SOME NOTES ON THE GEOLOGY OF THE QUATERNARY DEPOSITS OF THE "PIANURA PADANA" (PLAIN OF THE RIVER PO) WITH THE RESULTS OF BACTERIOLOGICAL AND CHEMICAL EXAMINATIONS OF SEVENTY POTABLE WATERS DERIVED THEREFROM.

by

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Some Notes on the Geology of the Quaternary Deposits of the "pianura padana" (plain of the River Po) with the results of bacteriological and chemical examinations of seventy potable waters derived therefrom.

The Origin and Nature of the Deposits.

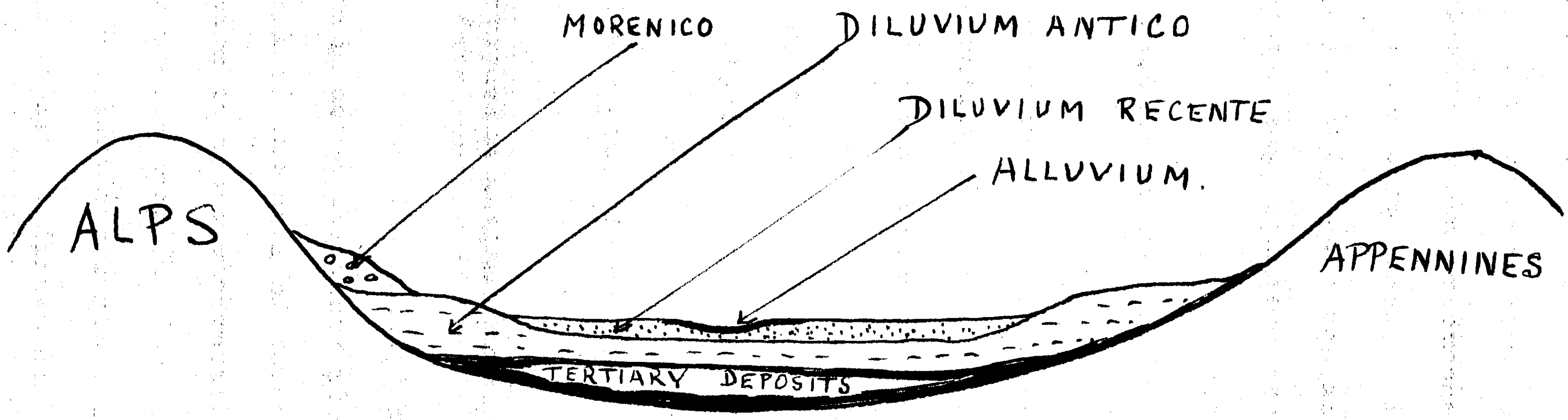
At the end of the Pliocene period a great tongue shaped gulf ran westwards from the head of the present Adriatic, bounded to the north and south by huge foldings which had occurred in Miocene times and led to the formation of the Alps and Appennines. Torrential streams from the recently elevated mountains spread far and wide their debris over the site of the present plain. To these accummulations were added, especially on the Alpine side, but to a lesser extent also on the Appennine, those of the glaciers flowing down the valleys during the glacial period and forming immense amphitheatres across their exits on the plain, through which flowed rivers in deep gorges. Examples of these are seen on the course of the rivers Dora Riparia, Orco, Dora Baltea, Ticino, Adda, Oglio, Mincio, Adige, Piave and Tagliamento. In the moraine surrounding Ivrea the debris is piled up to a height of 600 metres. The arc of the Garda moraines stretches for about 100 kilometres.

In many instances lakes are enclosed by the mounds, destined in the course of the ages to be filled up and converted into marshes and later into deposits of peat. The cones of the torrential rivers and the moraines comprising this sub Alpine zone go to make up an irregular country, arid and stony, and of but slight value for agriculture.

Still further from the mountains stretches a zone of coarse sediments which apparently once covered the entire plain commencing from the region of moraines and insinuating itself between them. Like the previous zones it is due to deposits from the mountain torrents spreading far and wide a thick layer of transported material on reaching more level country, in which the momentum of the streams is suddenly greatly diminished. Typically this formation gives rise to plateaux (altipiani diluviali) composed of the debris of the glacial moraines mingled with alluvial sands and gravels, through which the present-day streams have cut their way, and to whose margins the plateaux slope more or less sharply.

These regions are known as "vaude" or "brughiere" (brugo=erica) in Lombardy. Whilst a part of the material betrays its glacial origin the greater portion is composed of sands and gravels, brought down by the rivers, with pebble beds sometimes cemented to form conglomerate "ceppo".

The plateaux tend to be somewhat arid and, being difficult to irrigate, are in parts sterile, in others utilized for cultivation of the vine and the mulberry. Peculiar climatic conditions have in places transformed the soil to very considerable depths into a sandy clay of a red colour "ferretto" related to the laterite of the tropics.


MORENICO
DILUVIUM ANTICO
DILUVIUM RECENTE
ALLUVIUM.
ALPS
APPENNINES
TERTIARY DEPOSITS

At the same level the Alpine rocks are sometimes affected while the moraines seem to escape the damage.

While the lower plain is composed mainly of deposits of later date, there still remain isolated masses of the more ancient formation which have resisted denudation e.g. the Hill of San Colombaro, standing I30 m. above the plain (I44 above sea level)., composed of blue clay and yellow sand of the Pliocene capped by the deposits of the altipiano diluviale.

Nearer the Po, in the plain proper ("zona bassa"), the deposits consist of finer materials and in the vicinity of the Po and its tributaries there are alluvial formations laid down by the rivers. Thus the Italian geologists recognise in the lower plain ("zona bassa") -

a. "Alluvium" of modern river system.

b. "Diluvium recente" - the older alluvial deposits.

and in the higher plain (zona subalpina) of altipiano diluviale -

c. "Diluvium antico" partly alluvial from river fans, partly of glacial origin.

d. "Morenico" the glacial moraines.

As already noted, the upper plain by reason of the coarse material of the soil of which it is composed tends to be arid owing to ready absorption of rainfall. Thus we find there accurs near the junction of the diluvium antico with the diluvium recente a line of springs, "linea dei fontanili" or "linea delle resorgive" giving rise in parts to marshes. In addition to the springs, water bearing strata are to be found very near the surface, e.g. at Milan 2 to 4 m. and strata yielding a better quality of water at 7 and 14 m.

RAINFALL.

The most copious rains fall in October. There are on the average 106 days per annum on which rain falls, being considerably fewer than in Central Europe generally. Rain tends to fall in sharp downpours rather than in fine persistent showers. In summer there is some rainfall one day out of three. Periods of drought are rare. Snow is recorded usually nine days per annum between the end of October and the middle of April. In some winters the plain is buried in snow to the depth of several feet so that traffic is held up on the roads and railways. The winter is the driest season, the autumn the wettest as shown by the following table from Fischer (I) :-

Percentages of annual rainfall (in millimetres).

	Winter.	Spring.	Summer	Autumn.	Year.
Torino.	14.7	26.3.	31.6.	27.3	789
Milano.	21.3	23.8	23.9	30.9	966.5
Udine.	21.2	24.0	27.3	27.7	1384
Bologna.	18.4	20.1	29.7	31.8	536

The area may be roughly divided into four regions of rainfall :-

I. Central plain of Po (650 to 800 m.m.) Tortona, Voghera, Pavia, Mantova 644, Legnago, Bologna 659, Faenza 738.

2. A belt to north and one to south of the river including the northern slope of the Appennines (800 to I,000 m.m.) Torino 852, Cremona 804.

3. Approaching the southern slope of the Alps (I,000 to I,200 m.m.) Milano I,035, Treviglio ?.

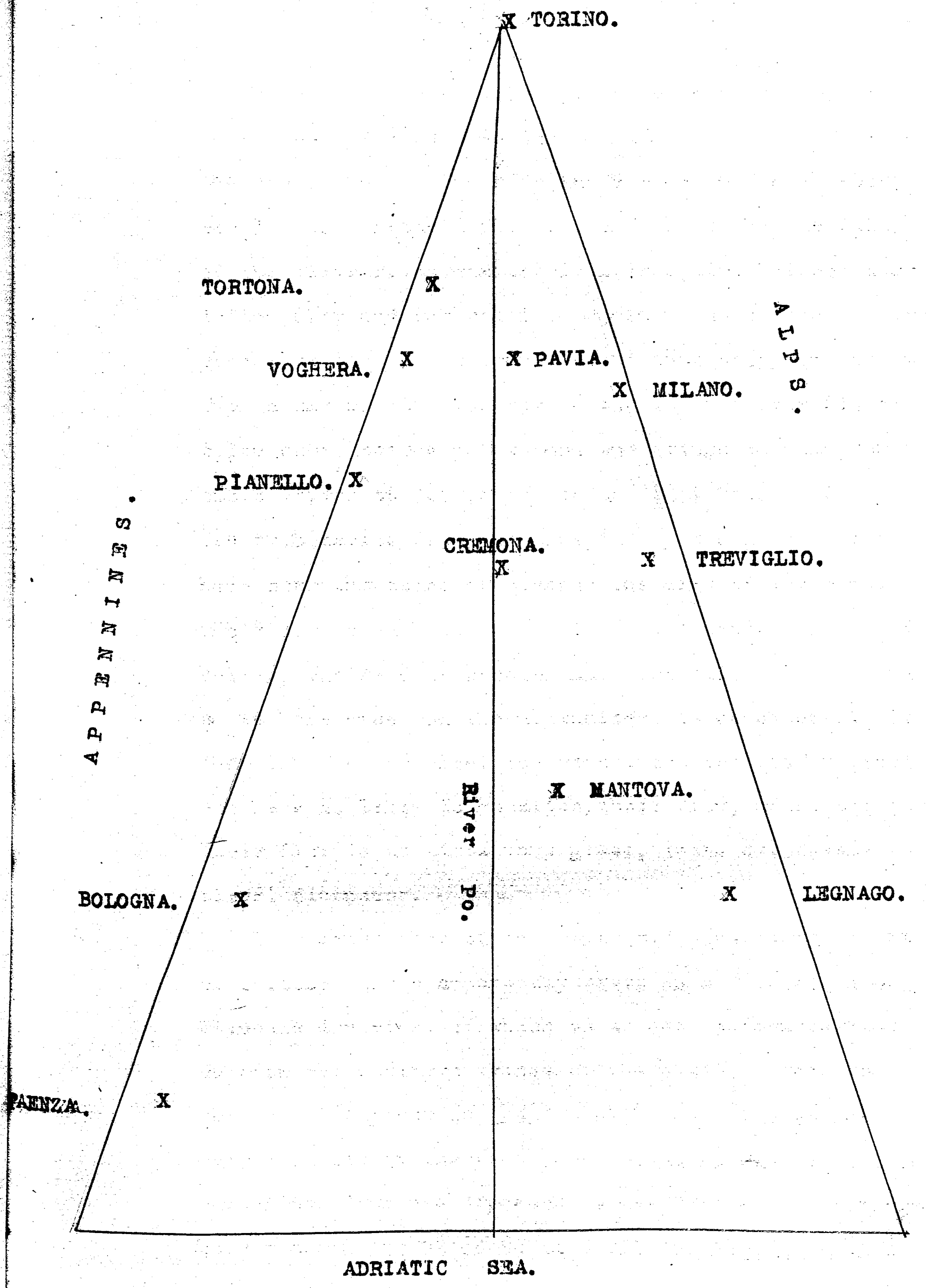
4. Alps north of the plain (I,200 to 2437) Tolmezzo (Carnic Alps) 2437.

The conditions therefore favour the supply of deep wells of artesian types the heaviest rainfall being atthe periphery. of the basin.

CONTOUR.

The plain lies in a great trough with steep sides and is roughly triangular in shape with the Alps to the north and the Appennines to the south, while the base is formed by the Adriatic. The Po between Turin and the sea may be taken as occupying a perpendicular dropped from the apex to the base.

A rise in sea level or a subsidence of I00 to I50 metres would practically restore the condition of the Pliocene time by flooding the plain. The limiting slopes from the mountains to the plain are very steep and thence from north and south are very gentle to the Po.


TORINO.
TORTONA.
VOGHERA.
PAVIA.
MILANO.
ALPS.
PIANELLO.
APPENNINES.
CREMONA.
TREVIGLIO.
MANTOVA.
River Po.
BOLOGNA.
LEGNAGO.
FAENZA.
ADRIATIC SEA.

The plain from west to east also tends very gently to the sea, the Po standing at 2I2 m. at Turin, 45 m. at the confluence of the Adda and 9 m. at Ostiglia, above sea level. Between Chivasso and Piacenza the fall of the river is approximately I in I,000, between the latter City and the sea I in 2,000. Hence the Po carries gravel as far as Piacenza, beyond that only sand and mud. The volume of its flow varies enormously, from 2I4 to 5,I49 cubic metres per second and brings down 42,760,000 cubic metres of debris per annum. (Edi Poggio) (2). Its tributaries from the Alps, fed by the greater rainfall, have been the means of pushing the line of the river in its upper course much to the south of the mesial line of the valley, eastward it becomes more central. The rainfall, as we have seen, on the Appennines, is considerably less than that on the Alps, the rivers are not fed by glaciers and have no lakes to equalise their flow, hence although their flow is at times very great, inthe dry season they almost disappear.

This great mass of sediment laid down since the close of Tertiary times apparently rests on a foundation of Pliocene deposits, of which an almost continuous band dips down on the southern fringe of the plain. Detached portions re-appear on the Alpine border, though the quaternary deposits in the north are banked up against all the formations from the Archaean to the Tertiary. Borings have reached the Pliocene at Forli 80. Reggio at 90 m. and Ravenna I20 m., but apparently the trough deepens to the north, as in the district between Milan and Venice it has not been reached at over 200 metres (Fischer).

