the disease are discussed. Awareness of the disease and the legislative provisions and

differences in the geological formations are not considered to be material influences between areas.

Age distribution of workers employed, closure of uneconomic pits and dry working conditions appear favourable to a high certification rate. The possible contribution of tuberculous infection will be discussed later in connection with complicated pneumoconiosis.

CHAPTER IX

PNEUMOCONIOSIS IN RELATION TO AGE AND YEARS OF EMPLOYMENT

During the six years 1944-49, 1315 persons were granted certificates under the Schemes. It is here proposed to analyse these according to age and period of employment, which is the period of exposure to the dust hazard. The age is taken as at the date of first certification.

TABLE 12

CERTIFICATIONS BY AGE GROUPS

Age Group	Certifications	
	Number	%
30 & under	0	0.0
31-40	30	2.4
41-50	299	22.7
51-60	553	42.0
61-70	393	29.9
71 & over	40	3.1
All ages	1,315	100.0

Before proceeding to discuss the above table and subsequent tables it should be emphasised that the percentage distribution of cases by ages is in relation to the total certifications over all age groups. No attempt is made to estimate the relative incidence of the disease in different age groups, as this would involve knowledge of the population

at risk at these ages, a matter on which no data are available for the period surveyed.

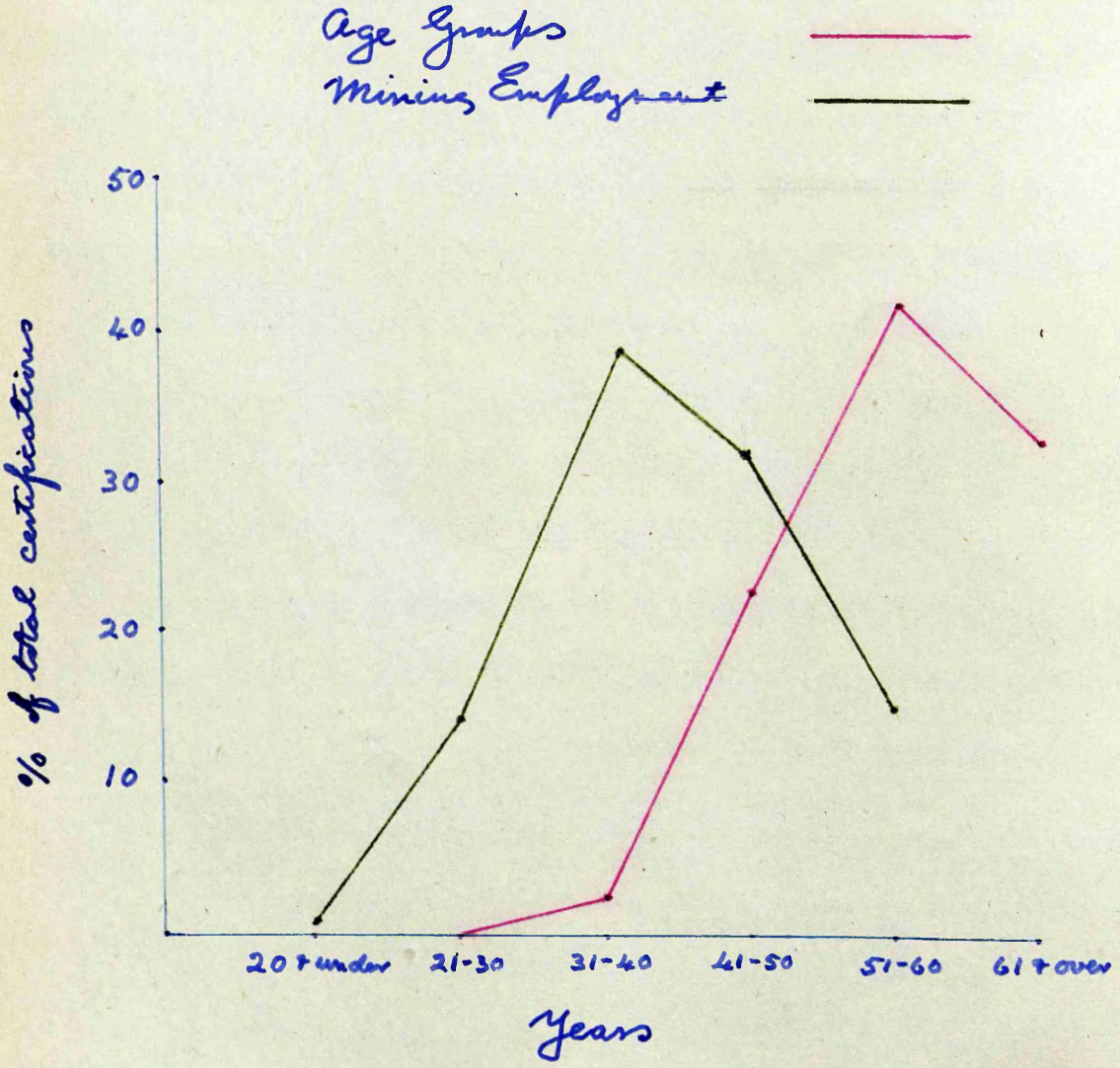
Thus it appears that in the Scottish area only 2.4 per cent of certifications occur under the age of 41 years. This reveals quite clearly that among Scottish coal-miners the main impact of disabling disease, which is the origin of applications and certifications, is almost entirely in middle and late life.

The next question for consideration is in relation to years of employment in mining work to which the disease is attributable. The great majority of the men had spent their whole working lives from the age of fourteen years, some even earlier, in the mines, although in some cases the period had been interrupted by service in H.M.Forces during the First World War. A few had engaged for short periods in non-mining occupations. In computing the period of employment in mining, these extraneous occupations have been excluded.

TABLE 13. CERTIFICATIONS ACCORDING TO YEARS OF MINING EMPLOYMENT

Employment Years	Certifications	
	Number	%
20 and under	6	0.5
21-30	184	14.0
31-40	513	39.0
41-50	421	32.0
51 & over	191	14.5
Total	1,315	100.0

CERTIFICATIONS BY AGE GROUPS AND BY YEARS OF MINING EMPLOYMENT



It emerges that the disease seldom is manifest under 20 years of mining employment.

By representing the data of Tables 12 and 13 graphically one immediately recognizes that the disease in relation to age and years of employment for all practical purposes follows an identical course, except as would be expected by reason of the age of commencement in employment, the employment curve lags 15-20 years behind the age curve. Accordingly the age at certification may be regarded generally as a fairly accurate index of the period of employment though it is not an absolute measure in individual cases.

It may be of interest to analyse likewise these same certifications according to their origin from the four main coalfields.

TABLE 14.

CERTIFICATIONS BY AGE GROUPS AND COALFIELDS

Age Groups	Coalfield							
	A		B		C		D	
	Certs.	%	Certs.	%	Certs.	%	Certs.	%
30 and under	0	0.0	0	0.0	0	0.0	0	0.0
31-40	16	1.9	5	2.8	9	5.0	0	0.0
41-50	181	22.0	50	27.9	47	26.3	21	15.7
51-60	334	40.6	79	44.2	81	45.4	59	44.0
61-70	258	31.4	44	24.6	40	22.4	51	38.1
71 and over	34	4.1	1	0.6	2	1.1	3	2.2
Total	823	100.0	179	100.0	179	100.0	134	100.0

From this table it appears that the percentage of the total certifications in Coalfields A (35.5) and D (40.3) after the age of 60 years is much greater than in Coalfields B (25.2) and C (23.5).

TABLE 15.

CERTIFICATIONS ACCORDING TO YEARS OF MINING EMPLOYMENT BY COALFIELDS

Employment Years	Coalfield							
	A		B		C		D	
	Certs.	%	Certs.	%	Certs.	%	Certs.	%
20 & under	3	0.4	2	1.1	1	0.6	0	0.0
21-30	103	12.4	31	17.4	37	20.7	13	9.6
31-40	312	37.4	78	43.7	78	43.7	45	33.3
41-50	264	31.7	60	33.6	49	27.4	48	35.5
51 & over	141	16.9	8	4.5	14	7.8	28	20.7
Total	823	100.0	179	100.0	179	100.0	134	100.0

As was found in the whole Scottish area age and period of employment run parallel in the separate coalfields though the absolute number of certifications in these areas are considerably different. These analyses are for the full period of six years 1944-1949; is the experience uniform for individual years?

TABLE 16.

CERTIFICATIONS IN SEPARATE YEARS AND IN AGE GROUPS

Age Group	1944		1945		1946		1947		1948		1949	
	Certs.	%	Certs.	%	Certs.	%	Certs.	%	Certs.	%	Certs.	%
30 & under	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
31-40	3	4.0	7	5.6	4	2.6	9	3.1	5	1.7	2	0.5
41-50	36	47.5	36	28.8	42	27.3	68	23.3	54	18.7	63	16.6
51-60	26	34.2	50	40.0	65	42.3	114	39.0	136	47.1	162	42.6
61-70	11	14.5	31	24.8	38	24.7	90	30.8	86	29.8	137	36.0
71 & over	0	0.0	1	0.8	5	3.2	11	3.8	8	2.8	15	3.9
Total	76	100.0	125	100.0	154	100.0	292	100.0	289	100.0	379	100.0

A definite trend is apparent; the number of certifications and the percentage of each year's total has steadily advanced in the older age groups, ranging from 11 or 14.7 per cent in 1944 to 152 or 39.9 per cent in 1949 among men over the age of 60 years. This would appear to be related to the analysis in Table 14 from which it emerged that Coalfields A and D have a definitely higher percentage of the total certifications in this advanced age group than have Coalfields B and C.

Lanarkshire (A) and Ayrshire (D) are the oldest coal-mining areas and in recent years there has been a considerable decline of mining in the former (see Table 1), which has been accompanied by closure of uneconomic pits and displacement of their man-power. This lends support to our previous contention that the increase of certification throughout the Scottish area during the years 1944-1949 may have been due in part to applications of displaced men, who though feeling unfit tried to carry on as long as possible. When their own pits closed down they felt disinclined and indeed unfit for work elsewhere.

AGE IN RELATION TO DISABILITY

As previously explained an application is disposed of by either certification or certificate refused. In certified cases assessment of disablement (loss of faculty) is on the basis of total (T.D.), partial (P.D.), or no disability (N.D.) and the degree of this disablement is as found at date of first

certification.

TABLE 17.

CERTIFICATIONS BY AGE AND DISABILITY

(1315 cases)

Age Group	T.D.		P.D.		N.D.		Total	
	Cases	%	Cases	%	Cases	%	Cases	%
30 and under	0	0.0	0	0.0	0	0.0	0	0.0
31-40	4	1.3	16	1.7	10	12.9	30	2.4
41-50	28	9.2	234	25.1	37	48.1	299	22.7
51-60	107	35.1	424	45.4	22	28.6	553	42.0
61 & over	166	54.4	259	27.8	8	10.4	433	33.0
All ages	305	100.0	933	100.0	77	100.0	1315	100.0

Further elucidation of these same cases is possible by examining the disposal of cases in each separate group, in which the total number of certifications in each particular age group is treated as 100 per cent.

CERTIFICATIONS BY DISABILITY IN SEPARATE AGE GROUPS

T.D. ——
P.D. ——
N.D. ——

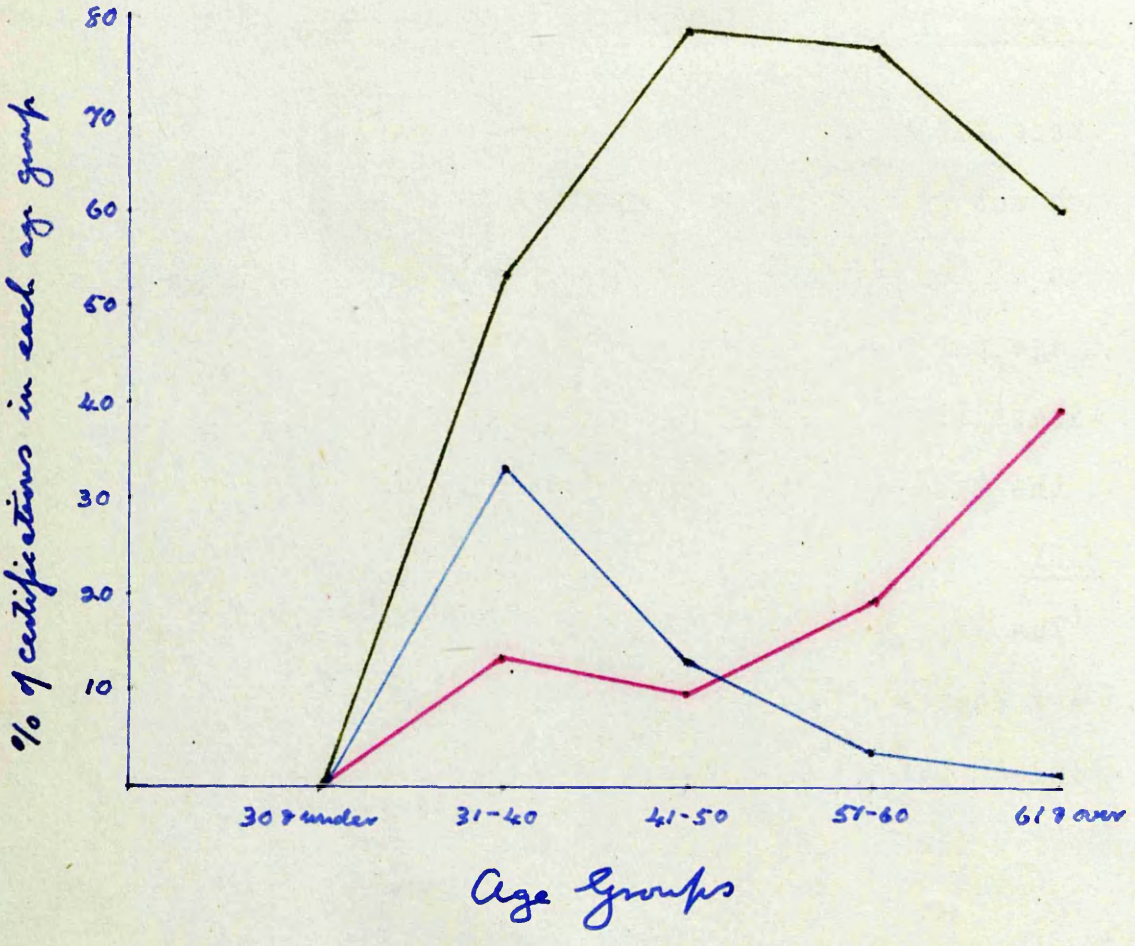


TABLE 18.

CERTIFICATIONS BY DISABILITY IN SEPARATE AGE GROUPS

Age Groups	Certifications Total	T.D. No.	T.D. %	P.D. No.	P.D. %	N.D. No.	N.D. %	All %
30 & under	0	0	0.0	0	0.0	0	0.0	100.0
31-40	30	4	13.3	16	53.3	10	33.3	100.0
41-50	299	28	9.4	234	78.3	37	12.4	100.0
51-60	553	107	19.4	424	76.6	22	3.9	100.0
61 & over	433	166	38.3	259	59.8	8	1.8	100.0
All ages	1315	305	23.2	933	71.0	77	6.0	100.0

These tables and accompanying graph reveal quite clearly, though not unexpectedly, that the degree of disability by reason of the disease increases with age. This does not mean that age per se is the only factor in determining the degree of disability for evidence will later be adduced to suggest that the type of disease is an important consideration.

SUMMARY

The 1315 certifications have been examined in relation to age and degree of disability arising from the disease. It is concluded that the highest incidence of serious disablement occurs in the advanced age groups.

CHAPTER X

PNEUMOCONIOSIS IN COAL MINING OCCUPATIONS

While all the men examined in the present investigation had been mainly employed underground in collieries, this underground work embraces a variety of occupations. Study of the detailed industrial histories of the 1315 persons certified indicates that in most cases the individual has engaged in several processes. This is not surprising for coal-mining is a skilled craft which the new entrant must acquire by practical work progressively in the many operations such as on the haulage, filling, and work at the coal face. Some, of course, specialise in repair and maintenance work, while others are promoted after certificate examination to the supervisory grades, deputies and shot-firers.

A certain number, however, gave information which showed that they had been mainly employed in one type of work long enough to suggest that any pneumoconiotic changes present were probably attributable to work in this particular occupation. This population, it was found, could conveniently be arranged according to occupation into four main groups. These are defined below together with a description of the occupation. The definitions are in accordance with those given in the Glossary of Mining Occupational Terms, prepared for the guidance of surgeons in charge of Rehabilitation Centres and Medical Referees by the Ministry of Fuel and Power.

1. Brusher and Stoneminer - a brusher is a workman engaged in ripping down the roof in roadways so as to make sufficient height for travelling or traffic purposes, and in most cases he also moves and stows away the stone or rubbish, thus made, in the roadways. A stoneminer is engaged in mine development as opposed to coal getting. His work is in stone, whereas the coal-miner works mainly in coal. The two occupations, brusher and stoneminer, are largely undertaken by the same persons, as work requires.
2. Fireman and Shotfirer. In Scotland the usual practice appears to be that these operations are carried out by the same individual. The shotfirer fires shots in cases where blasting operations are required.
3. Machineman - the man in charge of machines used in some seams to undercut the face of coal.
4. Hewer and Stripper. A hewer is a man engaged in the getting of hand-wrought coal. A stripper is a man engaged in breaking up coal after it has been under-cut by a coal-getting machine. In many cases it is very difficult to separate the two processes in the industrial histories and for this reason they are considered together.

Certain arbitrary decisions as to the allocation of workmen to the special groups should be mentioned. As has been demonstrated previously 99.54 per cent of certified cases of pneumo-

coniosis among coal-miners in Scotland occur only after an exposure of 20 years or more. Consequently only those men are included who indicated that their recent underground work fell into one of these occupational groups and that this type of employment had been carried on by them for at least 20 years; or, if the period was less, that it constituted at least two-thirds of their work in the mines. A further proviso was that, with the exception of course of the first group, there was no history of any substantial employment in brushing or stonemining. Hewers who stated that they had done their own brushing were also excluded, although it is possible that some who did not specify this may have been included.

The total number fulfilling these requirements of the four special groups was 562, or 43 per cent of all certified cases, leaving 753 others whose exposure was of mixed type. The numbers were distributed among the groups as follows:-

1. Brusher and Stoneminer	261
2. Fireman and Shotfirer	35
3. Machineman	79
4. Hewer and Stripper	187
5. Others (mixed employment)	753
Total	1315

It should be emphasised that these figures are based on persons granted certificates on account of pneumoconiosis and are not in any way related to the numbers of these type of workers employed in the coal-mining industry. Thus no indication can be derived from them of the relative incidence of pneumoconiosis in the various groups.

Some information about the disease in these groups is obtainable by classifying them in age groups, which as already suggested is equivalent to years of exposure.

TABLE 19.

CERTIFICATIONS BY OCCUPATIONS AND AGE

Age Group	Occupational Group									
	Brusher and Stoneminer		Fireman and Shotfirer		Machineman		Hewer and Stripper		Others	
	Certs.	%	Certs.	%	Certs.	%	Certs.	%	Certs.	%
30 & under	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
31-40	3	1.4	0	0.0	5	6.3	2	1.2	20	2.7
41-50	57	21.7	0	0.0	22	27.8	43	23.0	177	23.5
51-60	111	42.2	11	31.5	38	47.9	89	47.6	304	40.3
61-70	84	31.9	23	65.7	14	17.6	46	24.6	226	29.36
71 & over	6	2.3	1	2.9	0	0.0	7	3.8	26	3.5
All ages	261	100.0	35	100.0	79	100.0	187	100.0	753	100.0

When allowance is made for the gross variations in the size of the separate groups, no striking difference emerges except perhaps that the percentage of certifications among machinemen appears somewhat higher in the age groups under the age 51 years. The type of disease in these occupational groups is discussed later (see p.84).

SUMMARY

The certifications have been reviewed in relation to special occupational groups and the age of the workmen in these groups.

CHAPTER XI

COMPLICATED PNEUMOCONIOSIS IN SCOTTISH COAL-MINERS

In describing the radiological and pathological appearances of pneumoconiosis, the disease, following Davies and Mann, was classified into two main types, simple pneumoconiosis and complicated pneumoconiosis. The former includes discrete nodulation and dust reticulation, while the latter embraces all degrees of massive fibrosis.

It is now proposed to discuss these two types of the disease as they have occurred in the 1315 certified cases. For convenience of presentation, however, discussion will be restricted to complicated pneumoconiosis. It will be apparent to readers that conversely this will reflect simple pneumoconiosis.

Of the 1315 cases certified during the years 1944-1949, 358 (27.2 per cent) presented the radiological appearances of complicated pneumoconiosis.

TABLE 20.