WATER SUPPLY.

The plain is covered by a close network of channels and ditches, which are important for irrigation and drainage, but owing to their universal pollution by washings from cultivated land and roads, and in villages from their use as washing places and receptacles for filth they must be left out of count as possible sources of potable water supply. Wells drawing their water from the subsoil must in general be looked upon with suspicion, especially when sunk in the neighbourhood of dwellings.

The rivers, some of which in the dry months almost disappear and others, such as the Po, in which the flow is more or less abundant throughout the year, but which contain much suspended matter and are polluted to a greater or lesser extent in the plains, do not contribute to the solution of the problem.

There remains then for the towns recourse either to long aqueducts bringing water from the hilly regions, or deep wells.

For example, the town of Cremona stands at least 40 kilometres from any possible hill supply so that on the ground of expense, recourse to deep borings appeared

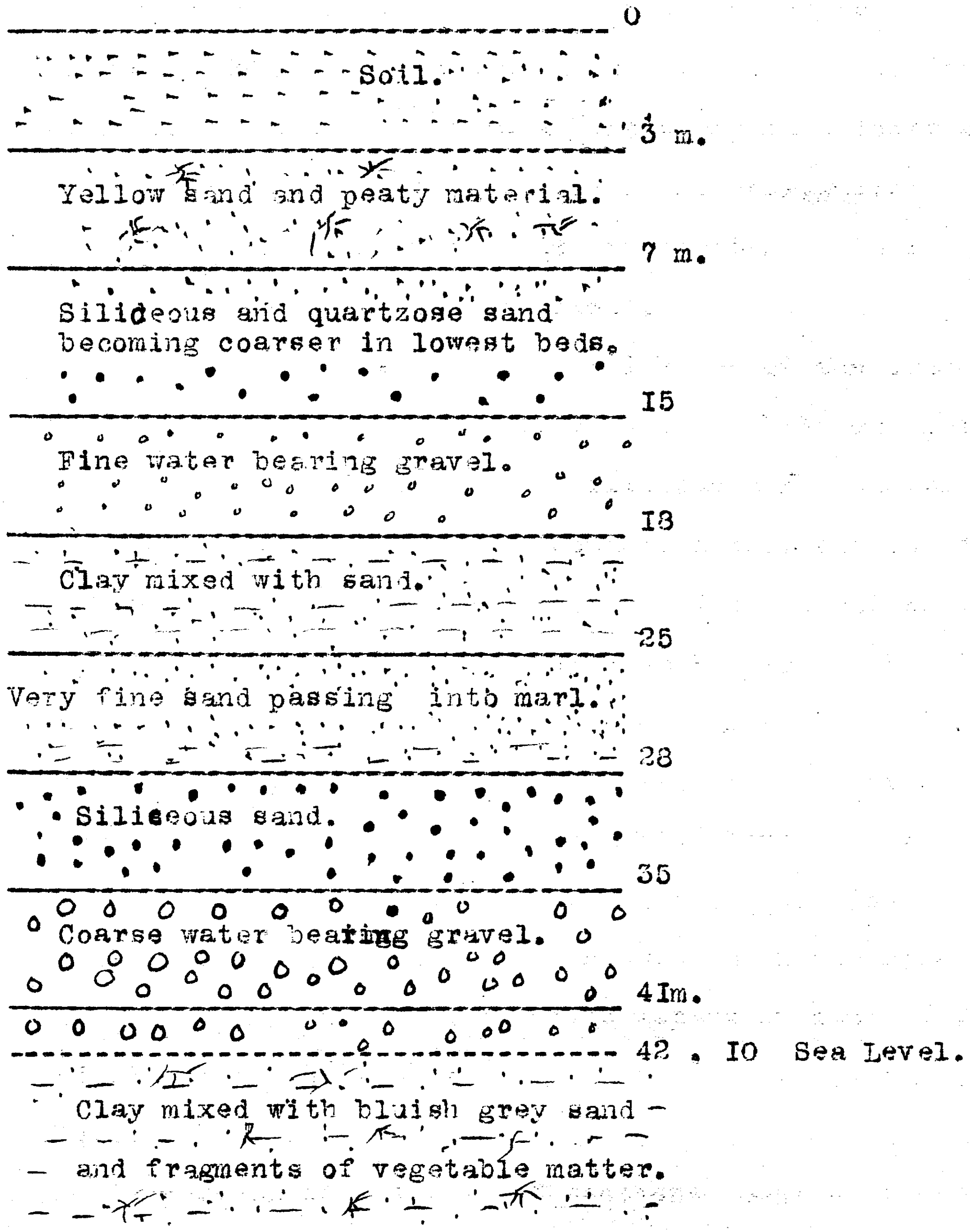
the only possible way out of the difficulty.
The first attempt was made with the idea of obtaining an artesian supply to obviate the necessity of pumping, especially as similar attempts had met with success no further away than Mantova. Though water was struck, it did not rise to the surface and did not appear to be plentiful, save near the surface. The project was then abandoned for a time after boring 233 metres (Grasselli) (4). Fresh borings later showed water at 40 and 100 metres, not rising to the surface, with an objectionable odour and taste, and of a turbid character. Finally twelve trial borings cleared up the situation. It was found that there were four main water bearing strata, and some minor ones of poor yield :-

a. A superficial, met with at 3 to 6 metres from the surface, of good physical character but apt to be polluted, as in general it was not protected by an impervious stratum.

b. A medium, at 16 to 22 metres from surface, also physically of good quality but apparently not protected, and from its chemical composition, probably related to the superficial water.

c. A deep, at about 40 metres from the surface, 2 m. above sea level, protected at 26 to 29 m. from surface by a bed of clay. This water rose to within 4 metres of the surface, was chemically and bacteriologically pure but became turbid on standing. It contains iron to the extent of .2 to .5 parts per 100,000. It has also a slight odour of hydrogen sulphide. Temp. 13.4° to 13.6° Cent.

d. A very deep, at 100 metres covered with 10 metres of clay. This does not become turbid as it contains practically no iron but it smells and tastes of hydrogen sulphide. Temp. 14.6 to 14.8 Cent.



After Grasselli.

Choice fell finally on the 40-metre water, as it was found that by pumping to an elevated tank, from which it was distributed in a fine spray to a lower one, the sulphur gases passed off into the atmosphere (a very distinct odour of H_2S is felt on entering the hall containing the purification plant).

The same process causes precipitation of the iron salts and aeration of the water, while subsequent passage through "Bollmann" filters of siliceous sand removes the iron so efficiently that none is detectable in the town supply by the ordinary tests. The present water supply is derived from five wells sunk through the alluvium on which the lower part of the town stands, the higher portions being on the "diluvium recente". After being freed from iron it is pumped to a high level cistern for distribution. From the accompanying section it will be seen that the soil through which the bore passes is composed of alternating layers of sand, gravel and clay and a similar structure has been met with to the greatest depths reached.

Comparison of a series of sections compiled from the results of fourteen borings by Augusto Stella (3) indicates that these beds are not laid down horizontally but in a lenticular form. Hence the disposition of the beds of coarse sand and fine or coarse gravel in which water is found are struck at varying distances above or below sea level. Constantly, however, water is struck at 20 to 30 metres above sea level, as a rule in sand or gravel, but in few cases is a layer of clay met with in reaching it, hence it is unsuitable as a supply, presumably being subject to admixture with the ground water.

Between 10 m. above and 20 m. below sea level there is also constantly reached the bed of water bearing gravel or coarse sand from which the Cremona supply is drawn, and in every case a bed of clay has been pierced in drilling to it.

Three wells strike another water bearing bed at depths of 40 to 60 under sea level, while one has reached water again at 100 metres.

NATURE of SUB-SOIL.

Sand is the chief component of the sub-soil with lenticular masses of gravel and clay, and these deposits are met with to the greatest depth so far reached in the Cremona region, 233 metres.

The sole difference, passing from surface to the depths, is that the yellow colour of the sand after the first water bearing stratum has been traversed becomes greyish or greyish green. Water percolating from the surface has been gradually deprived of its atmospheric gases and loses its oxidising power, hence the difference in the deeply buried sediments.

The sand is of varied origin but largely composed of quartz with more or less mica and calcareous material. Calcium carbonate is at a minimum in the coarse sand, while the percentage rises in the finer to a maximum in the more clayey sands.

The clay is usually sandy and sometimes only exceptionally, as in the layer 10 to 20 metres above sea level, is it clay in a strict sense. Speaking generally it is calcareous clay or marl.

The gravels, especially the fine, contain a fair amount of calcareous material with occasional pebbles and greenish concretions of this nature. At all depths the gravels and pebbles indicate by their appearance derivation from pre-alpine and interalpine regions (basins of Oglio and Adda) and consist of quartz, gneiss, mica schists, tonalite and serpentine, while the secondary rocks are represented by limestone pebbles, variegated schists, sandstones and flints.

Traces of vegetable remains are occasionally met with indicating old lake deposits and peat formation.

PHYSICAL CHARACTERS OF WATERS.

As a whole the waters examined were of excellent quality, clear, colourless and bright, without odour or taste, and neutral or slightly alkaline.

BACTERIOLOGICAL EXAMINATIONS. METHODS USED.

The routine carried out in each instance was the estimation of the number of organisms per c.c. of water developing on agar plates in 24 hours at 37^{o} C. and on gelatine in 3 days at 20^{o} C. For Bacillus coli, tubes of MacConkey's bile salt lactose neutral red peptone water were inoculated with the water. The quantities used were $\frac{I}{IO}$ c.c. I c.c., 5 c.c., IO c.c., IO c.c., IO c.c., 64 c.c., Any tube shewing fermentative change was set aside, the organisms sub-cultured and their reactions more fully investigated. Each lactose-fermenting organism was examined as to :-

a. Motility.
b. Liquefaction of gelatine.
c. Fermentation of glucose, lactose, saccharose, mannite and dulcite.
d. Changes in litmus milk after I, 2 and I5 days.
e. Formation of indol.

The so called "Benteritidis" change in milk was investigated by adding quantities of IO, IOO and 250 c.c . to whole milk, heating to 80^{o} C. for IO minutes and incubating for one to three days. The organism was not confirmed by further tests, e.g. animal inoculation.

CHEMICAL EXAMINATIONS. METHODS EMPLOYED.

Thresh's "Examination of Waters and Water Supplies" was taken as a basis and selection made of processes as under :-

a. Nitrites - naphthylamine (Ilosvay's Test) colorimetric estimation.

b. Nitrates - phenol-sulphonic acid and caustic potash - colorimetric estimation.

c. Ammonia - Wanklyn's test.

d. Chlorine- Silver nitrate and potassium chromate.

e. Total solids dried at 180° C. for one hour.

f. Metals as given by Thresh.

g. Oxygen absorbed from acid permanganate. Tidy-Forchammer process, 3 hours at 37° C in dark.

h. Hardness. Soap test.

i. Saline constituents following Thresh's method for calcium and magnesium, sodium being estimated by difference, as there appeared to be no other bases, save iron, in amounts capable of estimation in any of the water examined. Carbonates and Sulphates as given on pages 336 - 340 (Thresh) second edition. The combination of acids and bases to form salts were calculated from factors - pages 345.

Total solids less salts calculated gave "Silica etc".

See Appendix.

RESULTS OF ANALYSIS OF TOWN SUPPLIES.

The source was usually a deep well, but two cases require special mention. The Veneria supply to Turin is from a filtering gallery more or less horizontal, driven so as to intercept the subterranean flow of water from the mountains. The Faenza is from a spring encountered in boring a railway tunnel and had been chlorinated prior to analysis.

The Cremona water samples had been deprived of their iron by aeration and filtration prior to the chemical examination.

Bacteriologically the waters are of good character, all giving a low count on agar and only one, Treviglio having a high count on gelatine. Lactose fermenters were detected but once in a single sample from the Sangone supply at Turin. Further examination identified the organism with B. fluorescens.

B. enteritidis sporogenes was never found although in most instances litres of water were tested in the course of successive examinations.

CHEMICAL CONSTITUENTS.

Nitrogen as nitrites and nitrates was usually low, in only one instance exceeding .I per I00,000 in the case of the Voghera well in which .4 was found. Though possibly due to admixture with sub-soil water, this being apparently confirmed by the high chlorine 2.07.

no corroboration is obtained from the ammonia and oxygen-comsumed figures, and even the high chlorine is explicable as we shall see later. The nitrites are probably due to reducing agents ? ferruginous sands.

Ammonia (Saline). Practically none was found except in the Treviglio and Mantova samples. The former .005 was associated with .0I0 albuminoid and moderate chlorine .59 while the bacterial count 256 was high. The low nitrate figure, taken in conjunction with the Cremona and Mantova figures .05 for Cremona where no saline ammonia is found, and .002 for Mantova, would appear to negative any considerable pollution.

The saline ammonia .054 is noteworthy in Mantova samples, and is associated with an average amount of albuminoid ammonia and low chlorine, while nitrates have reached the vanishing point. It would therefore seem feasible to assume the presence of an agent (possibly a ferruginous sand) reducing nitrates to ammonia. In confirmation, we ought to note that sometimes a faint trace of nitrite is found and occasionally a trace of iron.

The albuminoid ammonia is variable in the series and may be related to deposits of vegetable debris, which, as we have already noticed, are brought to light in borings.