COMPLICATED PNEUMOCONIOSIS AND TOTAL DISABLEMENT IN SEPARATE YEARS

Year	Certifications Number	Complicated Pneumoconiosis		Total Disablement	
		cases	%	cases	%
1944	76	27	35.5	27	35.5
1945	125	37	30.0	31	24.8
1946	154	62	40.0	45	29.2
1947	292	78	26.7	75	25.7
1948	289	74	25.6	64	22.2
1949	379	80	21.1	63	16.6
All years	1315	358	27.2	305	23.2

Thus it appears that throughout the six years there has been a definite increase in the absolute number of certifications by reason of complicated pneumoconiosis but the percentage incidence of these certifications in each year has decreased substantially from 35.5 in 1944 to 21.1 in 1949. The percentage incidence of certificates of total disablement has declined in like manner. Complicated pneumoconiosis does not necessarily involve total disablement and the double trend noted above would suggest that claimants are coming forward more readily at an earlier stage of the disease and before they are wholly incapacitated for work. This, as previously explained, was to

be expected especially after 5th July, 1948, as under the National Insurance (Industrial Injuries) Act,1946, certification no longer involved suspension from work and disablement benefit was payable without regard to earnings.

The next problem which presents is whether or not there exists any relation between the age of the applicant and the type of pneumoconiosis.

TABLE 21.

TYPE OF PNEUMOCONIOSIS IN RELATION TO AGE

(Scottish Area)

Age Group	Certifications Number		Complicated Pneumoconiosis Cases		% of age group	
30 and under	0	30	0	4	0.0	13.3
31 - 40	30		4		13.3	
41 - 50	299	852	49	195	16.4	22.9
51 - 60	553		146		26.4	
61 - 70	393	433	146	159	37.1	36.7
71 & over	40		13		32.5	
All ages	1315		358		27.2	

The percentage incidence of complicated pneumoconiosis progressively increases with age and conversely (by difference) the percentage incidence of simple pneumoconiosis declines. Whereas under the age of 41 years complicated pneumoconiosis accounts for 13.3 per cent of cases, over the age of 60 years

the figure is 36.7 per cent., while intermediately 41-60 years it accounts for 22.9 per cent. This suggests that age, the equivalent of period of exposure to risk, is a factor in the production of massive fibrosis or complicated pneumoconiosis. So it appears for the whole Scottish area, but does it apply equally in the constituent coalfields?

TABLE 22.

COMPLICATED PNEUMOCONIOSIS IN YEARS AND COALFIELDS

Year	Coalfield A		Coalfield B		Coalfield C		Coalfield D		Scottish Area	
	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.
1944	40	32.5	15	33.3	9	33.3	12	50.0	76	35.5
1945	75	24.0	17	35.0	20	40.0	13	38.4	125	30.0
1946	96	40.6	24	33.3	26	45.0	8	37.5	154	40.0
1947	196	29.0	31	19.3	39	23.0	26	30.8	292	26.7
1948	171	28.0	48	20.8	38	21.0	32	25.0	289	25.6
1949	245	20.0	44	22.9	47	27.7	43	21.0	379	21.1
All years	823	27.2	179	25.0	179	28.6	134	29.0	1315	27.2

TABLE 23.

TYPE OF PNEUMOCONIOSIS IN RELATION TO AGE

(Coalfields)

Age Group	Coalfield A		B		C		D		Scottish Area	
	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.
30 & under	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
31 - 40	16	12.5	5	20.0	9	11.0	0	0.0	30	13.3
41 - 50	181	13.8	50	20.0	47	17.0	21	28.6	299	16.4
51 - 60	334	26.0	79	27.8	81	28.4	59	23.7	553	26.4
61 & over	292	37.3	45	26.6	42	45.2	54	35.2	433	36.7
All ages	823	27.2	179	25.0	179	28.6	134	29.0	1315	27.2

The separate coalfields present a pattern almost identical with the whole Scottish area, and this in spite of the diversity of the total numbers in each and in the separate age groups. Thus while the percentage incidence of complicated pneumoconiosis for the Scottish area is 27.2 the corresponding figures for the coalfields A, B, C and D are respectively 27.2, 25.0, 28.6 and 29.0, with such diverse numbers of total certifications as 823, 179, 179 and 134. The same is true if individual age groups are examined.

All this lends support to the tentative conclusion that age, the equivalent of period of exposure to risk, is a factor

in the production of massive fibrosis or complicated pneumoconiosis.

In a previous section we discussed the incidence of certifications of pneumoconiosis in separate coal-mining occupations. Now it may be of some interest to investigate the type of the disease in these same groups.

TABLE 24.

TYPE OF PNEUMOCONIOSIS IN OCCUPATIONAL GROUPS

Age Group	Brusher & Stoneminer		Fireman & Shotfirer		Machine-man		Hewer & Stripper		Others	
	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.	Certs.	% C.P.
50 & under	60	23.3	0	0.0	27	15.0	45	13.3	197	14.7
51 - 60	111	36.0	11	27.3	38	28.9	89	19.1	304	25.0
61 & over	90	45.5	24	25.0	14	35.7	53	35.9	252	34.7
All ages	261	36.0	35	25.7	79	25.3	187	22.7	753	25.6

This again reflects the increasing incidence of complicated pneumoconiosis with advancing age as already noted in the whole Scottish area and in the individual coalfields. In the case of brushers and stoneminers, that is, miners whose work is predominantly in the stone as compared with those who are mainly employed in the getting or handling of coal, the incidence of complicated pneumoconiosis not only increases with age but is relatively more common at all ages. This suggests that working in stone may be a further factor in the causation

of complicated pneumoconiosis. Massive fibrosis or complicated pneumoconiosis is a more advanced pathological state than simple pneumoconiosis. While in general the more advanced the degree and type of the disease the more advanced is the degree of disablement, simple pneumoconiosis may cause total disablement and complicated pneumoconiosis may still be consistent with considerable working capacity. This is regularly revealed by the number of men who appear for examination and who record that they have worked regularly for years immediately previously. The actual facts of the cases in the present series may be worthy of scrutiny.

TABLE 25.

DISABLEMENT IN COMPLICATED PNEUMOCONIOSIS

(358 cases)

Age Group	Total Disablement			Partial Disablement			No Disablement	
	total certs.	C.P. cases	%	total certs.	C.P. cases	%		
30 & under	0	0	0.0	0	0	0.0	0	0.0
31 - 40	4	1	25.0	16	3	18.8	10	0.0
41 - 50	28	14	50.0	234	35	14.9	37	0.0
51 - 60	107	62	57.9	424	84	19.8	22	0.0
61 - 70	156	94	60.3	232	52	22.4	5	0.0
71 & over	10	8	80.0	27	5	18.5	3	0.0
All ages	305	179	58.7	933	179	19.2	77	0.0

Complicated pneumoconiosis, it appears, has in every case caused some degree of disablement. In the case of total disablement certifications 58.7 per cent exhibited complicated pneumoconiosis. Simple and complicated pneumoconiosis have both resulted in total incapacity for work. However, while 50 per cent of the 358 persons suffering from complicated pneumoconiosis were certified to be totally disabled, the corresponding figure in respect of the 957 cases of simple pneumoconiosis was only 13.2 per cent.

So far then evidence has been adduced which suggests that age or period at risk is a factor in the etiology of massive fibrosis or complicated pneumoconiosis. In individual occupations stone work may be another contributory factor. Throughout the literature reference is always made to the influence of infection, notably tuberculosis, but relative to the present cases we have no direct information on this aspect of the problem. It is possible, however, to study our cases in conjunction with official statistics on tuberculosis. According to the latest published figures of the Registrar-General for Scotland (1936) the comparative mortality rate for coal-mining occupations is 108.2 (average 100). It is stated that this mortality rate is consistently above the average for each age, and is largely due to deaths from accidental causes and respiratory diseases. Mining and Quarrying occupations are

listed among those showing a low mortality rate from respiratory tuberculosis (70), but on the other hand these same occupations have a high mortality rate from bronchitis and pneumonia (151). If, as is frequently stated, complicated pneumoconiosis represents dust fibrosis modified by tuberculous infection or indeed a modified manifestation of tuberculosis in a dusted lung, it would be reasonable to expect that complicated pneumoconiosis would in general vary directly with the incidence of tuberculosis in separate coal-mining areas. This is all the more probable as most miners tend to spend their whole lives in the same geographical area.

For convenience the following facts are reproduced:

TABLE 26.

INCIDENCE OF PNEUMOCONIOSIS BY COALFIELDS

(1315 certifications)

Pneumoconiosis	Coalfield							
	A		B		C		D	
	cases	%	cases	%	cases	%	cases	%
simple	600	72.8	134	75.0	128	71.4	95	71.0
complicated	223	27.2	45	25.0	51	28.6	39	29.0

This reveals that the percentage incidence of certifications of the two types of pneumoconiosis is almost identical in the four coalfields. It has been shown, however, that the certification rate (see page 52) varies throughout these coalfields.

These rates are A 4.61, B 1.96, C 3.73, and D 2.34. It is now possible to relate the certification rates of pneumoconiosis to the death rate for respiratory tuberculosis and bronchitis and pneumonia in the corresponding areas as recorded by the Registrar-General (1936).

TABLE 27.

PNEUMOCONIOSIS IN RELATION TO RESPIRATORY TUBERCULOSIS AND BRONCHITIS AND PNEUMONIA

Area	Deaths per 1000 population		Coalfield and Pneumoconiosis Cert. Rate		
	Resp. Tub.	Bronchitis & Pneumonia			
Lanark County	0.82	2.97			
Airdrie Burgh	0.61	2.26		Simple	3.36
Hamilton Burgh	0.66	2.43	A.	Complicated	1.25
Motherwell & Wishaw Burghs	0.61	2.49		All	4.61
Stirling County	0.57	1.85			
Falkirk Burgh	0.70	2.38			
Fife County	0.52	1.47			
Cowdenbeath	0.42	-		Simple	1.47
Lochgelly	0.40	-	B.	Complicated	0.49
Leven	0.38	-		All	1.96
Buckhaven & Methil	0.57	-			
Midlothian County	0.78	1.96			
Dalkeith	0.51	-			
Loanhead	0.64	-		Simple	2.66
East Lothian County	0.54	1.18	C.	Complicated	1.07
Tranent	1.01	-		All	3.73
Prestonpans	0.49	-			
Ayr County	0.57	1.69		Simple	1.66
Cumnock & Holmhead	0.44	-	D.	Complicated	0.68
				All	2.34

In this comparison there is a possible source of fallacy in so far as the population used by the Registrar-General comprises all ages whereas the pneumoconiosis certification rate is based on a male population aged 14 years and upwards. Furthermore, these figures relate to mortality from tuberculosis and not to tuberculous infection. As revealed by tuberculin tests on adults, however, it is to be expected that practically all the miners who were certified were tuberculin positive.