Chlorine as befits strata laid down by fresh water action, is low throughout. Most samples fall below I a figure rarely reached in analyses of British waters.

The series indicates that the amount increases from a minimum in the West at Turin (.4 only) as we follow the slope of the river plain to the east. The soil from which the Turin supplies are derived is largely composed of detritus from the more ancient rocks, largely metamorphic, poor in chlorides. As the edges of the great basin are approached the saline contents of the waters rise markedly, since the tertiary (pliocene, miocene and eocene) fringing deposits yield salts freely, being ancient marine deposits. Chlorine reaches 2.07 at Voghera and I.30 at Bologna.

Total Solids are very low in the higher reaches, the waters derived from the harder metamorphic rocks (Turin) average 8, while those nearer the periphery (Voghera) average 34 probably due to the greater solubility of the adjoining tertiary formation.

Oxygen absorbed - the series gives an extremely low average figure ranging from nil to .038 at Cremona and .032 at Mantova, part of which is due to reducing power of inorganic constituents, iron etc.

Hardness (Soap Test.) Total varies from 6 to 2I. Here also the waters from the upper reaches are softer than those from the periphery, or nearer the sea, obviously less carbonate of lime has been available in the neighbourhood of the harder rocks. The deep well at Cremona supplies the highest figure, probably due to the long journey which the water has taken through deposits more or less rich in calcium.

SALINE CONSTITUENTS. The amount of calcium carbonate varies but slightly around the figure IO, being lowest in upper part of the river basin, while magnesium carbonate varies from nil to nearly 6 the maximum, again being towards the periphery of basin and in lower reaches of the river. Sodium carbonate is present in most of the waters except at Voghera and Bologna both on the Appennine border of the basin, in which waters Magnesium sulphate appears, a salt not found elsewhere save at Faenza also bordering on the Appennines. A fairly high sodium sulphate figure is given by the Voghera samples I4.20 and 8.8I, this too being most readily explained by the near presence of tertiary marine deposits. Sulphates of magnesium and sodium are frequently found in the waters from the tertiary formations in England.

SODIUM CHLORIDE. The remarks made regarding the presence of chlorine apply to this salt also .

(See appended Tables of Analyses).

Shallow Wells of Tortona District.

These are sunk in the alluvial deposits of the plain with the exception of eight located on the hilly ground to the south, bordering on the tertiary formations. Bacteriologically the bucket wells show considerable pollution, this method of drawing water leading to fouling of the well from contamination of buckets. For example the B. enteritidis sporogenes change was given by two samples, one from theplain and one from the hill, an old bucket well (No.I5) and a well at Villa Fiorita (No.I9), probably due to introduction of soil picked up by bucket from the gound surface. The other findings support pollution in first instance, while the second water compares favourably with the other hill waters. The pump at Villa Codevilla (No.I7) (B.Coli absent in I00 c.c., B.enteritidis sporogenes absent in 360 c.c.),which appeared well protected, gave the most favourable results of the series.

Two public fountains were also available for examination one new (No.24) and one old (No.25), both presumably fed by springs. It is worthy of note that while examination of the new supply 3I.8.I8, showed lactose fermenters present though no typical B. Coli,(a suspicious result), a later test demonstrated B. Coli in 5 c.c. and the increase in albuminoid ammonia and chlorine in the second sample supplied confirmation of possible access of polluted water to this supply, which in consequence could not be considered a satisfactory one.

Nitrites were demonstrated in some of the obviously polluted wells, and the nitrates figures were generally high, reaching 2.08 in well No.2I. The high nitrate figure was usually accompanied by high chlorine, the highest figure for chlorine, 7.50, being given by the same well. One sample from supply No. 24 gave the lowest nitrate.004, and another also the lowest chlorine .85, and amount comparable with that found on examination of the of the deep well waters previously discussed.

All the samples were remarkably free from saline ammonia. On the contrary the albuminoid ran as high as .036. The character varied from slightly hard, No. I7, to very hard No.22.

Calcium carbonate varied from 9.25 to 39.05, all contained magnesium carbonate I.93 to I0.38, many also magnesium sulphate up to I5.8I. and sodium sulphate up to 28.4I.

The three samples analysed from two wells at Rivalta Scrivia demonstrate the improvement in the chemical quality of water produced by a well in use for a time.

The new well sunk in open country gives much superior results in the second analysis to those given by the Casone well standing amidst farm buildings and probably receiving much soakage from manurial collections, witness the high ammonia (saline and albuminoid), though the chlorine figure affords no confirmation.

Although the wells are distant only a few miles from Tortona, the magnesium salts present in the Tortona waters are here absent and the sulphates have almost reached the vanishing point.

There is a possible explanation of this in the fact that the deposits in which the wells are sunk are composed of debris brought down from the mountains by the river Scrivia and hence are more closely related to those in which the deep wells of the towns in the centre of the basin of the Po are sunk, for, as we have seen, except at the periphery, magnesium salts are scanty and sulphates are rare.

V O G H E R A   W E L L S.

Bacteriologically these stand out pre-eminently from the point of view of B. enteritidis sporogenes, this organism having been found in three out of four tests. No. 31 gives a good all-round result, notably absence of B. Coli, while No. 30 shows the bacillus present in 30 c.c. absent in smaller amounts.

The high sodium sulphate figures 17.6 and 20.9 should be compared with 3.81 and 14.20 given by Voghera deep well waters, already noted as the highest sulphate figures (whether sodium alone or sodium plus magnesium) of all the town supplies.

Also interesting for the inter-relationship of low nitrate and high saline ammonia and vice versa are the results obtained -

	ascending series →			
Nitric nitrogen	.06	.11	.2	.33
Saline Ammonia.	.021	.003	.001	faint trace
	descending series. →			

Well No. 28 appears to be deriving water from the ground surface. It was sunk in the midst of a cavalry barracks. The ammonia and chlorine figures are unsatisfactory. The possibility of the albuminoid ammonia being derived largely from vegetable sources is raised in the case of the Bidella well No. 29, for saline ammonia and chlorine are relatively low. The bacteriological results, however, are bad.

The water from No 3I is a very hard one, 36 by soap test, yet for a well sunk in the middle of a town it gives very good results.

P I A N E L L O Sources of Supply.

This district in on the Appennine fringe to the east of Voghera. The old bucket well No 32 at Rocca d' Olgisio had been out of use for a considerable time and was examined to find if it was likely to prove a suitable source of supply. At this time (end of May) the water was very low, and the findings unsatisfactory from both chemical and bacteriological standpoints.

On the contrary the two springs yielded a plentiful and pure supply. The content of sodium chloride .74 is very low, but is comparable with those obtained in some instances where wells sunk in alluvial debris, presumably washed almost salt-free prior to deposition, gave very similar results. It will be recollected that certain of the town supplies from deep wells and presumably pure gave low figures - Turin .66, Pavia .77, Mantova .75.

P A V I A (City).

No. 35 was examined four times during the year and it will be noticed that while the last two examinations, November and December, closely agreed, there were several differences in certain of the figures as compared with April and August results, which were markedly worse bacteriologically and chemically. Chlorine scarcely varied, the water rich in organic matter (albuminoid ammonia .038) in April and poor in nitrate (.006) became poor in albuminoid ammonia and rich in nitrate in August; later no trace of nitrate was found, and the albuminoid ammonia increased. We may suppose this to be due to the spring rain rapidly penetrating the dry soil and bringing down decomposable material rapidly acted on by bacteria under favourable temperature conditions. During summer owing to heat and luxuriant vegetation access of water would be partially cut off with consequent improvement in the water shut up in the depths.

A similiar improvement in character is seen in the April and September examinations of No.36 the pump at the Observatory. The Via Magenta water (No.37) is very suspicious from the bacteriological point of view (lactose fermenters in I c.c.) confirmed by high nitrate, presence of saline ammonia, high albuminoid ammonia, and very high chlorine compared with other wells.

The oxygen consumed figure is higher than in any others of same series.

No. 38 satisfies all the requirements of a good potable water.

The chemical characters of water from the spring No. 39 are good, but as it bubbles up into a natural basin it was not possible to take satisfactory samples for bacteriological tests. It is not therefore certain that B. Coli is present in the spring water or whether its presence is due to contamination of the basin. Magnesium as carbonate was detected in all the waters, and in No 37 the sulphate was also found. The average total solids, carbonate and sulphate content was notably less than in Voghera, Pianello and Tortona waters, as one would expect from the more central position of Pavia and its proximity to the rivers Ticino and Po.

Comparison with the deep well water shows a pretty close relationship, and would lead one to infer that the two are derived from the same source, possibly largely from soakage from the river beds in the case of the deeper wells.

TREVIGLIO and CRESCENZAGO.

Here we approach the Alpine border of the Po basin.

Supplies 40 and 4I give a good contrast between a properly protected pumped well and an open bucket well sunk within a short distance of one another.

No. 40 except for slightly high total ammonia comes out satisfactorily. No. 4I is manifestly polluted.

No. 42 is rather suspicious, B. Coli found once, only lactose fermenters, not B. Coli, in second instance six weeks later. This is a good instance of the necessity of suspecting pollution in wells where B. Coli is not found, only lactose fermenters, none of which give the classical B. Coli reaction.

It is worthy of notice that later in the season the well gives less albuminoid ammonia, less chlorine and a rather more favourable bacteriological finding (no definite B. Coli).

Sulphates are scanty or absent, a marked difference fron condition found on opposite or Appennine side of the basin, and I think explicable by the relative paucity of tertiary marine deposits.

CREMONA (City and District).

All six wells shewed absence of B. ent. sporogenes in 360 c.c. No. 44 and No. 46 of B. Coli also; in 100 c.c.

While the bacteriological results in No. 43 would be classed as fair, the chemical results shew that the water was simply thoroughly filtered sewage a striking testimony to the efficacy of some soils as filtering media. The two wells in Via Castelleone were better. More open country is reached at Terra Amata, the first well is passable while the second, with its 48,000 count on gelatine and its 1.25 for chlorine, compared with .54 for the neighbouring one is not so.

The bucket well stands condemned for same reasons.

The presence of nitrite is to be commented on as is also the absence of nitrates in No.44.

The undernoted comparison is of interest.

Average figures.

	Cremona deep well.	Cremona shallow wells.
Calcium Carbonate.	17.32	20.45
Magnesium Carbonate.	4.97	4.39
Sodium Carbonate.	7.36	7.91
Sodium Sulphate.	.93	2.60
Sodium Chloride.	.87	1.62
Sodium Nitrate.	-	.61

Note (1) Close approximation of carbonate figure but -

Note (2) that the pebbles met with in deep bore as we have seen indicated an Alpine rather than Appenine origin for deeply buried sediments. The lower figures for sodium sulphate and chloride in the deep well water support this view.

DISTRICT EAST of CREMONA.

Removed from the immediate vicinity of the Po or any of its great tributaries, the results obtained may be taken as typical for wells sunk in the "diluvium recente".

The water from the first well examined No.49, had caused an outbreak of diarrhoea. Investigation showed that sewage had gained access to it freely. This was confirmed by the bacteriological and chemical examinations.

Well No. 50 was examined on four occasions. It was remarkable for the absence of nitrates, for the presence of iron and on one occasion for odour of H_2S. Compare with Cremona deep well water.

A fact previously brought out is again noticeable, the seasonable improvement in the character of the water. Compare results May and December. The latter results would be accepted as proving that the well supplied a safe drinking water, yet the previous analyses make this very doubtful indeed .

The results of No. 5I are unsatisfactory, the chlorine figure 2.73, and ammonias are high, and it is a very hard water. Bacteriologically No. 52 is good and chlorine is low, but the water is opalescent from the presence of iron. Possibly the Saline ammonia is due to reduction of nitrates by iron salts.

Compare with Mantova deep well water which sometimes contains faint traces of nitrites, traces of nitrates and sometimes traces of iron.

No. 53 is a very good example of chemical results improving later in the year, but curiously B. Coli present in 20 c.c. in February, is found in I c.c. in October. Torre de Picenardi wells may be briefly mentioned. The first, No. 54, obviously receives sewage soakings. No. 55 is better and apparently ground filtration is effective (No B.Coli), while the third, fairly good chemically (but without nitrates), is bacteriologically the worst.

San Lorenzo (No 58) gives a very high chloride, not readily explicable when one compares it with San Lorenzo No. 57, which is much worse from the point of view of ammonia and yet gives only .80.

The high nitrates is worthy of notice inthe San Giovanni sample No 59.

MANTOVA WELLS.

The results of analysis of No. 60 are obviously good. As in some other wells nitrates are practically absent.

The high free ammonia, moderate albuminoid ammonia, traces only of nitrates, low chloride and trace of iron of No. 6I, suggest comparison with the deep well supply. The presence of iron and hydrogen sulphide also remind us of the Cremona deep well water and of No.50 at Cicognolo. These findings are characteristic of the Cremona- Mantova region.

Notable points as regards new well No. 62 are the small amount of nitrate, high saline ammonia, and relatively small albuminoid, also presence of iron, all true to the Mantova type. Compared with other Mantova waters, the chloride figure is extremely high, and the other figures also suggest a comparison with No. 5I Cicognolo which had a high free and moderate albuminoid ammonia together with for Cicognolo a high chlorine 2.72, and a high sulphate 9.25. The relationship to waters from the southern tertiary fringe of the basin is strong, and at least three possibilities may be advanced.

(a) The wells have been sunk in the beds of former streams which carried debris from the southern tertiary slopes or from patches of the tertiary deposits of the Alps.