It emerges that the certification rate of pneumoconiosis (and it applies equally to simple and complicated pneumoconiosis) in the four main Scottish coalfields runs fairly parallel to the death rates for respiratory tuberculosis and acute respiratory infection in the same areas.

It has already been remarked that according to the Registrar-General (1936) the comparative mortality rate from tuberculosis among miners is low - 70, a fact which has long been remarked. Ogle (1885) in the Decennial Supplement to the Report of the Registrar-General observes:

> "The mortality of coal miners from phthisis is remarkably low, especially when their liability to irritation of the lungs from dust.....is taken into account".

In the succeeding Decennial Supplement Tatham (1897) writes:

> "Coal miners as a class do not suffer excessively from pulmonary consumption, their mortality being scarcely more than half the standard among occupied males".

Many other observers have confirmed these statements and scientists have sought an explanation. Gardner (1933) demonstrated that 'coal dust inhibits the growth of the tubercle bacillus' and Cummins (1934) writes:

"The coal miner seems to escape because coal dust so modifies and detoxicates the phthisical lung lesions that the condition of tuberculosis, though present, escapes recognition and is therefore absent from the death reports on which the Registrar-General's death statistics are based".

In effect the submission of these authors and many others is that infective fibrosis, massive fibrosis and complicated pneumoconiosis represent modified tuberculosis.

Our analysis of 1315 cases of pneumoconiosis in Scottish coal-miners shows that the incidence of certification in the separate coalfields is closely parallel to the respiratory tuberculosis mortality rate in the same areas. The really significant conclusion,however, is that this applies equally whether the disease is simple pneumoconiosis or complicated pneumoconiosis. This then would appear to suggest that <u>if</u> there is some relation between coal-miners' pneumoconiosis and tuberculous infection, it is in inducing the disease in general rather than any particular type. What then determines complicated pneumoconiosis? In our opinion, as already discussed, age is the material factor and age is an index of period of

exposure at risk. Stone dust may be another factor. This points to quantity and quality of dust.

It is not claimed that we have proved that complicated pneumoconiosis is essentially due to quantity and quality of the noxious dust cloud, but we do suggest that these are important factors hitherto obscured by the emphasis on the part played by the tubercle bacillus.

In the elucidation of the etiology of pneumoconiosis, this complex problem of the separate or combined rôles of dust and the tubercle bacillus, is the greatest challenge to the experimental pathologist. Though as yet we do not know the answer we cannot delay preventive action. The control of airborne dust demands the unremitting attention of all engaged in mining coal (Bryan, 1947,1948,1949, Meiklejohn,1950).

SUMMARY

The 1315 certified cases of pneumoconiosis are reviewed with particular reference to the occurrence of complicated pneumoconiosis. This is discussed in relation to age incidence, degree of accompanying incapacity for work, nature of employment in the mines and the rôle of tuberculous infection.

CHAPTER XII

SOME OBSERVATIONS ON POST-MORTEM EXPERIENCE AMONG SCOTTISH COAL-MINERS

Our purpose here is to record our experience of post-mortem findings in relation to the 1914 applicants.

Up to 31st December,1950, the Medical Board had investigated by post-mortem examination the deaths of 116 of these workmen and in 88 of these it was certified that the death of the workman had been caused either by pneumoconiosis or by pneumoconiosis accompanied by tuberculosis. It should be explained that 'death has been caused by' includes not only cases in which death was entirely attributable to the disease but also all cases in which the pneumoconiosis materially contributed to the fatal issue. In the remaining 28 cases death was due to causes other than pneumoconiosis, although as will appear a degree of pneumoconiosis was present in some of them. This difficult problem of death certification in relation to silicosis, which applies equally to coal-miners' pneumoconiosis, has been carefully reviewed by Meiklejohn (1949).

DEATHS DUE TO PNEUMOCONIOSIS

Of the 88 cases in this category, 55 showed complicated pneumoconiosis and 33 simple pneumoconiosis. In 72 death was directly attributable to the disease and its integral complications, while in the other 16 it was a material contributory factor. The post-mortem examination and histological investi-

gation in every instance were completed by a specialist pathologist.

TABLE 28.

DEATH DUE TO PNEUMOCONIOSIS ACCORDING TO TERMINAL EVENT

(72 cases)

Type of Pneumoconiosis		Terminal Event
Simple	Complicated	
No. of cases	No. of cases	
17	32	Congestive heart failure
2	10	Active tuberculosis of lungs
6	2	Pneumonia
1	1	Empyema
0	1	Spontaneous pneumothorax
26	46	

In 16 other cases extraneous diseases were present but in all of these the degree of pneumoconiosis was so advanced as to be adjudged, for certification purposes under the compensation scheme, the determining cause of death.

TABLE 29.

DEATH DUE TO PNEUMOCONIOSIS IN ASSOCIATION WITH EXTRANEOUS DISEASE

(16 cases)

Type of Pneumoconiosis		Extraneous Disease
Simple	Complicated	
2	4	Coronary artery disease
2	1	Mitral disease
1	0	Pericarditis
0	4	Early gastric carcinoma
1	0	Perforated gastric ulcer
1	0	Papillomatosis of urinary bladder
7	9	

Thus it emerges that active tuberculosis of the lungs occurred in 13.7 per cent of these 88 deaths attributed to pneumoconiosis, 6 per cent associated with simple pneumoconiosis and 18.2 per cent associated with complicated pneumoconiosis. McVittie (1949) in a similar analysis of 300 cases among South

Wales coal-miners records an incidence of tuberculosis of 3.5 per cent among 86 cases of simple pneumoconiosis and 29.9 per cent among 214 cases of complicated tuberculosis.

The numbers, other considerations apart, are too small for comparative purposes or to reflect accurately the influence of tuberculosis on pneumoconiosis. It does appear, however, that fatal tuberculosis is more commonly associated with complicated than with simple pneumoconiosis.

DEATHS NOT DUE TO PNEUMOCONIOSIS

This group numbered 28. Of these, 20 during life had been granted certificates in respect of pneumoconiosis and this diagnosis was confirmed at necropsy in all cases. The death, however, had not been caused or materially accelerated by the disease, but was due to extraneous causes. It is fair to record that in many cases the extraneous disease was recognized by the Medical Board in the course of the original clinical examination.

TABLE 30.

CERTIFIED CASES - DEATH DUE TO EXTRANEOUS CAUSES

(20 cases)

Cause of Death	No. of cases
Primary bronchial carcinoma	4
Carcinoma - other organs	5
Lymphosarcoma	1
Lymphadenoma	1
Strangulated hernia	1
Coronary thrombosis	4
Subarachnoid haemorrhage	1
Nephritis	1
Reticulosis	1
Rheumatoid arthritis	1
	20

In the remaining 8 cases pneumoconiosis was not diagnosed during life and a certificate was accordingly refused. These 8 cases were all notified to the Medical Board and a necropsy was completed; others refused a certificate during life may have died but as no claim for a certificate of death under the schemes was made, the Medical Board had no opportunity of post-mortem investigation. In 4 cases there was no evidence

of pneumoconiosis and in the other 4 cases it was of such slight degree that it would not appear radiologically.

TABLE 31.

REFUSED CASES - DEATH DUE TO EXTRANEOUS CAUSES

(8 cases)

Cause of Death	No.of cases
Primary bronchial carcinoma	2
Carcinoma - other organs	1
Coronary thrombosis	2
Mitral disease	1
Perforated gastric ulcer	1
Bronchitis and emphysema	1
	8

SUMMARY

Of the 1914 applicants, which are the subject of study, the death in 116 cases has been investigated by post-mortem examination by the Medical Board. In each instance the post-mortem examination was conducted by a specialist pathologist. The causes of death have been reviewed in relation to the disposal of the cases in life. There is almost complete correlation between the diagnosis in life and at death. Tuber-

culosis as a fatal complication appears more commonly in complicated pneumoconiosis than in simple pneumoconiosis. This accords with the experience among South Wales coal-miners.

CHAPTER XIII

RE-EXAMINATION OF REFUSED CASES

As has been stated earlier 599 of the 1914 applicants during the six years 1944-49 were refused a certificate in respect of pneumoconiosis. It will be recalled, however, from the explanations given in chapter V that a number of those included in the certifications were refused in the first instance through lack of specific evidence of the disease but were subsequently granted certificates on re-examination following further application. This number (126) added to the 599 persistently refused cases makes a total of 725 who were refused certificates at the first examination. Of these 312 made application for re-examination on one or more occasions.

An attempt is made in this section to examine the disposal of all applications in which a certificate was refused at the first examination. The cases considered here are those initially refused in the 1944-49 series but with the object of giving applicants in the year 1949 who were not granted a certificate opportunity for further examination, the period of review has been extended to 31st December,1950. This in effect means that all cases have had a minimum period of one year in which to make further applications, while those who originally applied early in 1944 have had nearly seven years. Furthermore, there is no restriction as to the number of times on which re-

application can be made but, as will appear, those who do re-apply usually do so within twelve months of the original refusal and few proceed beyond two re-applications. One workman did, in fact, make nine re-applications. Each case is finally determined by certificate granted or certificate refused and this may follow the first re-examination or a subsequent re-examination. Accordingly after each re-examination the number who do or can proceed to further re-examination progressively diminishes.

In order to present the data to cover the number of re-examinations and the time interval the following arbitrary procedure has been adopted.

The original application is called the initial examination, and so the re-examinations are one, two to nine as set out in column 1 of Table 32.

If only one re-examination was made then the disposal is recorded as certificate granted (C) or refused (R) in the appropriate year column, (e.g.) one re-examination made between 3 and 4 years would be recorded as C or R in columns 8 (-4) opposite 1. On the other hand a workman might proceed to five re-examinations ceasing finally between 4 and 5 years; this case would fall opposite 5 as C or R in column 9 (-5). Column 2 gives the number of examinees carried forward to each re-examination while column 12 gives the number finally disposed

of at each re-examination up to the end of December,1950. It follows that the difference between columns 2 and 12 represents the number proceeding to the next re-examination. Thus 47 made 3 re-applications and of these 22 were disposed of, certificate granted 6, refused 16, who did not persist; the difference is 25 (47 minus 22) proceeding to further re-examination.

TABLE 32.