(b) That there are islets of tertiary deposits in the midst of quaternary deposits almost reaching the surface, but not as in the case of the hill of San Colombano to the east of Pavia, which brings to light the blue clay and yellow sand of the Pliocene, emerging from the post tertiary mantle. Further east there are also visible the tertiary volcanoes of Monte Berici and Monte Euganei near Padova.

(c) At certain points waters may flow upwards from great depths owing to defects in the impervious strata, in the manner of the artesian wells, but not sufficiently high to reach the surface. One might thus strike in shallow wells accumulations of water part of which had come from great depths comparatively near the tertiary deposits, and in consequence rich in chlorides and sulphates.

I have not data to help in solving the problem of their origin.

LEGNAGO. WELLS.

This town being situated on the Adige the wells are sunk in alluvial deposits, the sands of which evidently form a very efficient filtering medium, as witness the excellent bacteriological results.

In one sample only were nitrates detected and in another iron. The high saline ammonia suggests comparison with Mantova waters and the high albuminoid the presence of peaty deposits, for the chlorine figures are very low .2 to .4. The only comparable figures are the Turin, Pavia and Mantova deep wells presumably free from pollution. As befits the distance from any tertiary deposits, the total sulphates are low.

The waters are all soft and contain very little mineral matter in solution, average only 14 parts per 100,000, a figure slightly less than that for Pavia deep well water and only surpassed by the Turin samples 9.41 and 7.9. The soil is evidently mainly siliceous with little soluble material, probably largely derived from the more ancient rocks of the Alps.

FAENZA WELLS.

Bacteriologically all show evidence of pollution, one, No.68, yielding B. enteritidis sporogenes. Traces of Nitrite are frequent in these waters and No. 67 shows marked variations in nitrate figure from nil to .4I

Wells 68 and 69 sunk in the plain near the river Lamone presumably are sunk in river alluvium and give comparatively low figures for chlorides and sulphates, while Nos. 67 and 70 towards the south and adjoining pliocene deposits show high chlorides sodium and magnesium, and in the latter total sulphates calcium and magnesium amounting to 35.85 parts per I00,000 and thus showing a close relationship with the Tortona and Voghera waters.

	MAGNESIUM SALTS.		SULPHATES.		CHLORIDES.	
I.	Faenza	II.85	Voghera	I2.88	Faenza	5.9I
2.	Tortona	8.52	Tortona	I2.33	Tortona	5.80
3.	Cicognolo	7.55	Pianello	7.57	Cicognolo	3.27
4.	Mantova	6.77	Bologna	7.07	Mantova	2.98
5.	Treviglio	6.45	Faenza	6.38	Voghera	2.94
6.	Voghera	6.33	Cicognolo	3.69	Pianello	2.65
7.	Pianello	5.66	Cremona	3.25	Crescenzago	I.59
8.	Bologna	5.49	Legnago	2.54	Cremona	I.5I
9.	Cremona	4.47	Pavia	2.40	Bologna	I.44
IO.	Pavia	4.33	Mantova	2.06	Rivalta Sc.	I.37
II.	Crescenzago	I.74	Crescenzago	I.I8	Treviglio	I.34
I2.	Milan	I.58	Rivalta Sc.	..94	Pavia	I.20
I3.	Legnago	.89	Milan	.76	Milan	I.04
I4.	Turin	.64	Treviglio	.00	Turin	.66
I5.	Rivalta Scrivia	.00	Turin	.00	Legnago	.53

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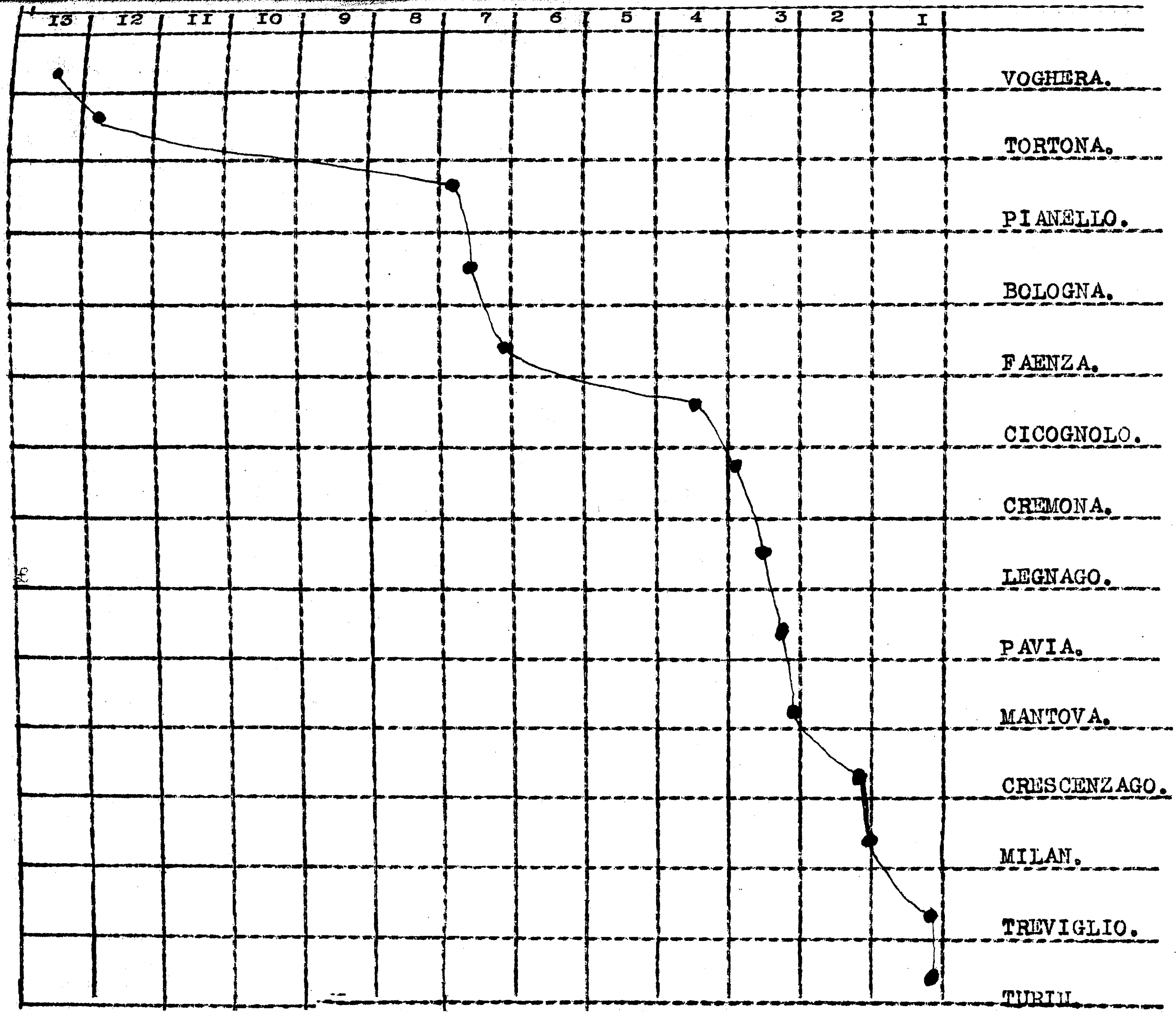
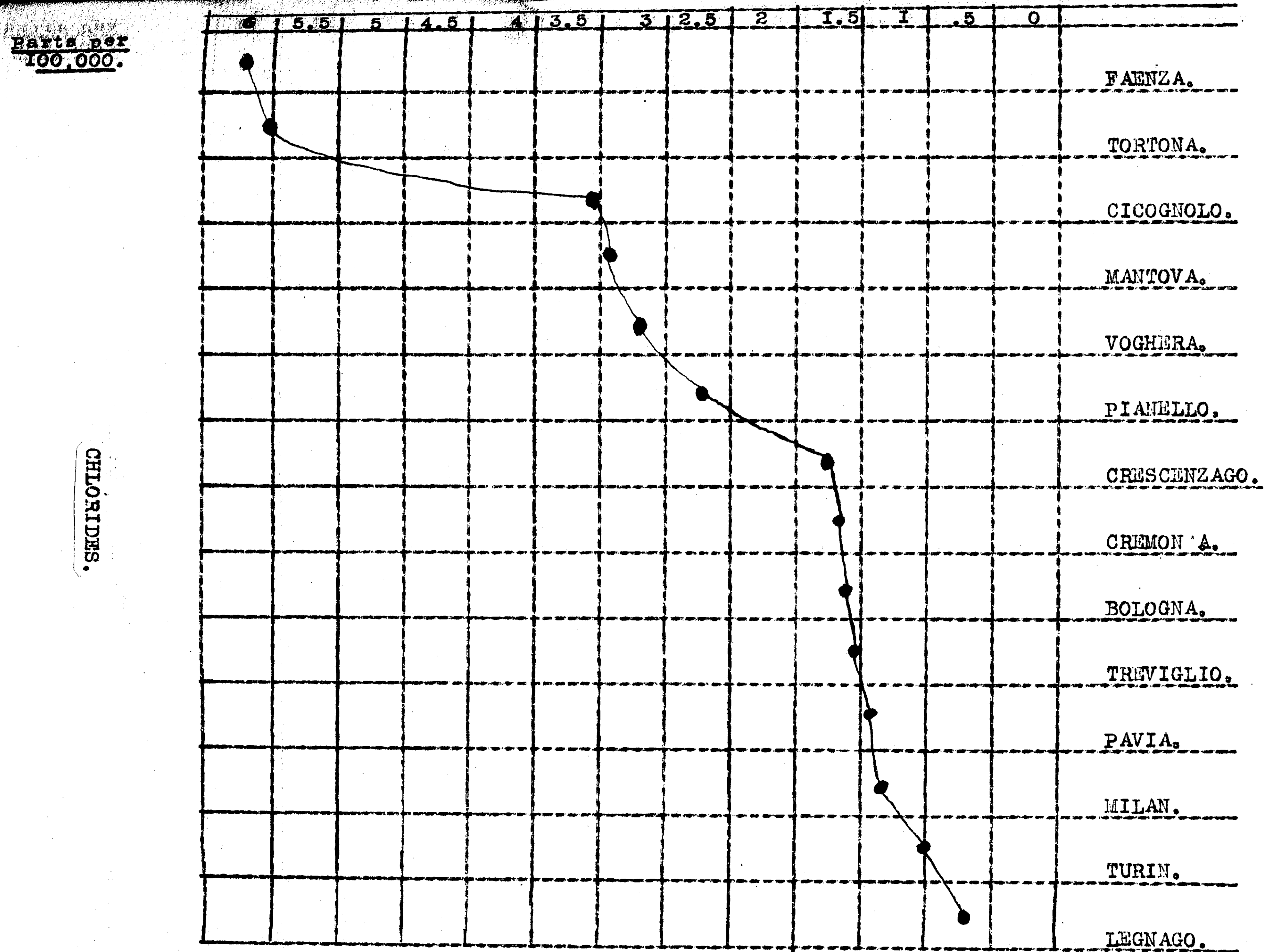
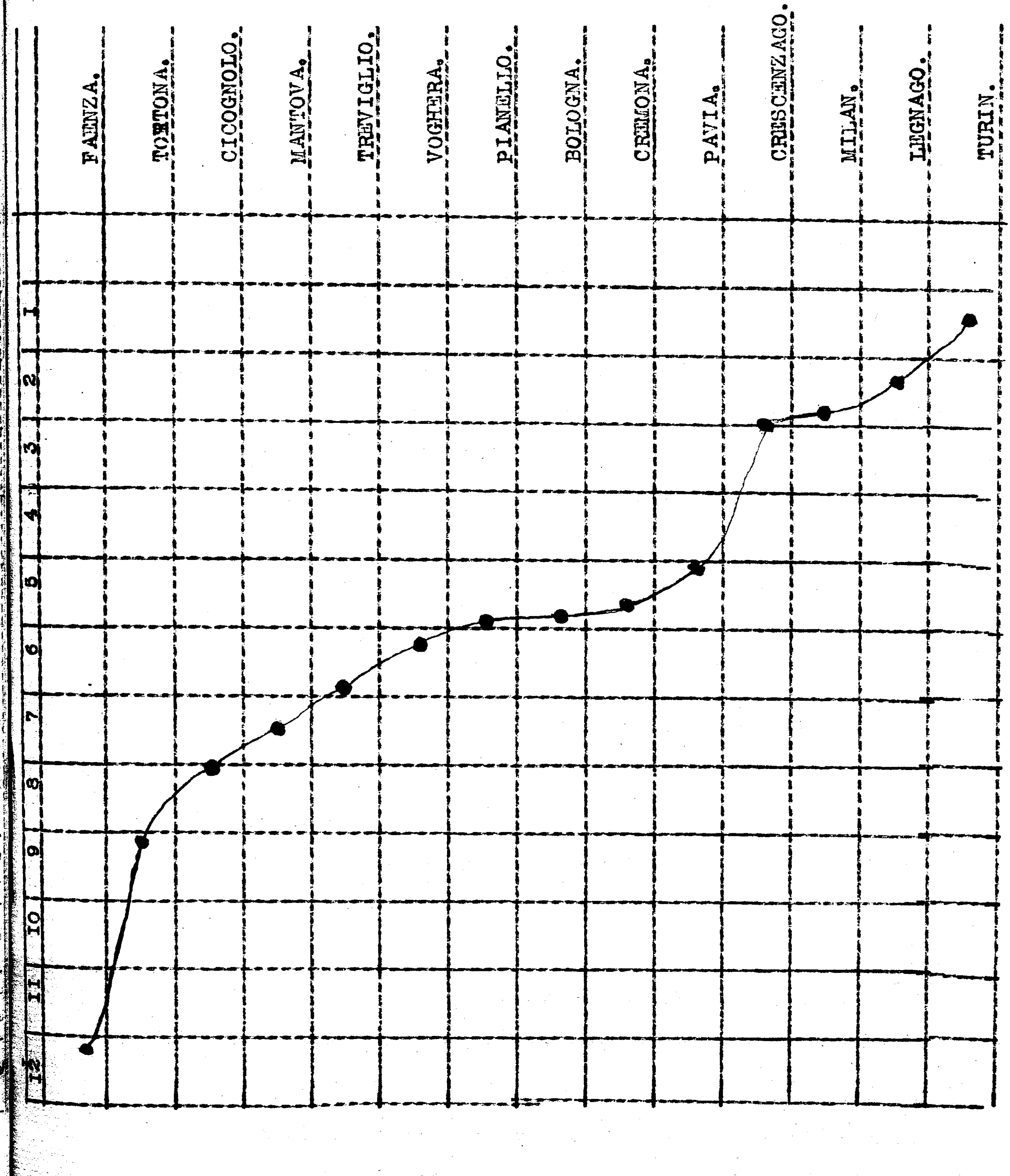
SULPHATES.