DISPOSAL OF REFUSED CASES AFTER RE-EXAMINATION

(312 cases)

1	2	3	4	5	6	7	8	9	10	11	12
No. of re-exam.	No. of refused cases re-examined	Disposal	Period in years elapsing between first and last examinations.							No. of re-examinations completed	
			6/12	-1	-2	-3	-4	-5	-6		
1	312	C	19	45	15	5	7	3	3	97	215
		R	17	49	25	11	7	7	2	118	
2	97	C			10	1	2	2		15	50
		R		3	22	7		2	1	35	
3	47	C			4	1		1		6	22
		R			5	7	1	2	1	16	
4	25	C			1	1				2	14
		R				8	1	3		12	
5	11	C								0	7
		R				1	3	3		7	
6	4	C								0	1
		R				1				1	
7	3	C								0	1
		R								1	
8	2	C							1	1	1
		R								0	
9	1	C								0	1
		R						1		1	

The area framed in red is the important part of the table, because the time period of one year permits ample opportunity for re-examination and before further exposure might reasonably alter the condition. It emerges that of 725 cases who were refused a certificate on the initial examination, 312 made re-

application and of these 138 were finally disposed of within one year. In that period 64 or 8.8 per cent of the original 725 were granted a certificate. It is submitted that this represents a very small proportion as there are always a large number of borderline cases which cause difficulty because of the variations in radiological technique and in the quality of the films (Fletcher and Oldham, 1949).

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Pneumoconiosis of coal-miners as an incapacitating disease resulting in considerable wastage of labour in the mining industry throughout Great Britain, has constituted a major social and economic problem in this country particularly during the last ten years. The main focus has been on the South Wales coalfield and the literature on the subject has largely been related to experience in that area. In this thesis an attempt has been made for the first time to record the present situation in the Scottish coalfield. The investigation has been made during the last four years and consists of a critical review of all the cases (1315) certified under the Coal Mining Industry Pneumoconiosis (Compensation) Scheme,1943, and the National Insurance (Industrial Injuries) Act,1946, during the six years 1944-1949.

As a general background to the analyses brief reference is made to the geographical and geological features of the area. A short account is given of the accepted clinical, radiographic and pathological appearances of the disease, and these are further illustrated by a series of representative exhibits contained in an appendix. The development of the law and the existing legal provisions as to the disposal of cases by the Pneumoconiosis Medical Panels is explained.

Data, derived from official records, are presented to

shew that pneumoconiosis - simple and complicated - occurs among coal-miners in Scotland. The disease has been recognized in all the constituent coalfields and all the colliery districts within these. Since 1944 the number of certifications on account of the disease has substantially increased not only in the Scottish area as a whole but throughout all the divisions. Evidence is adduced that there has been an increase in cases of the "silicotic" type and this is considered to indicate a real increase in the actual occurrence of the disease (all forms of pneumoconiosis) within recent times. The broader scope of recent compensation legislation, the retiral of older and unfit workmen, the closure of pits and increased radiological facilities are all considered to have contributed to the progressive incidence of certifications between the years 1944 and 1949.

It is noted that the increase is not uniform in the separate coalfields and the local factors which may have influenced these differences are discussed. From an analysis of cases which could reasonably be attached to individual pits, it is submitted that there is no reliable evidence which would justify the common allegation that certain pits are bad.

The main factors which determine a high certification rate in an area are considered to be local underground conditions such as dry workings, thin seams and frequent faulting with

intrusion of stone into the production area.

The relationship between age and degree of disability arising from the disease has been examined and it is concluded that the degree of disablement advances with age. Certified cases of the disease have seldom occurred under the age of 40 years, which is the equivalent of 20 years' working. In this matter age reflects fairly accurately the length of exposure in years to the dust risk. It is further shewn that complicated pneumoconiosis, a more advanced type of the disease than simple pneumoconiosis, is more common in the older age groups and this form of the disease is invariably associated with some degree of disability and is at the same time the most common cause of total incapacity for work.

The possible relationship of pneumoconiosis to tuberculous infection is discussed and it is revealed that the certification rates of pneumoconiosis in the separate coalfields are closely related to the mortality rates from tuberculosis of the lungs in the same geographical areas. As this is true of certification rates for both forms of pneumoconiosis, simple and complicated, it is submitted that <u>if</u> there exists any etiological relationship between pneumoconiosis and tuberculosis, it is as a general influence and is not restricted to complicated pneumoconiosis.

As a measure of the accuracy of the 1315 certifications, on which the study is based, reference is made to necropsy findings in cases from the series, who have since died, and to the disposal after re-examination of cases in which a certificate was originally refused.

GENERAL CONCLUSIONS

Pneumoconiosis is at present a serious risk to health and to the working capacity of coal-miners in all the main coalfields in Scotland. During the years 1944-49 there has been a substantial progressive increase in certifications by reason of the disease and more recent experience suggests that this upward trend has not yet been arrested.

RECOMMENDATION

The various factors which influence the occurrence and type of the disease are many and complex. Whether certain places underground are more dangerous than others, and whether men engaged in certain operations are more seriously exposed than others, is not yet determined. The only causative agent which can, without fear of contradiction, be indicted is the dust. It may be that the quality of the dust is important but quantity itself cannot be ignored. Again certain individuals by reason of their constitution may be more susceptible than others. Until more precise scientific knowledge about the cause of the disease is available the only reasonable

approach to prevention is an all-out and unremitting attack against all dust in all coal-mines.

APPENDIX I

BLOOD PRESSURE IN RELATION TO PNEUMOCONIOSIS OF COAL-MINERS

In this thesis we have not been concerned to examine critically the clinical features of the disease. The blood pressure in such cases, however, is a matter of frequent reference by authors and as readings were available in 1305 applicants, it was considered that it might be of some value if only for reference purposes, to include these in an appendix.

The actual estimations were made by the auscultatory method using a mercury sphygmomanometer. The readings were made in the course of the clinical examination and always before any exercise tolerance test had been carried out. In general the recorded reading is the mean of three observations made in uninterrupted succession. For uniformity the reading in certified cases is at date of first certification and in consistently refused cases as at date of first refusal. It will be appreciated that all these medical examinations are related to workmen's compensation with the effect that a degree of attendant nervousness may have influenced the blood pressure temporarily.

The tabulation of the findings is similar to that used in the M.R.C.South Wales Report,1942. The blood pressure readings are divided into arbitrary classes as follows: Class (a) systolic under 160 m.m. of mercury with diastolic under 95 m.m.; Class (b) systolic under 160 m.m. with diastolic 95 to 99 m.m. or systolic 160 to 169 m.m. with diastolic under 100 m.m.;

Class (c) systolic 180 m.m. or over, or diastolic 100 m.m. or over or both. Class (a) is regarded as normal, and Classes (b) and (c) abnormal for comparison.

TABLE A

BLOOD PRESSURE ACCORDING TO DEFINED CLASSES

All Cases

Age	Number	Class (number)			Class (per cent)	
		a	b	c	b & c	c
39 & under	27	19	3	5	29.6	18.5
40 - 49	288	239	13	36	17.0	12.5
50 - 64	796	521	68	207	34.5	27.0
65 & over	194	93	21	80	52.1	41.2
All ages	1305	872	105	328	33.2	25.1

TABLE B

Age	Certifications						Refusals					
	Number	Class			Class %		Number	Class			Class %	
		a	b	c	b & c	c		a	b	c	b & c	c
39 & under	8	5	1	2	37.5	25.0	19	14	2	3	26.3	16.0
40 - 49	150	126	9	15	16.0	10.0	138	113	4	21	18.1	15.1
50 - 64	591	391	57	143	33.8	24.3	205	130	11	64	36.6	31.2
65 & over	166	80	20	6	51.8	39.8	28	13	1	14	53.6	50.0
All ages	915	602	87	226	34.2	24.7	390	270	18	102	30.9	26.2

TABLE C

Age	Simple Pneumoconiosis						Complicated Pneumoconiosis					
	Number	Class No.			Class %		Number	Class No.			Class %	
		a	b	c	b & c	c		a	b	c	b & c	c
39 & under	6	5	0	1	20.0	20.0	2	0	1	1	100.0	50.0
40 - 49	138	118	8	12	14.5	8.8	12	8	1	3	33.0	25.0
50 - 64	461	304	46	111	34.1	24.1	130	87	11	32	33.0	24.6
65 & over	105	50	13	42	52.4	40.0	61	30	7	24	50.8	39.3
All ages	710	477	67	166	32.8	23.4	205	125	20	60	39.0	29.5

With the exception of the 39 and under age group in which the numbers are small it is evident that there is a progressive increase in the percentage of abnormal readings with advancing age and that this trend and the percentages are practically the

same in all categories - complicated pneumconiosis, simple pneumoconiosis and refusals.

TABLE D

MEAN SYSTOLIC AND DIASTOLIC BLOOD PRESSURE

Age	Simple Pneumoconiosis.			Complicated Pneumoconiosis.			Refusal.		
	No.	Mean Blood Pressure. Systolic	Diastolic	No.	Mean Blood Pressure. Systolic	Diastolic	No.	Mean Blood Pressure. Systolic	Diastolic
39 & under	6	147.1	89.4	2	158.0	90.0	19	135.1	86.1
40 - 49	138	133.9	87.7	12	142.7	93.4	138	135.9	87.2
50 - 64	461	148.0	87.6	130	148.0	90.6	205	147.6	91.1
65 & over	105	157.1	96.6	61	155.4	93.5	28	158.0	96.4
All ages	710	146.3	88.9	205	149.9	91.7	390	143.5	89.8

Again, excluding age group 39 and under, the picture in regard to the mean blood pressures is similar to that seen in connection with the percentage of abnormal readings.

As in the South Wales findings there is no material difference either in the mean blood pressure readings or in the percentage of abnormal classes in the different X-ray categories. It is true that if taken over all ages the readings in the above analysis both as regards the mean blood pressures and the percentage of abnormals are higher than those recorded in the South Wales Survey. However, it is important to note that 43.0 per cent of the men examined in South Wales were below 40 years of age as against only 2.1 per cent in Scotland while the corresponding figures for men over 65 years were Scotland 14.5 and South Wales 0.9 per cent.

No strictly comparable normal group of similar age, occupational type or social class could be found for comparison, but McKinlay and Walker (1935) carried out a series of examinations on presumably healthy unemployed men with a view to estimating their suitability for admission to a course of training for heavy manual labour. The ages of the men ranged from 18 to 40 years of age. The 30-40 age group numbering 45 showed a mean systolic pressure of 132.7 m.m. of mercury and a mean diastolic pressure of 85.7 m.m. In the 40-49 age group of this present study numbering 288 men the corresponding figures

are 135.2 m.m. and 88.0 m.m. of mercury respectively.

From the above facts it seems reasonable to conclude that there is no evidence to suggest that coal-miners' pneumoconiosis is necessarily accompanied by an increase of blood pressure.