Parts per 100,000.




Parts per 100,000.
6
5.5
5
4.5
4
3.5
3
2.5
2
I.5
I
.5
0
FAENZA.
TORTONA.
CICOGNOLO.
MANTOVA.
VOGHERA.
PIANELLO.
CRESCENZAGO.
CREMONA.
BOLOGNA.
TREVIGLIO.
PAVIA.
MILAN.
TURIN.
LEGNAGO.

CHLORIDES.



MAGNESIUM SALTS.

C O N C L U S I O N.

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The taking of average figures for the various districts yields some suggestive results.

(a) SULPHATES, sodium, magnesium and calcium.

The graph shews at the summit the Voghera and Tortona districts which are in close relationship to the Appennine tertiary deposits.

It falls through Pianello, Bologna and Faenza, also on the fringe of the deposits, and after a decided drop to Cicognolo, Cremona, Legnago, Pavia and Mantova in the more central region of the plain, diminishes still further as the Alpine regions are approached, at Crescenzago, Milan and Treviglio, to a minimum at Turin.

(b) CHLORIDES. While the curve differs to some extent from that for sulphates, the maximum again falls from the Appennine fringe represented by Faenza and Tortona, through Cicognolo, Mantova, Voghera and Pianello in a rapid descent, until at Crescenzago a fairly flat portion is reached in which are placed Cremona and Pavia the central towns of the plain, while a minimum is reached at Milan, Turin and Legnago. Again the Alpine border is characterised by low figures. The position of Legnago in the middle of sulphate series, while placed at the bottom of the chloride graph deserves notice. The paucity of chlorides is due to the distance of the town from marine formations, while the comparative excess of sulphates may be due to the neighbouring Euganean and Berician hills which are extinct tertiary volcanoes.

Sulphur deposits are common in the regions characterised by volcanic activity, hence the district of Legnago is in this respect somewhat comparable to the strip of country lying at the foot of the Appennines, for in these mountains are hot springs, mud volcanoes and other evidences of volcanic activity.

(c) MAGNESIUM SALTS. Again the position of the various supplies is fairly constant when this is compared with the previous curves. In fact, comparison of the magnesium and chloride curves shows that the four highest and the three lowest in both practically correspond, and that again there is a gradual descent from high figures on the Appennine to low figures on the Alpine fringe of the basin.

A clear relationship is thus shewn to exist between the geological nature of the soil and the waters derived therefrom. The waters from the south of the basin obviously demonstrate their origin from old marine deposits, and the amount of magnesium salts, sulphates and chlorides are readily seen to vary inversely with the distance of the source from the Appennine or southern Tertiary boundary of the river basin. As we have already seen, deposits of Tertiary formations are rarely exposed on the northern or Alpine fringe, and they appear to be deeply buried beneath great masses of

Material laid down in Quaternary times.
We have already seen that borings failed to reach them at 200 metres in the region between Milan and Venice.

There appears to be a possibility that by careful collection of data something corresponding to "isochlors" could be mapped out, though in this case distance from marine influence can be traced by sulphates and magnesium salts as well as by chlorides.

The saline characteristics of waters clearly originating from the tertiary fringe of Pliocene or Miocene formation, approximate more closely to those of the Lower London Tertiaries, as given by Thresh, than to those of English waters from the Pliocene Crags, Upper Eocene, Barton and Bagshot sands which are less markedly marine in origin. See results given by Thresh - "Examination of Waters and Water Supplies" - pages 457 - 460.
Unfortunately war conditions offered neither time nor opportunity for the taking of a really adequate number of observations, and this paper in consequence is but a disjointed and imperfect contribution to the work hitherto done on Geology in relation to water supplies.

R E F E R E N C E S.

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APPENDIX.

RESULTS OF BACTERIOLOGICAL and CHEMICAL EXAMINATIONS OF WATER SUPPLIES.

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	TOWN SUPPLIES.					DEEP WELLS.			Averages from repeated Examinations.		
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Bacteriological.	Turin. Venaria.	Turin. Sangone.	Milan.	Pavia.	Voghera.	Voghera Montagnia.	Treviglio.	Cremona.	Mantova.	Bologna.	Faenza. Allochi.
No. of Colonies Agar 24 hrs. at 37° C.	4	14	7	2	12	3	3	5	4	4	2
Gelatine 3 days at 20° C.	13	2 1	28	8	21	8	256	8	14	5	7
B. Coli.	Absent in 100 c.c.	Absent in 100 c.c.	Absent in 100 c.c.	Absent in 100 c.c	Absent in 100 c.c.	Absent in 100 c.c.	Absent in 100 c.c.	Absent in 100 c.c.	Absent in 100.c.c.	Absent in 100 c.c	Absent in 100 c.c.
B. Enteritidis Sporogenes.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 100 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
Chemical. (in parts per 100,000). Nitrous nitrogen.	-	-	-	-	Sometimes minute trace.	-	-	-	Sometimes a faint trace.	-	Sometimes a faint trace.
itric Nitrogen.	.06	.1	.1	-	.4	.08	.012	.05	.002	.04	.008
aline Ammonia.	.-	.001	-	-	-	-	.005	-	.054	-	-
lbuminoid Ammonia.	.003	.006	.004	.006	.003	.006	.010	.004	.011	.009	.008
hlorine as Chlorides.	.40	.40	.63	.45	2.07	1.11	.59	.64	.45	1.30	.87
otal solids dried at 180° C.	9.41	7.9	16.9	15.06	33.3	35.00	21.50	34.08	25.92	25.50	27.12
etals, Iron, Copper, Lead	-	-	-	-	-	-	-	-	Sometimes a trace of iron.	-	-
xygen absorbed from permanganate 3 hrs. at 37° C.	.005	-	.003	.017	.013	.03	.008	.038	.032	.01	.004
hysical Characters.	Clear, bright colourless	do.	do.	do.	Slightly opalescent deposit of lime.	Clear.	Clear.	Clear.	Clear.	Clear.	Clear.
Hardness Total.	6	6	13	12	18	20	14	21	17	18	16
oap test. Permanent.	3	3	4	3	8	7	5	5	6	3	5
oap test. Temporary.	3	3	9	9	10	13	9	16	11	5	11
Calcium Carbonate.	3.12	2.87	9.30	9.10	10.67	12.85	9.50	17.82	11.66	11.25	10.39
agnesium Carbonate.	-	1.29	3.16	3.47	2.71	4.70	5.88	4.97	5.67	4.50	5.70
Sodium Carbonate.	3.94	2.22	1.19	1.06	-	-	4.63	7.86	6.99	-	3.21
agnesium Sulphate.	-	-	-	-	4.23	-	-	-	-	.99	1.59
odium Sulphate.	-	-	.76	-	8.81	14.20	-	.93	-	6.08	2.87
odium Chloride.	.66	.66	1.04	.77	3.41	1.83	.97	.87	.75	2.14	1.44
odium Nitrate.	.36	.6	.54	-	2.48	.48	.07	.30	-	.24	.05
ilica etc.	.47	.27	.52	.35	1.01	.94	.45	1.49	.36	.30	1.39

[illegible] O N A 2 (Plain).

	I2.	I3.	I4.	I5.
	Bucket Well. Via Emilia. I5. 3. I8	Bucket Well. Via Passalacqua. I5. 3. I8	New Bucket Well. IO metres deep. 3I. 8. I8.	Old Bucket Well 20 Metres deep 3i. 8. I8.
Colonies agar 24 hrs. at 37° C.	I2	272	328	I920
Gelatine 3 days at 20° C.	544	5568	8I6	4600(2days
B. Coli.	Present in I c.c.	Present in I/IO c.c.	Present in 5 c.c.	Present in I c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Present in 250 c.c.
	PARTS PER IOO,000.			
Nitrous Nitrogen.	0	0	0	.0I
Nitric Nitrogen.	.5	.2I	.5	2.08
Saline Ammonia.	.002	.000	.002	.000
Albuminoid Ammonia.	.0I6	.020	.004	.008
Chlorine as Chlorides.	4.8I	2.93	I.4I	9.70
Total Solids dried at I80° C.	62.50	52.50	43.50	I00.00
Metals.	0	0	0	0
Oxygen absorbes from Permanganate 3 hrs. at 37° C.	.0I8	.003	0	.03
Physical Characters.	Colourless, clear alkaline.	Colourless, clear alkaline.	Colourless, clear alkaline.	Colourless, clear alkaline.
Hardness. Total.	22	24	28	34
Permanent.	8	6	6	I3
Temporary.	I4	I8	22	2I
Probable Saline Constitutents.	Calc.Carb. I9.47 Mag,Carb, 5.36 Sod.Carb. 9.04 Sod.Sulph. I4.57 Sod.Chlor. 7.93 Sod.Nitr. 3.03 Silica Phosphates etc. 3.I0	Calc.Carb. 30.30 Mag.Carb. 3.25 Mag.Sulph. I.68 Sod.Sulph. 9.85 Sod.Chlor. 4.83 Sod.Nitr. I.27 Silica. I.32	Calc.Carb. 2I.57 Mag,Carb. 6.09 Sod.Carb. 5.72 Sod.Sulph. 8.88 Sod.Chlor. 2.32 Sod.Nitr. 3.03 Silica. .89	Calc.Carb. 23.60 Mag.Carb. I0.38 Sod.Carb. 7.I5 Sod.Sulph. 28.4I Sod.Chlor. I6.00 Sod.Nitr. I2.63 Silica. I.30

	I6.	I7.	I8.	I9.
	Bucket Well. Villa Forzano. 22.3. I8.	Pump. Villa Codevilla. 22 .3 .I8.	Bucket Well. Villino Bruno. 22. 3. I8.	Bucket Well. Villa Fiorita. 29. 3. I8.
Colonies agar 24 hrs.at 37° C.	34	22	42	32
Gelatine. 3 days at 20° C.	544	480	2686	480
B. Coli.	Present in 64 c.c.	Absent in 100 c.c.	Present in 5 c.c.	Present in 10 c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Present in 360 c.c.
	PARTS PER 100,000.			
Nitrous Nitrogen.	0	0	0	0
Nitric Nitrogen.	.25	.I85	.I25	.24
Saline Ammonia.	0	.002	.004	.004
Albuminoid Ammonia.	.025	.008	.008	.012
Chlorine as Chlorides.	2.I7	4.7I	3.8I	2.6I
Total Solids dried at I80° C.	34.50	27.50	30.00	67.50
Metals.	0.	0.	0.	0.
Oxygen absorbed from permanganate 3 hrs. at 37° C.	.22	.032	.029	.06
Physical Characters.	Slight brown tinge, clear slightly alkaline.	Colourless, clear (slight-) slightly alkaline.	Colourless, clear slightly alkaline.	Colourless, clear alkaline.
Hardness. Total	I4	I0	I6	28
Permanent.	7	6	7	I2
Tempirary.	7	4	9	I6
Probable Saline Constituents.	Calc.Carb. I5.30 Mag.Carb. 3.68 Mag.Suplh. 2.57 Sod. Sulph. 6.6I Sod.Chlor. 3.58 Sod.Nitr. I.52 Silica. I.24	Calc.Carb. 9.25 Mag.Carb. 2.32 Mag.Sulph. I.48 Sod.Sulph. 3.30 Sod.Chlor. 7.77 Sod.Nitr. I.I2 Silica. 2.26	Calc.Carb. I4.53 Mag.Carb. I.93 Mag.Sulph. 4.29 Sod.Chlor. 6.28 Sod.Nitr. .75 Silica. 2.37	Calc.Carb. 22.50 Mag.Carb. I0.38 Sod. Carb. I2.59 Sod.Sulph. I4.20 Sod.Chlor. 4.30 Sod.Nitr. I.45 Silica. 2.06

T O R T O N A - (Hill).

	20.	21.	22.	23.
	Bucket Well. Villa Bona. 29. 3. I8.	Bucket Well. Villa Granelli. 29. 3. I8.	Bucket Well. Villa Canegallo. I4. IO. I8.	Bucket Well. Villa Balladore I4. IO. I8.
Colonies agar 24 hrs. at 37° C.	92	256	2080	200
Gelatine 3 days at 20°C.	2048	4256	6080	I760
B. Coli.	Present in I/IO c.c.	Present in I/IO c.c.	Present in I/IO c.c.	Present in 5 c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER IOO,OOO.			
Nitrous Nitrogen.	0	0	Faint trace.	0
Nitric Nitrogen.	.I8	2.08	.66	.06
Saline Ammonia.	0	0	0	0
Albuminoid Ammonia.	.0I2	.036	.009	.020
Chlorine as Chlorides.	I.59	7.50	4.38	I.33
Total Solids dried at I80° C.	58.00	85.00	62.00	32.00
Metals.	0	0	0	0
Oxygen absorbed from Permanganate 3 hrs at 27° C.	.07	.0I8	.04	.03
Physical Characters.	Colourless, clear alkaline.	Colourless, clear alkaline.	Colourless, clear neutral.	Colourless, clear neutral.
Hardness. Total.	I6	34	40	26
Permanent.	6	II	I5	6
Temporary.	IO	23	25	20
Probable Saline Constituents.	Calc.Carb. 32.80 Mag.Carb. 7.48 Sod.Sulph. I2.72 Sod.Chlor. 2.62 Sod.Nitr. I.08 Silica, etc. I.30	Calc.Carb. 39.05 Mag.Carb. 8.53 Mag.Sulph. 5.I3 Sod.Sulph. 4.60 Sod.Chlor. I2.37 Sod.Nitr. I2.63 Silica etc. 2.69	Calc.Carb. 20.00 Mag.Carb. 3.79 Mag.Sulph. I5.8I Sod.Sulph. 9.75 Sod.Chlor. 7.22 Sod.Nitr. 4.00 Silica. I.43	Calc.Carb. IO.I5 Mag.Carb. IO.I4 Mag.Sulph. 8.02 Sod.Chlor. 2.I9 Sod.Nitr. .37 Silica. I.I3

	24.		25.
	New Fountain Supply- Source filtering gallery.		Old Supply from underground cistern.
	3I. 8. I8.	I4. IO. I8.	I5. 3. I8.
Colonies Agar 24 hrs. at 37° C.	I4	I9	5
Gelatine 3 days at 20° C.	I6	528	726
B. Coli.	Lactose fermenters not B.Coli in IO c.c.	B. Coli present in 5 c.c.	Present in 5 c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER IOO,000.		
Nitrous Nitrogen.	0	0	.00I
Nitric Nitrogen.	.025	.004	.25
Saline Ammonia.	0	0	0
Albuminoid Ammonia.	.003	.020	.005
Chlorine as Chlorides.	.85	I.I2	I.37
Total Solids dried at I80° C.	30.00	29.5 0	48.00
Metals.	0	0	0
Oxygen absorbed from permanganate 3 hrs. at 37° C.	0	.03	.0I3
Physical Characters.	Colourless, clear.	Alkaline.	Clear, Alkaline.
Hardness. Total.	2 0	20	I8
Pemanent.	5	4	7
Temporary.	I5	I6	II
Probable Saline Constituents.	Calc.Carb. I5.78 Mag.Carb. 4.20 Sod.Carb. I.28 Sod.Sulph. 6.22 Sod.Chlor. I.62 Sod.Nitr. .09 Silica.etc. .55	2 Analyses.	Calc.Carb. I8.I2 Mag.Carb. 4.84 Sod.Carb. 4.58 Sod.Sulph. I4.57 Sod.Chlor. 2.26 Sod.Nitr. I.50 Silica. 2.I3

	26.	26.	27.
	Newly sunk Well. IO metres deep. 9. 3. I8.	New Well. IO metres deep. 22. 5. I8.	Pump at Casone. 9. 3. I8.
Colonies agar 24 hrs at 37^{o} C.	I3	I984	5
Gelatine 3 days at 20^{o} C.	4864 (2 days)	6400	I952
B. Coli.	Present in $\frac{I}{IO}$ c.c.	Present in $\frac{I}{IO}$ c.c.	Present in I c.c.
B. E. S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER IOO,000.		
Nitrous Nitrogen.	0	.00I	0
Nitric Nitrogen.	.83	.33	.66
Saline Ammonia.	.0I5	.004	.075
Albuminoid Ammonia.	.220	.004	.040
Chlorine as Chlorides.	.86	.77	.80
Total Solids dried at I80^{o} C.	35.00	27.50	28.00
Metals.	0	0	0
Oxygen absorbed from Permanganate 3 hrs at 37^{o} C.	.32	.002	.0I6
Physical Characters.	Whitish turbidity, alkaline, colourless.	Colourless, clear, alkaline.	Colourless, clear alkaline.
Hardness. Total.	20	22	20
Permanent.	4	4	4
Temporary.	I6	I8	I6
Probable Saline Constituents.	Calc.Carb. I7.38	Calc.Carb. I9.67	Calc.Carb. I8.75
	Sod.Carb. 5.98	Sod.Carb. 2.30	Sod.Carb. 2.2I
	Sod.Sulph. I.89	Sod.Sulph. .94	Sod.Chlor. I.52
	Sod.Chlor. I.52	Sod.Chlor. I.27	Sod.Nitr. 4.0I
	Sod.Nitr. 5.04	Sod.Nitr. 2.00	XXXXXXXXX XXX
	Silica. 3.I9	Silica etc. I.32	Silica etc. I.7I

	28.	29.	30.	31.
	Pump. 25 metres deep. Barracks. 28.I. I8.	Pump. 37 metres deep. Bidella. 28. I. I8.	Pump. 37 metres deep. Villa Calverzara. Bidella. 28. 2. I8.	Pump. Via Emilia. IO.6.I8.
Colonies agar 24 hrs. at 37° C.	3	I4	6	3
Gelatine 3 days at 20° C.	I44	I20	7	I2
B. Coli.	Present in I c.c.	Present in $\frac{I}{IO}$ c.c.	Present in 30 c.c.	Absent in 300 c.c.
B. E. S.	Present in 360 c.c.	Present in 360 c.c.	Present in 250 c.c.	Absent in 360 c.c.
	PARTS PER 100,000.			
Nitrous Nitrogen.	0	0	.004	0
Nitric Nitrogen.	.06	.II	.2	.33
Saline Ammonia.	.02I	.003	.00I	faint trace.
Albuminoid Ammonia.	.025	.032	.004	.008
Chlorine as Chlorides.	2.86	I.07	I.IO	2.50
Total Solids dried at I80° C.	46.0	40.00	50.00	65.00
Metals.	0	0	0	0
Oxygen absorbed from permanganate 3 hrs at 37° C.	.022	.008	.004	.02
Physical Characters.	Colourless, clear, bright alkaline.	Colourless, bright alkaline.	Colourless, clear alkaline.	Colourless, clear alkaline.
Hardness. Total.	23	I4	I7	36
Permanent.	IO	5	8	II
Temporary.	I3	9	9	25
Probable Saline Constituents.	Calc.Carb. I8.45	Calc.Carb.I5.58	Calc.Carb.2I.IO	Calc.Carb.24.85
	Mag.Carb. 7.54	Mag.Carb. 3.94	Mag.Carb. 5.54	Mag.Carb. 9.45
	Sod.Carb. 8.09	Sod.Carb.I2.37	Sod.Carb. 2.48	Sod.Carb. 2.78
	Sod.Chlor. 4.72	Sod.Chlor.I.76	Sod.Chlor. I.8I	Sod.Sulph.20.29
	Sod.Sulph. 6.66	Sod.Sulph. 5.32	Sod.Sulph.I7.76	Sod.Chlor. 4.I2
	Sod.Nitr. .03	Sod.Nitr. .I5	Sod.Nitr. .27	Sod.Nitr. 0.45
	Silica. .46	Silica. .88	Silica. I.04	Silica etc.3.36

	32.	33.	34.
	Bucket Well 35 m. deep. Rocca d' Olgisio. 3I. 5. I8.	Spring at Casa Verae. 3I. 5. I8.	Spring at Gramonti. 3I. 5. I8.
Colonies agar 24 hrs. at 37° C.	70	4	2
Gelatine 3 days at 20° C.	I20	54	40
B. Coli.	Present in IO c.c.	Absent in IOO c.c.	Absent in IOO c.c.
B. E.S.	Present in IOO c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER IOO,000.		
Nitrous Nitrogen.	.028	0	0
Nitric Nitrogen.	trace.	.I2	.045
Saline ammonia.	.02	.000	.000
Albuminoid Ammonia.	.02	.0I4	.008
Chlorine as Chlorides.	3.93	.45	.45
Total Solids dried at I80° C.	53.50	33.00	38.00
Metals.	0	0	0
Oxygen absorbed from permanganate at 37° C.	.I4	0	0
Physical Characters.	Brown tinge, no odour, slight turbidity alkaline.	Colourless, clear alkaline.	Colourless, clear alkaline.
Hardness. Total.	2I	I8	24
Permanent.	7	4	8
Temporary.	4	I4	I6
Probable Saline Constituents.	Calc.Carb. I3.I0 Mag.Carb. 5.74 Sod.Carb. I8.I5 Sod.Sulph. I2.38 Sod.Chlor. 6.48 Silica. 2.65	Calc.Carb. I5.65 Mag.Carb. 3.25 Sod.Carb. 8.85 Sod.Sulph. 3.04 Sod.Chlor. .74 Sod.Nitr. .73 Silica. .74	Calc.Carb. I6.25 Mag.Carb. 7.99 Sod.Carb. 4.72 Sod.Sulph. 7.3I Sod.Chlor. .74 Sod.Nitr. .28 Silica. .7I

P A V I A.

	35. "Ruota" Pump. I4. 4. I8.	35. " Ruota" Pump. I7. 8. I8.	35. "Ruota"Pump. I6. II. I8.	35. "Ruota"Pump. I7. I2. I8.
Colonies agar 24 hrs. at 37° C.	352	I44	5	6
Gelatine 3 days at 20° C.	763	500	5	II
B. Coli	Present in IO c.c.	Lactose fermenters not B.Coli in I c.c.	Present in 64 c.c.	Lactose fermenters not B.Coli in IOO c.c.
B. E. S.	Present in 250 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER IOO,000.			
Nitrous Nitrogen.	0	.005	0	0
Nitric Nitrogen.	.006	.4	0	0
Saline Ammonia.	0	0	0	0
Albuminoid Ammonia.	.038	.004	.0I2	.0I4
Chlorine as Chlorides.	.52	.54	.55	.55
Total Solids dried at I80° C,	I7.50	I9.00	I7.50	I7.00
Metals.	Fe faint trace.	0	0	0
Oxygen absorbed from permanganate 3 hrs. at 37° C.	.0I5	.03	.036	.04
Physical Characters.	Colourless, clear alkaline.	Colourless, clear neutral.	Colourless clear, neutral	Colourless, clear neutral.
Hardness. Total.	6	I2	I0	8
Permanent.	3	3	3	2
Temporary.	3	9	7	6

Probable Saline Constituents.	Mean of 4 analyses.		
		Calc.Carb.	8.I9
		Mag.Carb.	3.I2
		Sod.Carb.	I.49
		Sod.Sulph.	2.33
		Sod.Chlor.	.88
		Sod.Nitr.	.6I
		Silica.	.6I

P A V I A.

	36.	36.	37.
	Pump Observatory. I4. 4. I8.	Pump Observatory. I8. 9. I8	Pump Via Magenta. I7. 8. I8.
Colonies on Agar 24 hrs. at 27° C.	3I6	3	I60
Gelatine 3 days at 20° C.	320 (2days)	I8	600
B. Coli.	Present in IO c.c.c	Loctose fermenters not B.Coli present in IO c.c.	Lactose fermenters not B.Coli in I c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER 100000.		
Nitrous Nitrogen.	0	0	.002
Nitric Nitrogen.	.006	.02	2.00
Saline Ammonia.	.00I	0	.003
Albuminoid Ammonia.	.0I3	.008	.0I9
Chlorine as Chlorides.	.5I	.58	2.04
Total Solids dried at I80° C.	I5.00	I7.00	44.00
Metals.	Fe very faint trace.	0	0
Oxygen absorbed from permanganate 3 hrs. at 37° C.	.0I8	.02	.05
Physical Characters.	Colourless, clear alkaline.	Colourless, clear neutral.	Colourless, clear neutral.
Hardness. Total.	6	I5	20
Permanent.	3	3	5
Temporary.	3	I2	I5
Probable Saline Constituents.	Calc.Carb. 4.85 Mag. Carb. 2.II Sod. Carb. 4.40 Sod.Sulph. 2.44 Sod.Chlor. .84 Sod.Nitr. .04 Silica. .32	Calc.Carb. I2.20 Mag.Carb. 3.49 Sod.Sulph. 2.34 Sod.Chlor. .79 Sod.Nitr. .24 Silica. .94	Calc.Carb. I5.32 Mag.Carb. 5.7I Mag.Sulph. 6.02 Sod.Chlor. 3.36 Sod.Nitr. I2.I5 Silica.etc. I.44

P A V I A.

	38.	39.
	Pump. I8. 9. I8.	Spring near Observatory. I8. 9. I8.
Colonies Agar 24 hrs at 37° C.	II	40
Gelatine 3 days at 20° C.	I50	250
B. Coli.	Absent in I00 c.c.	Present in 5 c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER	I00,000.
Nitrous Nitrogen.	.00I	trace.
Nitric Nitrogen.	.04	.04
Saline Ammonia.	0	.003
Albuminoid Ammonia.	.008	.004
Chlorine as Chlorides.	.60	.48
Total Solids dried at I80° C.	I4.75	20.00
Metals.	0	0
Oxygen absorbed from permanganate 3 hrs. at 37° C.	.0I	0
Physical Characters.	Colourless, clear neutral.	Colourless, clear neutral.
Hardness. Total.	I0	I8
Permanent.	4	5
Temporary.	6	I3
Probable Saline Constituents.	Calc.Carb. 5.77 Mag.Carb. 2.94 Sod.Carb. I.68 Sod.Sulph. 2.64 Sod.Chlor. .98 Sod.Nitr. .24 Silica etc. .30	Calc.Carb. I2.20 Mag.Carb. 3.49 Sod.Sulph. 2.34 Sod.Chlor. .79 Sod.Nitr. .24 Silica. .94

TREVIGLIO and CRESCENZAGO.