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APPENDIX II

RADIOLOGICAL AND PATHOLOGICAL APPEARANCES OF PNEUMOCONIOSIS OF COAL-MINERS

(Illustrations)

In this section a representative series of X-ray films, large tissue sections of lungs, and photo-micrographs are presented to illustrate the radiological and pathological appearances of coal-miners' pneumoconiosis as described in Chapter VI.

1. Normal.
2. Simple Pneumoconiosis (dust-reticulation) - fine type.
3. Simple Pneumoconiosis (dust-reticulation) - coarse type.
4. Simple Pneumoconiosis (silicosis) - nodular type.
5. Complicated Pneumoconiosis (massive fibrosis).
6. Complicated Pneumoconiosis (massive fibrosis).
7. Pneumoconiosis accompanied by Tuberculosis.

The exhibits in this section have been selected as far as possible from cases included in the series which has been the subject of study. This being so they do not always represent the best possible illustrations, but they are sufficiently good to demonstrate the essential features of the disease. In some instances it has been necessary to select pathological exhibits from my general collection as these more appropriately represent

the condition which it is desired to illustrate. The source of each exhibit is clearly shewn in the explanatory notes preceding each category.

ACKNOWLEDGMENTS

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Professor G.L.Montgomery, University of Glasgow.

Professor J. Glaister, University of Glasgow.

NORMAL

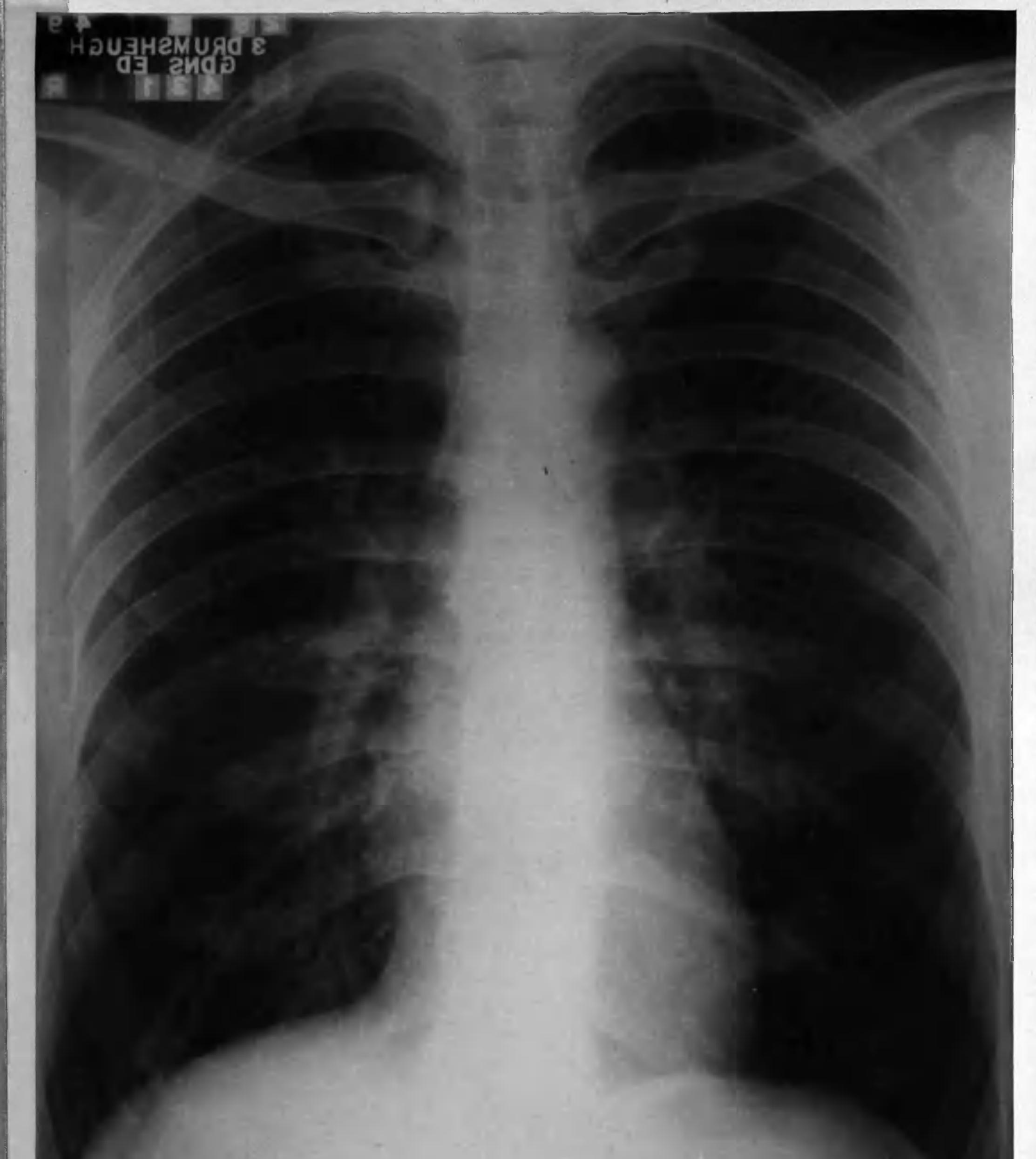
No history of occupational dust hazard.

1. X-ray film: adult male.

2. Large tissue section of lung (actual): adult male.

3. Photo-micrograph: normal lung tissue.

   (The magnification in this and all subsequent photo-micrographs is 120)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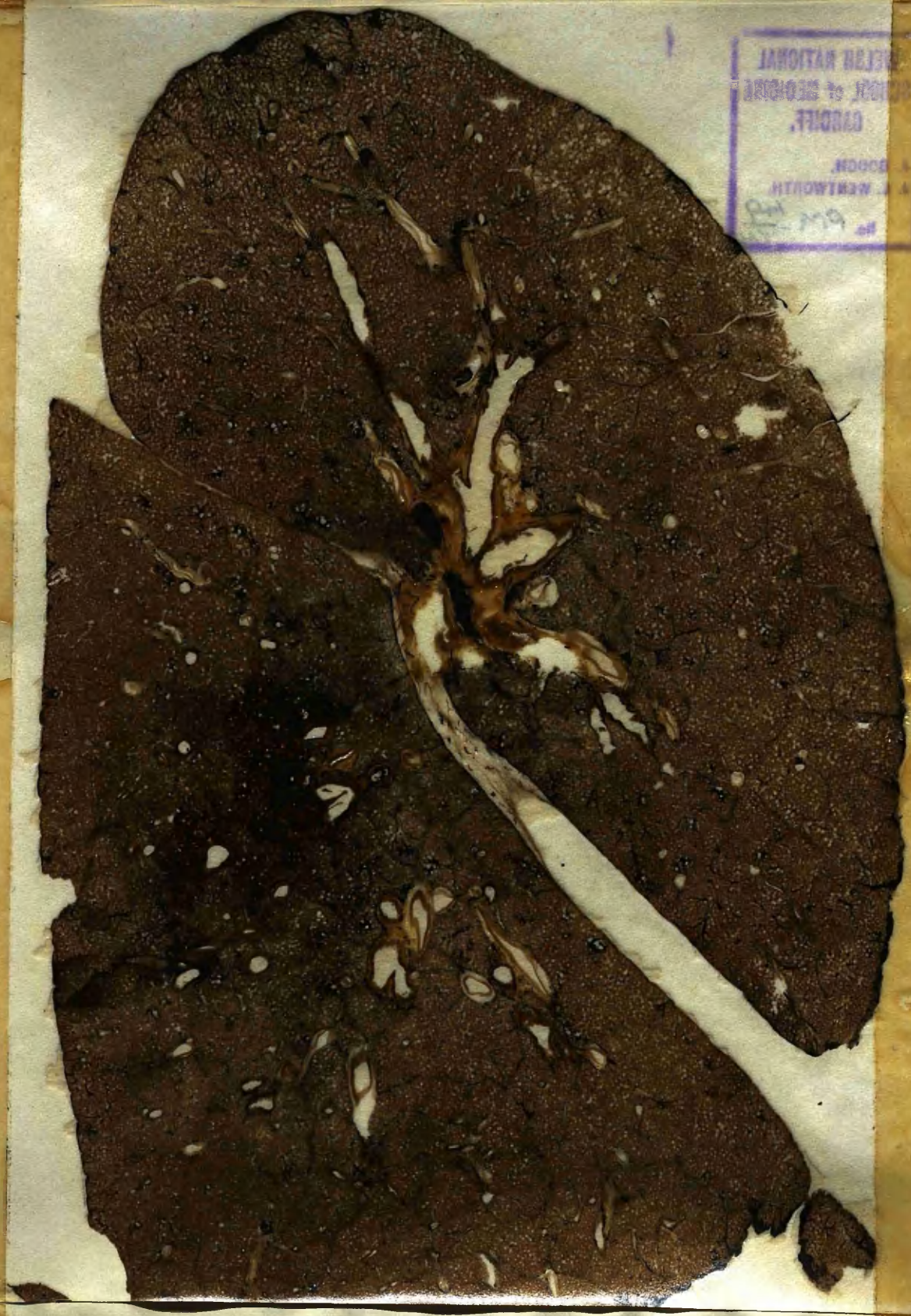


SIMPLE PNEUMOCONIOSIS

(Dust reticulation: fine type)

Certified case from series: actual exhibits.

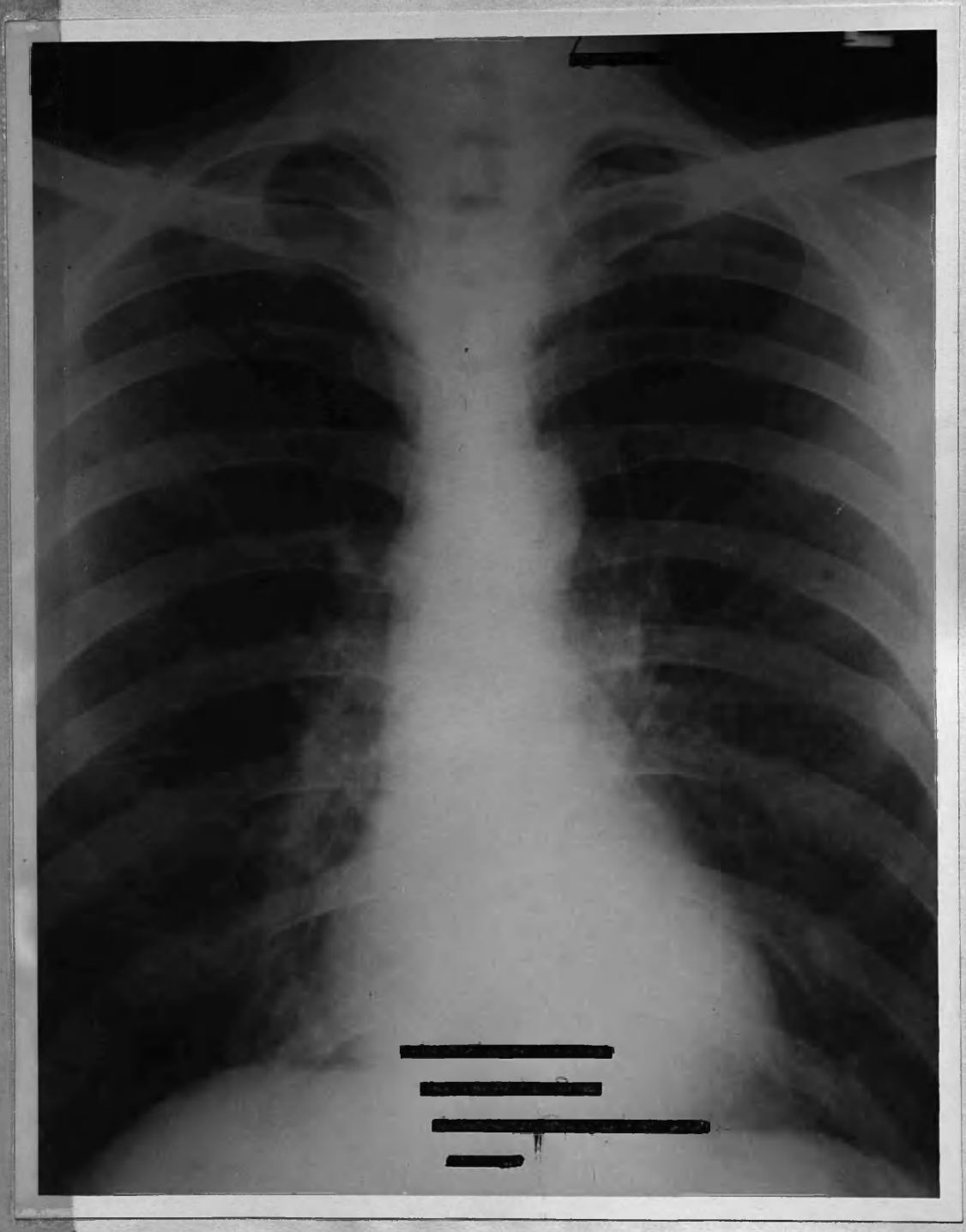
1946 Aged 53 years. Lanarkshire (A3).

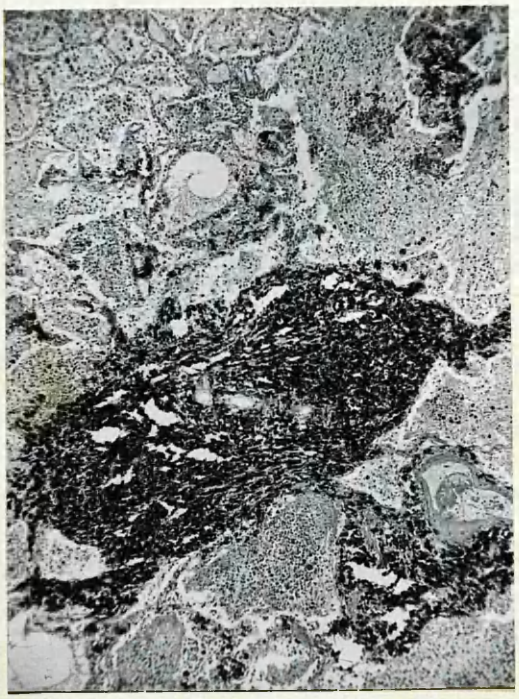
Coal-miner 34 years - hewer, stripper and machine-man.

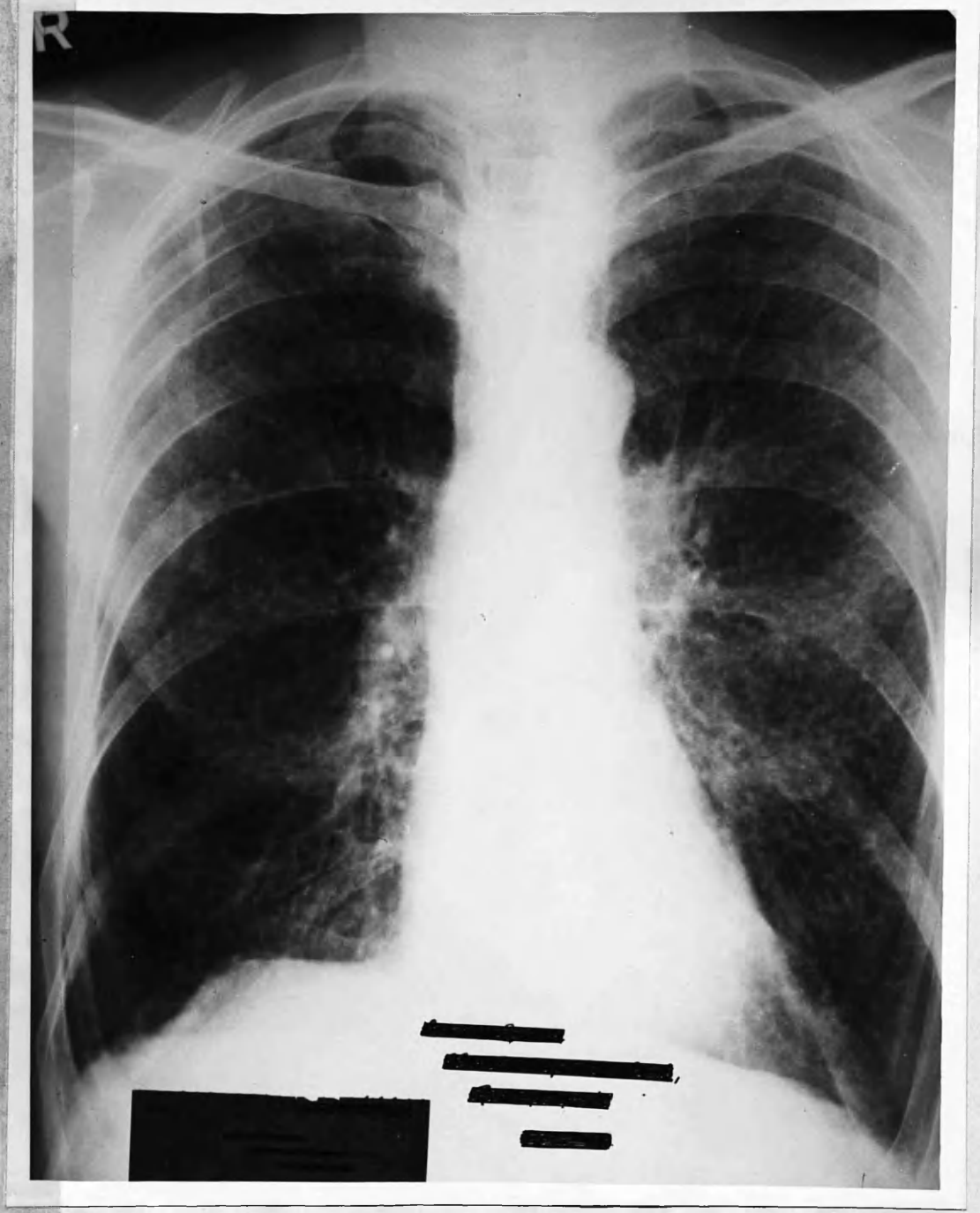
Certificate of total disablement.

1950 Died aged 57 years.

Simple pneumoconiosis and acute broncho-pneumonia.