	40.	41.	42.	42.
	Well (pumped) 25 metres deep Treviglio. 29. 4. I8.	Bucket well. Treviglio. 29. 4. I8.	Pump at Ponte Nuovo Crescenzago. I2. 9. I8.	Pump at Ponte Nuovo, Crescenzaggo 2I. IO. I8.
Colonies agar 24 hrs. at 37° C.	3	I952	6	I2
Gelatine 3 days at 20° C.	256	4480 (2 days).	I50	2I
B. Coli.	Absent in I00 c.c.	Present in $\frac{I}{IO}$ c.c.	Present in IO c.c.	Lactose fermenters not B.Coli in IO c.c.
B. ESS.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER I00,000.			
Nitrous Nitrogen.	0	Faint trace.	0	0
Nitric Nitrogne.	.0I2	.4	.I5	.22
Saline Ammonia.	.005	.0I3	0	trace.
Albuminoid Ammonia.	.0I0	.028	.007	.004
Chlorine as Chlorides.	.59	I.04	I.03	.85
Total Solids dried at I80° C.	2I.50	27.00	24.50	24.00
Metals.	0	0	0	0
Oxygen absorbed from Permanganate 3 hrs at 37° C.	.008	.02	0	.0I
Physical Characters.	Colourless, clear alkaline.	Colourless, deposit of vegetable debris alkaline.	Colourless, clear, neutral.	Colourless, clear neutral.
Hardness. Total.	I4	2 0	I8	20
Permanent.	5	6	2	3
Temporary.	9	I4	I6	I7
Probable Saline Constituents.	Calc.Carb. 9.50 Mag.Carb. 5.88 Sod.Carb. 4.63 Sod.Chlor. .97 Sod.Nitr. .07 Silica. .45	Calc.Carb. I5.50 Mag.Carb. 7.03 Sod.Chlor. I.7I Sod.Nitr. 2.43 Silica. .33	Calc.Carb. I6.55 Mag.Carb. I.59 Sod.Carb. .95 Sod.Chlor. I.73 Sod.Nitr. .90 Silica. I.I5 Sod.Sulph. I.58	Calc.Carb. I7.20 Mag.Carb. I.90 Sod.Sulph. .78 Sod.Chlor. I.40 Sod.Nitr. I.33 Silica. I.39

	43.	44.	45.
	Pump Via Venezia. 26. I. I8.	Pump Via Castelleone. 4. 2. I8.	Pump Castelleone. 4. 2. I8.
Colonies Agar 24 hrs at 37^{o} C.	3	20	86
Gelatine 3 days at 20^{o} C.	24	224	400 ... 2 days gelatine liquifying.
B. Coli.	Present in 30 c.c.	Absent in I00 c.c	Present in 5 c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Present in 360 c.c.
	PARTS PER I00,000.		
Nitrous Nitrogen.	0	.0I	.02
Nitric Nitrogen.	.33	0	.5I
Saline Ammonia.	.24	.02	.0I
Albuminoid Ammonia.	.I6	.02	.03
Chlorine as Chlorides.	I.9	.46	.47
Total Solids dried at $I80^{o}$ C.	34.00	48.00	48.00
Metals.	0	0	0
Oxygen absorbed from permanganate 3 hrs. at 37^{o} C.	.0I6	.032	.0I6
Physical Character.	Colourless, clear alkaline.	Colourless, clear alkaline.	Colourless, clear alkaline.
	I8		
Hardness. Total.	9	I8	20
Permanent.	9	6	7
Temporary.		I2	I3
Probable Saline Constituents.	Calc.Carb. I7.40	Calc.Carb. I5.95	Calc.Carb. I8.50
	Mag.Carb. 6.53	Mag.Carb. 4.22	Mag.Carb. 5.43
	Sod.Carb. 3.72	Sod.Carb. I9.I6	Sod.Carb. I4.22
	Sod.Chlor. 3.I3	Sod.Chlor. .76	Sod.Chlor. .77
	Sod.Nitr. 0.45	Sod.Sulph. 6.20	Sod.Sulph. 6.85
	Silica. 2.77	Silica. I.7I	Sod.Nitr. 0.70
			Silica. I.53

	46.	47.	48.
	Pump. Terra Amata. 30. 5. I8.	Pump. Terra Amata. IO. 7. I8.	Bucket Well. Terra Amata. 4. 7. I8.
Colonies Agar 24 hrs at 37° C.	8	64	I200
Gelatine 3 days at 20° C.	50	4800	5200
B. Coli.	Absent in IOO c.c.	Present in 5 c.c.	Present in $\frac{I}{IO}$ c.c.
B.E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER IOO,000.		
Nitrous Nitrogen,	0	.004	.00I
Nitric Nitrogen.	.20	.I3	.I2
Saline Ammonia.	0	0	.00I
Slbuminoid Ammonia.	.0I4	.008	.008
Chloride as Chlorides.	.54	I.25	I.30
Total Solids dried at I80° C.	25.00	4I.00	42.00
Metals.	0	0	0
Oxygen absorbed from permanganate 3 hrs at 37° C.	.02	.032	.02
Physical Characters.	Colourless, clear alkaline.	Colourless, clear, alkaline.	Colourless, clear, slightly alkaline.
Hardness. Total.	I8.	29	28
Permanent.	4	4	4
Temporary.	I4	25	24
Probable Saline Constituents.	Calc. Carb. I5.85 Mag.Carb. 2.98 Sod.Carb. 2.60 Sod.Sulph. .89 Sod.Chlor. .89 Sod.Nitr. I.20 Silica. .59	Calc.Carb. 28.00 Mag.Carb. 4.94 Sod.Sulph. 4.03 Sod.Chlor. 2.06 Sod.Nitr. .79 Silica. I.I8	Calc.Carb. 27.97 Mag.Carb. 2.25 Sod.Carb. 3.75 Sod.Sulph. 3.85 Sod.Chlor. 2.I4 Sod.Nitr. .73 Silica. I.3I

CICOGNOLO. Pumps - Shallow Wells.

	49.	5 O.	50.
	WELL. I9. I. I8.	WELL. I. 5. I8.	WELL. 29. 7. I8.
Colònies Agar 24 hrs. at 37° C.	Innumerable.	208	7
Gelatine 3 days 2t 20° C.	Innumerable.	640	20
B. Coli.	Present in I/IO c.c.	Present in I c.c.	Present in I/IO c.c.
B.E.S.	Present in IO c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER IOO,OOO.		
Nitrous Nitrogen.	.09	0	0
Nitric Nitrogen.	0	0	0
Saline Ammonia.	2.05	.02	.004
Albuminoid Ammonia.	I.00	.03	.0I0
Chlorine as Chlorides,	8.97	.56	.93
Total Solids dried at I80° C.	82	28.50	30.00
Metals.	0	Fe a trace.	Fr a trace.
Oxygen absorbed from permanganate 3 hrs at 37° C.	I.2	.0I3	.04
Physical Characters.	Pale straw, odour of sewage, turbid, alkaline.	Brown tinge, no odour, slightly opalescent, alkaline.	Colourless.
Hardness. Total.	25	I8	22
Permanent.	I2	5	6
Temporary.	I3	I3	I6
Probable Saline Constituents.	Calc.Carb. 24.38 Mag.Carb. 4.84 Sod.Carb. 25.5I Sod.Sulph. II.04 Sod.Chlor. I4.79 Silica.etc. I.44	Calc.Carb. I9.09 Mag.Carb. 3.I2 Sod.Carb. 22.05 Sod.CSulph. 2.93 Sod.Chlor. I.05 Silica. .93	

Pumps - Shallow Wells.

	50.	50.	5[illegible].
	Well. 2. IO. I8	Well. 3. I2. I8.	Well. 3. I2. I8.
Colonies Agar 24 hrs. at 37° C.	40	I2	480
Gelatine 3 days at 20° C.	50	60	500
B. Coli.	Absent in IOO c.c.	Absent in IOO c.c.	Present in IO c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
Nitrous Nitrogen.	0	0	.0I
Nitric Nitrogen.	0	0	.I6
Saline Ammonia.	trace.	.000	.028
Albuminoid Ammonia.	.004	.008	.0I2
Chlorine as Chlorides.	.72	.42	2.73
Total Solids dried at I80° C.	30.00	28.50	52.00
Metals.	Fe .IO	trace.	0
Oxygen absorbed from permanganate 3 hrs at 37° C.	.04	.05	.08
Physical Characters.	Yellow tinge, odour of H_2S.	Brownish, opalescent, neutral.	Colourless, clear bright, neutral.
Hardness. Total.	24	26	42
Permanent.	5	4	8
Temporary.	I9	22	34
Probable Saline Constituents.	Calc.Carb. I9.09 Mag.Carb. 3.I2 Sod.Carb. 2.05 Sod.Sulph. 2.93 Sod.Chlor. I.05 Silica. .93		Calc.Carb. 35.66 Mag.Sulph. 9.25 Sod.Chlor. 4.49 Sod.Nitr. I.0I Silica etc. I.59

	52. Well. 3. 2. 18.	53. Well. 8. 2. 18.	53½ Well. 28. 3. 18.	53. Well. 9. 8. 18.	55. Well. 2. 10. 18.
Colonies Agar 24 hrs at 37°C	4	128	5	32	16
Gelatine 3 days at 20° C.	6	704	80	240	24
B. Coli.	Absent in 100 c.c.	Present in 20 c.c.	Present in 5 c.c.	Present in 1 c.c.	Present in 1 c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS	PER 100,000.			
Nitrous Nitrogen.	0	.002	0	0	0
Nitric Nitrogen.	0	.08	.048	.02	trace
Saline Ammonia.	.010	.004	0	0	0
Albuminoid Ammonia.	.011	.012	.009	.004	.004
Chlorine as Chlorides.	.28	1.41	1.15	1.06	.75
Total Solids dried at 180°C.	36.5	46.50	44.00	38.00	36.25
Metals.	Fe.4	0	0	0	0
Oxygen absorbed from permanganate 3 hrs at 37° C.	.033	.011	.016	.008	.03
Physical Characters.	Brownish tinge, opalescent, alkaline.	Colourless, clear, alkaline.	do.	do.	neutral.
Hardness. Total.	14	14	16	30	32
Permanent.	5	6	5	10	7
Temporary.	9	8	11	20	25
Probable Saline Constituents.	Calc.Carb 19.05 Mag.Carb. 6.26 Sod.Carb. 8.12 Sod.Chlor. .46 Sod.Sulph. 2.50 Ferrous Carb. .83 Silica 2.28		Calc.Carb. 21.48 Mag.Carb. 7.39 Mag.Sulph. .75 Sod.Sulph. 2.71 Sod.Chlor. 1.84 Sod.Nitr. .03 Silica. 1.45	4 Analyses.	

[illegible] S.LORENZO. S.Giovanni in CROCE.

	54.	55.	56.
	Pump. Torre. I9. 4. I8.	Pump. Torre. 28. 4. I8.	Pump. Torre. 24. 4. I8.
Colonies Agar 24 hrs. at 37° C.	24	80	88
Gelatine 3 days at 20° C.	832?	496	I728
B. Coli.	Present in 5 c.c.	Absent in I00 c.c.	Present in $\frac{I}{IO}$ c.c.
B.E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER I00,000.		
Nitrous Nitrogne.	.008	.00I	0
Nitric Nitrogen.	.83	.4	0
Saline Ammonia.	.008	.004	.003
Albuminoid Ammonia.	.0I6	.0I2	.008
Chlorine as Chlorides.	I.60	.59	.58
Total Solids dried at I80° C.	32.50	3I.50	25.50.
Metals.	0	0	0
Oxygen absorbed from permanganate 3 hrs at 37° C.	.003	.004	.0I8
Physical Characters.	Colourless, clear alkaline.	Colourless, clear, alkaline.	Colourless, clear alkaline.
Hardness. Totsl.	I2	I6	I4
Permanent.	5	5	5
Temporary.	7	II	9
Probable Saline Constituents.	Calc.Carb. I3.45 Mag.Carb. 4.I5 Sod.Carb. 3.23 Sod.Suplh. 3.27 Sod.Chlor. 2.64 Sod.Nitr. 5.03 Silica. .73	Calc.Carb. I8.I2 Mag.Carb. 4.94 Sod.Carb. 2.57 Sod.Sulph. .60 Sod.Chlor. .97 Sod.Nitr. 2.42 Silica etc. I.88	Calc.Carb. I3.35 Mag.Carb. 3.66 Sod.Carb. 4.58 Sod.Chlor. 2.25 Sod.Nitr. .95 Silica .7I

TORRE DE PICENARDI, S. LORENZO, S. GIOVANNI IN CROCE.