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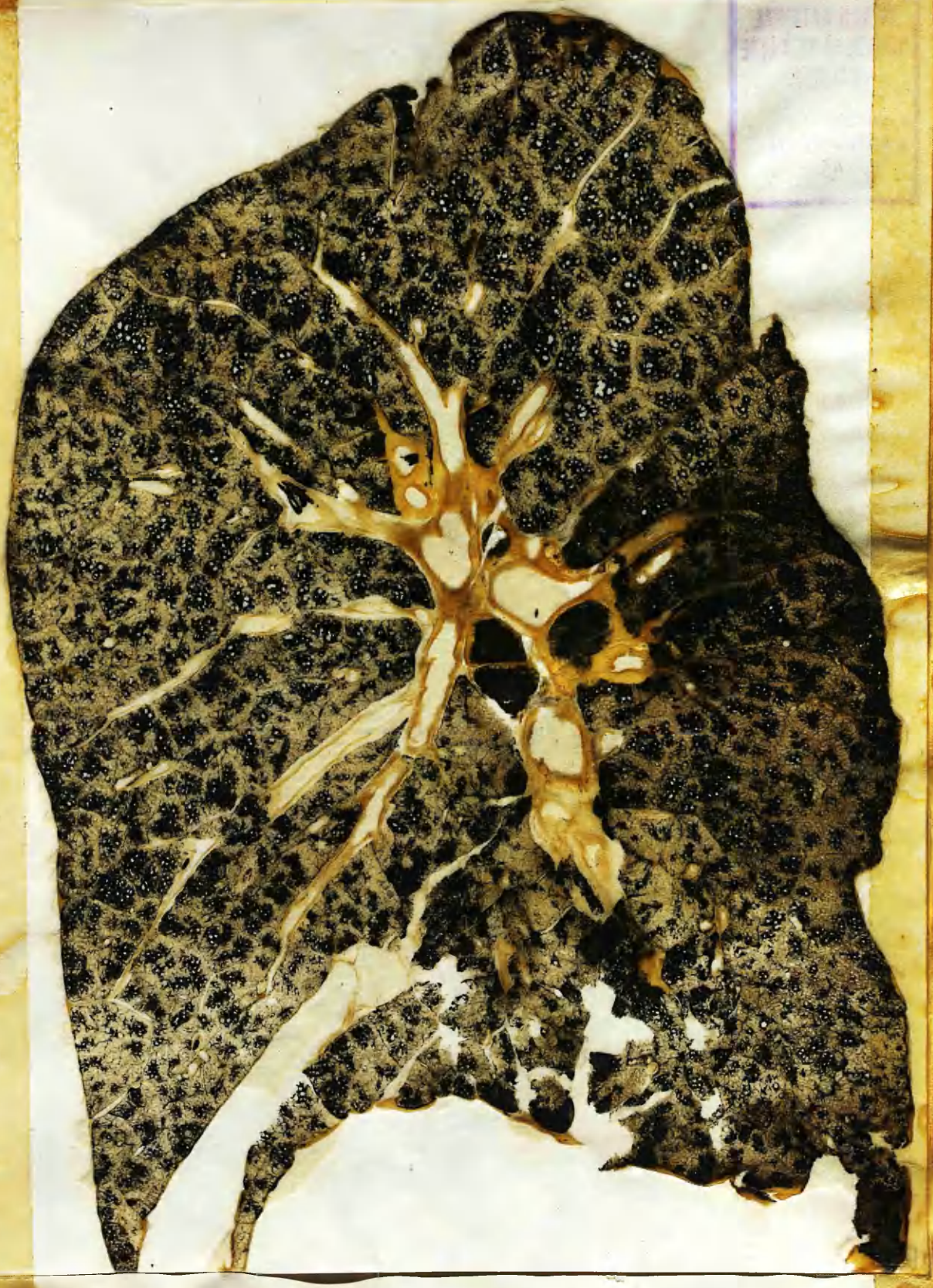
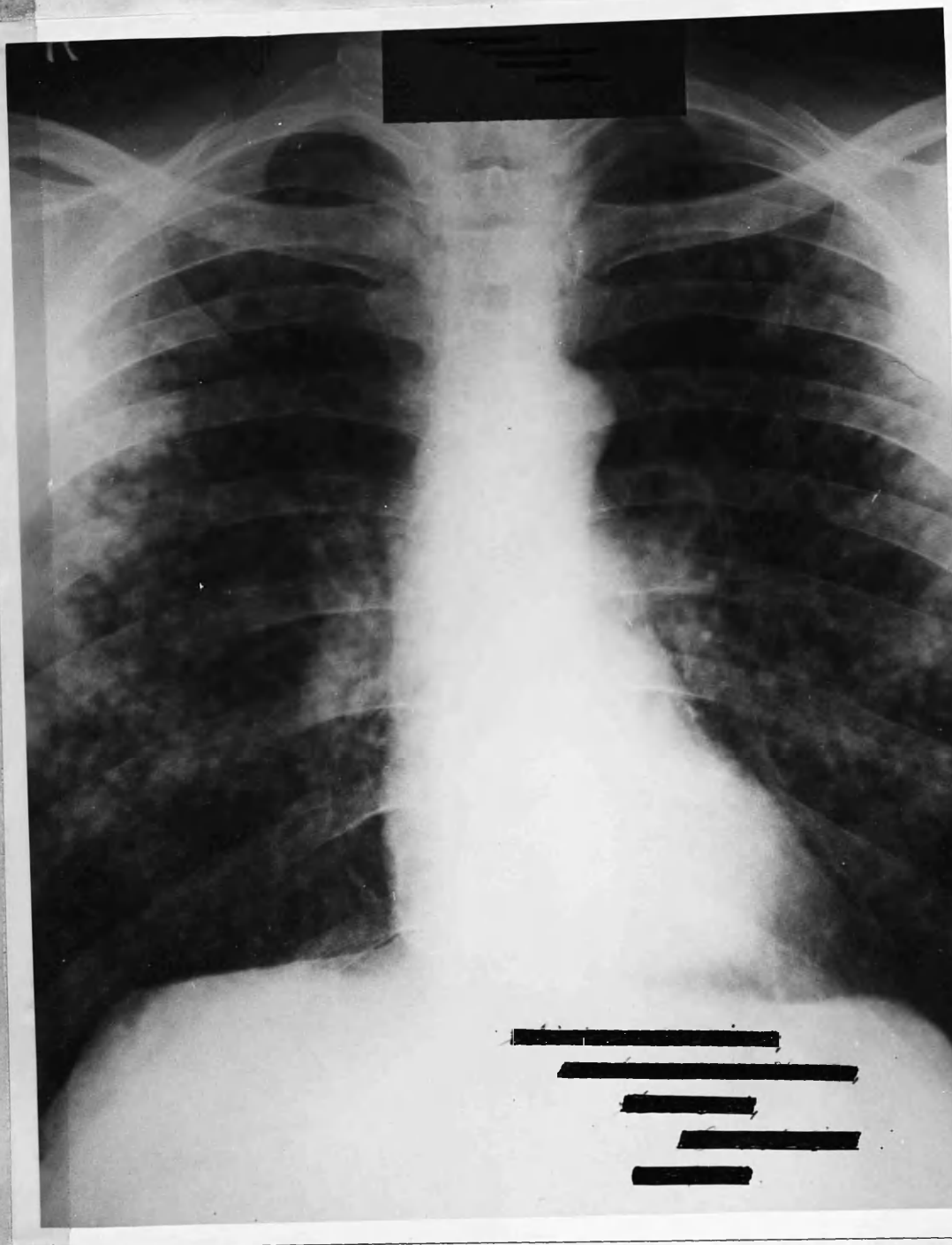
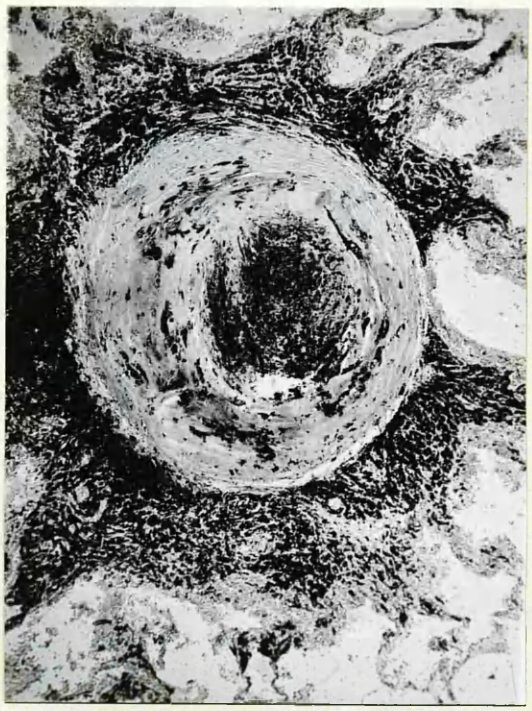






COMPLICATED PNEUMOCONIOSIS

(massive fibrosis)

Certified case from series: actual exhibits.

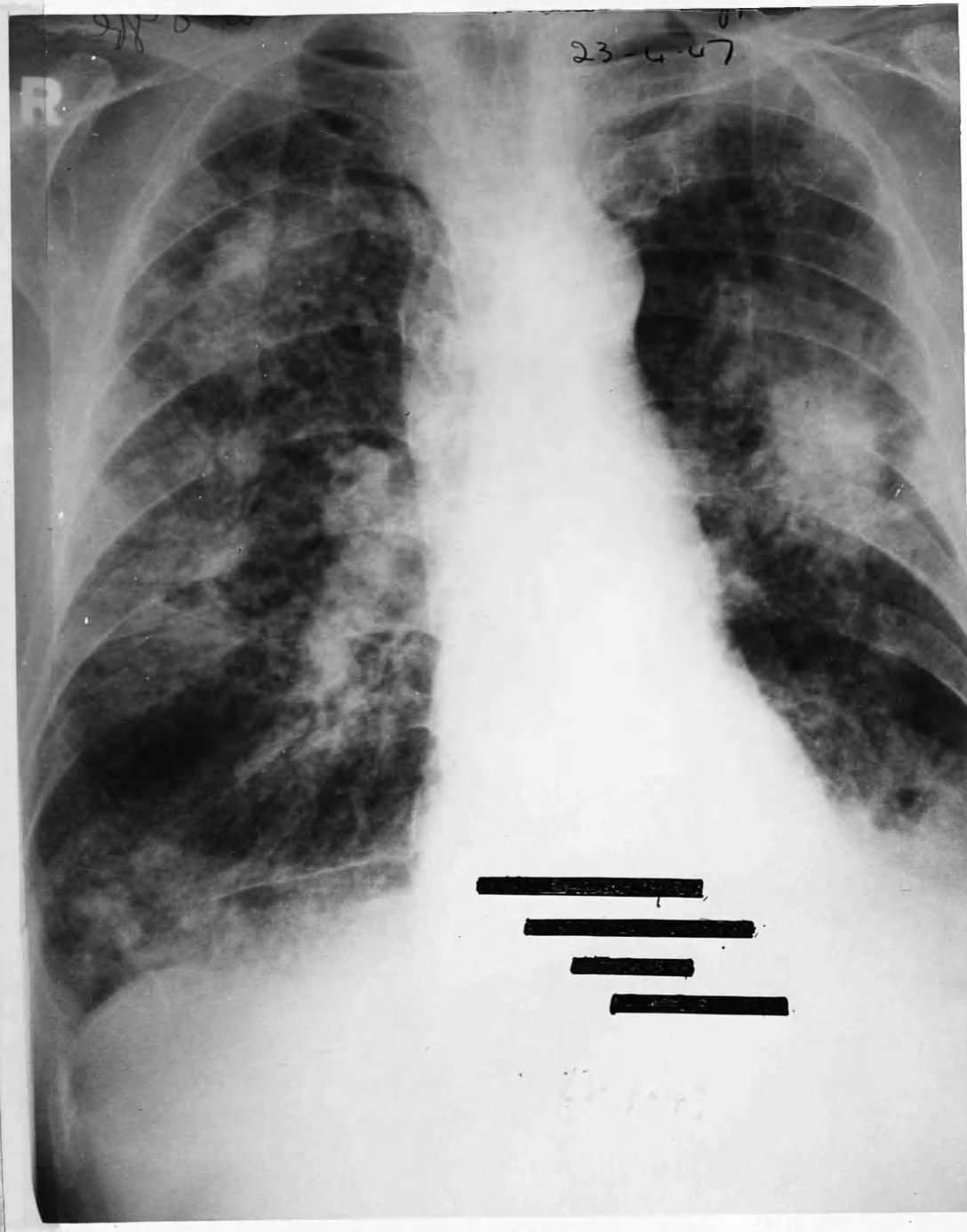
1947 Aged 62 years. Lanarkshire (A2).

Coal-miner 47 years - hewer and stripper.

Certificate of total disablement.

1950 Died aged 65 years.

Complicated pneumoconiosis (massive fibrosis).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COMPLICATED PNEUMOCONIOSIS

(massive fibrosis)

Certified case under Various Industries (Silicosis) Scheme. Actual exhibits.

1947 Aged 65 years. Lanarkshire (A2).

Coal-miner 44 years - mainly brusher.

Certificate of total disablement.

1950 Died aged 67 years.

Complicated pneumoconiosis, bronchiectasis and emphysema.