	57.	58.	59.
	Bucket Well. I9. 4. I8. S.Lorenzo.	Pump. S.Lorenzo. 28. 4. I8.	Pump. S.Giovanni. I9. 4. I8.
Colonies Agar 24 hrs. at 37° C.	28	IO	72
Gelatine. 3 days at 20° C.	I792	I504	3328
B. Coli.	Present in IO c.c.	Present in IO c.c.	Present in I c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER	IOO,000.	
Nitrous Nitrogen.	.003	0	.003
Nitric Nitrogen.	.25	.33	.63
Saline Ammonia.	.004	.000	.000
Albuminoid Ammonia.	.028	.0I2	.040
Chlorine as Chlorides.	.80	6.I2	I.46
Total Solids dried at I80° C.	25.00	52.50	42.50
Metals.	0	0	0
Oxygen absorbed from permanganate 3 hrs at 37° C.	.05	.005	.02
Physical Characters.	Colourless, clear alkaline.	Colourless, clear faintly alkaline	Colourless, clear alkaline.
Hardness. Total.	IO	22	I8
Permanent.	5	8	6
Temporary.	5	I4	I2
Probable Saline Constituents.	Calc.Carb. 9.50 Mag.Carb. 3.56 Sod.Carb. 8.26 Sod.Chlor. I.32 Sod.Nitr. I.52 Silica. .84	Calc.Carb. 27.20 Mag.Carb. 8.53 Sod.Sulph. 2.75 Sod.Chlor. IO.09 Sod.Nitr. 2.00 Silica. I.83	Calc.Carb. I6.37 Mag.Carb. 8.89 Sod.Carb. 7.53 Sod.Sulph. 2.5I Sod.Chlor. 2.4I Sod.Nitr. 3.83 Silica. .96

MANTOVA - Wells.

	60.	61.	62.	63.	62.
	Pump. 7. 9. I8.	Pump. 7. 9. I8.	Pump. II.II.I8.	New Well. 7. IO. I8.	New.Well. II.II. I8.
Colonies Agar 24 hrs. at 37° C.	I2	9	2	IO	20
Gelatine 3 days at 20° C.	54	20	4	20	25
B. Coli.	Absent in IOO c.c.	Lactose fermenters not B. Coli in 5 c.c.	Lactose fermenters not B.Coli in 5 c.c.	Present in I c.c.	Lactose fermenters not B.Coli in 5 c.c.
B.E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER IOO,OOO.				
Nitrous Nitrogen.	0	0	0	0	0
Nitric Nitrogen.	trace.	.008	0	.0I4	.002
Saline Ammonia.	faint trace.	.046	.04I	.058	.048
Albuminoid Ammonia.	.003	.008	.0I3	.026	.0I2
Chlorine as Chlorides.	.85	.50	.40	5.80	5.I5
Total Solids dried at I80° C.	4I.00	26.00	24.00	47.00	45.00
Metals.	0	0	Fe a trace.	Fe .3	Fe .25
Oxygen absorbed from permanganate 3 hrs at 37°C.	.03	.07	.03	.09	.0I
Physical Characters.	Colourless, clear, neutral.	Colourless, odour of H_2S, alkaline.	Slight brown tinge, odour of H_2S, alkaline.	Brown, tinge, turbid on standing, neutral.	do.
Hardness. Total.	28	I2	I8	34	32
Permanent.	I2	3	2	8	4
Temporary.	I6	9	I6	26	28
Probable Saline Constituents.	Calc.Carb. I6.IO Mag.Carb IO.38 Sod.Carb. 6.65 Sod.Sulph. 5.68 Sod.Chlor. I.40 Silica. .79	Calc.Carb. I2.II Mag.Carb. 3.70 Sod.Carb. 7.35 Sod.Chlor. .74 Sod.Nitr. .0I Silica. I.09		Calc.Carb. 25.53 Mag.Carb. 7.34 FerrousCarb. .57 Sod.Sulph. 2.59 Sod.Chlor. 9.03 Sod.Nitr. .04 Silica. I.I5	

	63.	64.	65.	66.
	Pump. 20 metres well at Railway station. 28.2.I8.	Pump. Via Mura Demolite. 28. 2. I8.	Pump. Via XX Settenbre. 7. 3. I8.	Pump. Sugar Factory. 7. 3. I8.
Colonies agar 24 hrs. at 37° C.	3	7	6	5
Gelatine 3 days at 20° C.	400	56	26	24
B. Coli.	Absent in 100 c.c.c	Absent in 100 c.c.	Absent in 100 c.c.	Absent in 100 c.c.
B.E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS	PER 100,000.		
Nitrous Nitrogen.	0	0	0	0
Nitric Nitrogen.	0	.0I	0	0
Saline Ammonia.	.09	.I7	.002	.029
Albuminoid Ammonia.	.0I	.02	.006	.005
Chlorine as Chlorides.	.40	.40	.20	.30
Total Solids dried at I80° C.	I4.00	I2.50	I4.5	I5.00
Metals.	Fe .08	0	0	0
Oxygen absorbed from permanganate 3 hrs. at 37° C.	.006	.0I	.0I	.0I
Physical Characters.	Colourless, clear alkaline.	Colourless, clear, alaklin.	Colourless, clear alkaline.	Colourless, clear, alkaline.
Hardness. Total.	6	7	7	7
Permanent.	4	3	3	4
Temporary.	2	4	4	3
Probable Saline Constituents.	Calc.Carb 8.I2 Sod.Carb. .97 Ferrous Barb .I6 Sod.Chlor. .66 Sod. Sulph. 2.96 Silica. I.I3	Calc.Carb. 5.32 Mag.Carb. 2.07 Sod.Carb. I.48 Sod.Chlor .66 Sod.Sulph. 2.37 Silica. .60	Calc.Carb. 9.70 Sod.Carb. .I4 Sod.Sulph. 2.96 Sod.Chlor. .38 Silica. I.37	Calc.Carb. 9.07 Mag.Carb. .2I Mag.Sulph. I.28 Sod.Sulph. I.89 Sod.Chlor. .49 Silica 2.06

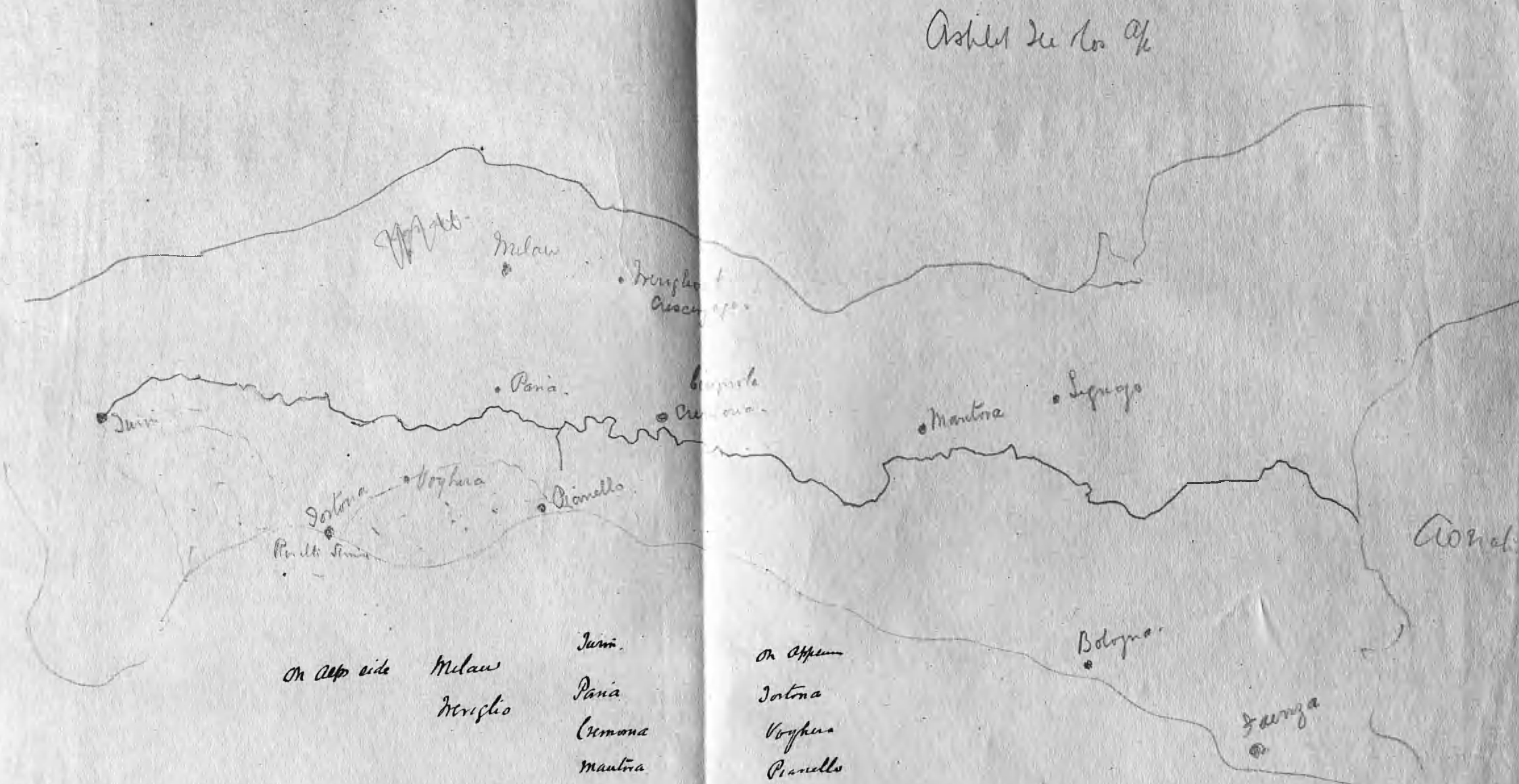
FAENZA - Fountain Supply - Spring $1\frac{1}{2}$ litrs per second.

	8. 5. I8.	25. 6. I8.	I3. 8. I8.
Colonies Agar 24 hrs. at 37° C.	6	7	250
Gelatine 3 days at 20° C.	56	25	800
B. Coli.	Absent in 20 c.c.	Present in 30 c.c.	Lactose fermenters not B.Coli in 5 c.c.
B. E.S.	Absent in 360 c.c.	Absent in 360 c.c.	Absent in 360 c.c.
	PARTS PER I00,000.		
Nitrous Nitrogen.	.00I	0	trace.
Nitric Nitrogen.	0	.4I	.30
Saline Ammonia.	.004	.005	.004
Albuminoid Ammonia.	.024	.009	.0I0
Chlorine as Chlorides.	6.79	7.65	8.50
Total Solids dried at I80°C.	64.00	70.00	69.50
Metals.	0	0	0
Oxygen absorbed from permanganate 3 hrs at 37° C.	.00I	.008	.0I
Physical Characters.	Colourless.	Clear.	Slightly alkaline.
Hardness. Total.	28	48	44
Permanent.	7	I6	I0
Temporary.	2I	32	34

Probable Saline Constituents.		Mean of 3 Analyses.
Calc. Carb.	34.25	
Mag.Carb.	I0.80	
Mag.Sulph.	.85	
Sod.Sulph.	6.I6	
Sod.Chlor.	I2.6I	
Sod.Nitr.	I.43	
Silica.	I.7I	

FAENZA- Wells.

	68.	69.	70.
	Open Well. 7. 5. I8.	Pump. 7. 5. I8.	Bucket Well. Villa Montusci. 7. 5. I8.
Colonies Agar 24 hrs at 37° C.	2400	96	600
Gelatine 3 days at 20° C.	I6000	I920	3200
B. Coli.	Present in 5 c.c.	Present in I c.c.	Present in $\frac{I}{IO}$ c.c.
B.E.S.	Present in I00 c.c.	Absent in 360 c.c.	Present in 360c.c.
	PARTS PER I00,000.		
Nitrous Nitrogen.	0	.00I	.00I
Nitric Nitrogen.	0	.33	.04
Saline Ammonia.	.008	.020	.040
Albuminoid Ammonia.	.032c	.072	.080
Chlorine as Chlorides.	2.I2	I.8I	6.32
Total Solids dried at I80°C.	39.50	5 0.00	87.50
Metals.	trace of Iron.	0	0
Oxygen absorbed from permanganate 3 hrs at 37° C.	.04	.05	.02
Physical Characters.	Colourless, Clear, alkaline.	Brownish tinge, slightly turbid, deposit of vegetable debris, alkaline.	Colourless, clear, alkaline.
Hardness. Total.	22	34	50
Permanent.	6	7	22
Temporary.	I6	27	28
Probable Saline Constituents.	Calc.Carb. 22.80 Mag.Carb. 8.33 Sod.Sulph. 3.3I Sod.Chlor. 3.50 Silica. I.56	Calc.Carb. 28.I2 Mag.Carb. II.07 Sod.Carb. 3.29 Sod.Sulph. 2.37 Sod.Chlor. 2.98 Sod.Nitr. 2.00 Silica. .I7	Calc.Carb. 40.0 Calc.Sulph. 21.08 Mag.Sulph. I4.77 Mag.Chlor. 6.I7 Sod.Chlor. 2.85 Sod.Nitr. .24 Silica. 2.39



On Alps side Milan
Treviglio

Turin.
Pavia
Cremona
Mantova
Legnago.

On Appenn
Tortona
Voghera
Pianello
Bologna
Faenza,

Sampling - Taenga Mg -
Nov 13.

Mg CO3	10.8	8.33	11.07	14.17 Sio
Mg Sio	.85	—	—	6.17

11.65
8.33.
11.07
20.94

4 | 51.99
13.

66 6.79
7.65
8.5
2.1
1.8
6.3
6 | 33.1
5.5

Jortina Mg

CO3	Sio
5.36	
3.25	1.65
6.09	
10.38	
3.66	2.57
2.32	1.48
1.93	4.29
10.38	
7.48	
8.53	5.13
3.79	15.8
10.14	8.02
4.2	38.94
4.84	82.39
82.39	14 / 121.33 (8.7

Rhwalla . None. Clos 6

Jortina -