1917.

NEW ZEALAND.

MINES DEPARTMENT.

GEOLOGICAL SURVEY BRANCH

(ELEVENTH ANNUAL REPORT (NEW SERIES) OF THE).

Laid on the Table of the House of Representatives by Leave.

CONTENTS.

LETTER OF TRANSMITTAL.

SIR,— Geological Survey Office, Wellington, 9th August, 1917.

I have the honour to forward herewith the eleventh annual report of the Geological Survey Branch of the Mines Department. This report covers the work of the Geological Survey during the twelve months that ended on 31st May, 1917. Its preparation has been delayed by the pressure of my other duties, chiefly in connection with the routine work of the Mines Department.

I have, &c.,

P. G. MORGAN,

Director, New Zealand Geological Survey.

The Hon. W. D. S. MacDonald, Minister of Mines, Wellington.

DIRECTOR'S REPORT.

SUMMARY OF FIELD-WORK.

DURING the field season ending 31st May, 1917, no regularly organized field-parties were employed, and the only detailed survey undertaken was in the south-west part of Taranaki. Visits were made by the Director to Te Kuiti, Thames, Greymouth, and other localities, but these were principally on Mines Department business, and only a few geological notes were made. Dr. J. Henderson made a reconnaissance survey of a considerable area near Te Kuiti in order to determine the probability of workable coal being found. He also visited Mahoenui, Awakino, and Lower Mokau in order to report on limestone-deposits. At the request of the Chief Electrical Engineer, Public Works Department, he examined the Waikato Valley in the neighbourhood of Maungatautari. In the South Island Dr. Henderson visited Deep Creek (Marlborough), Bainham, Murchison, Inangahua Junction, Greymouth, Ross, Kaikoura, Cheviot, and other localities. His investigations were principally concerned with limestone-deposits. Mr. W. Gibson, Assistant Geologist, reported on boring operations undertaken near Kaitoke in order to locate a supposed seam of coal. Mr. Ongley, Assistant Geologist, besides making a moderately detailed survey of a considerable area in south-west Taranaki, visited many localities in the North Auckland Peninsula, principally in order to examine limestone-deposits, and with the same object visited Mabel, Limehills, and Dipton, in Southland. He also made a brief inspection of the Wairio Coalfield, near Nightcaps, and visited Wangaloa, near Kaitangata, in order to collect early Tertiary fossils.

EGMONT SUBDIVISION.

In last year's report the survey of the Egmont Subdivision was announced as finished, but it was decided to continue the survey so as to include the whole of Mount Egmont and the surrounding country. Mr. Ongley was therefore instructed to examine in moderate detail the survey districts of Opunake, Kaupokonui, Ngaire, Oeo, and Waimate, and, owing to the simplicity of the geology, was able to cover the ground in about seven weeks during the months of February, March, and April last.

LIMESTONE-DEPOSITS.

Early last year it was decided that a detailed report on the limestone-deposits of New Zealand should be prepared by the Geological Survey. The report, as planned, is to contain, in the first place, general information concerning limestone, its chemical composition, and uses in agriculture. Descriptions, brief or moderately detailed according to the amount of information available, of all limestone-deposits examined by members of the Geological Survey staff or mentioned in New Zealand geological literature are to follow. The report will include all analyses of any value, and all available data concerning quality, quantity, and accessibility. It is proposed also to add a chapter on phosphate-deposits, and another on limestone-crushing machinery. Such a report, it is felt, will be of assistance not only to farmers, but also to all who desire information concerning limestone for other than agricultural purposes.

During the past twelve months numerous localities, as mentioned above, have been visited by members of the staff in order to collect information, and data for a lengthy report on New Zealand limestone have now been obtained. Owing, however, to the Director, who was to undertake a considerable portion of the field-work, having been fully employed in the office-work of the Geological Survey and by his duties as Under-Secretary of Mines, and owing to the small staff available, the compilation of the report in a form suitable for publication will necessarily take a considerable time. Some delay in the carrying-out of the general plan has been caused by demands from local bodies and farming associations for special examinations and reports upon limestone-deposits in which they were directly interested. Some of the requests were granted, but the time occupied in the visits made was largely lost so far as the interests of the public as a whole were concerned, for it is believed that at the present time the good of the community can be better served by a report of general interest than by brief and hastily written notes of local value only.

Detailed examinations of limestone-deposits with a view to establishing lime-kilns or lime-crushing plants will, of course, be found necessary in many localities, but these will be as well or better undertaken by the Agricultural Department, the officers of which possess expert knowledge of the needs of agriculture in the different districts of the Dominion. If work of this kind is to be undertaken by the Geological Survey, then, as implied above, it should not precede but follow the publication of a general report which will give the greater part of the information desired to all concerned in less time and at less expense than can be expected from a piecemeal method.

Coalfield Surveys.

No more important work than the systematic examination of New Zealand coalfields could be undertaken by the Geological Survey. During previous years complete surveys of the Greymouth, Westport, and Reefton coalfields have been made, but important coalfields in many parts of New Zealand still remain to be examined in detail. Last year reconnaissance surveys were made in the Te Kuiti and North Taranaki district and in the Wairio-Ohai section of the Nightcaps - Mount Linton coalfield, in order to ascertain the prospects of coal being successfully mined in those areas. Summaries of the results obtained are given in special reports on later pages.

With regard to the Te Kuiti district it may be observed that the geological evidence of a workable coalfield being present is scanty and disappointing. This district, however, forms only a small part of a large area, extending northward to Drury and southward to Ohura, in which coal-bearing rocks occur here and there but not continuously. In most places the possible coal-seams are hidden by younger rocks. Boring is therefore necessary if the hidden coal is to be discovered, but I have to state that only systematic exploration on a large scale is likely to be of any use. At Huntly in the Waikato and Waitewhena in north Taranaki, where workable coal is already known, few blank boreholes need be drilled, but in the intervening area it may be necessary to drill dozens of holes before the presence or absence of workable coal can be definitely ascertained. Recently in the United States a zinc-prospecting company drilled twenty-eight successive bores without success, but the twenty-ninth and thirtieth holes found a valuable deposit.

Palæontological Work.

During the past year Mr. H. Suter, Consulting Palæontologist, has been employed in identifying or describing the Tertiary Mollusca contained in the Geological Survey collections and in similar work for private collectors. His report, mentioned last year under the title of "Descriptions of New Tertiary Mollusca occurring in New Zealand, accompanied by a Few Notes on Necessary Changes in Nomenclature, Part I," is now ready for publication as Palæontological Bulletin No. 5. During the past few years Mr. Suter has compiled a large number of manuscript lists of fossils, and these he is now preparing for publication.

Dr. J. A. Thomson, Director of the Dominion Museum, has continued to work, so far as his ordinary duties permitted, on New Zealand Brachiopoda. He has identified many specimens for Professor Park and officers of the Geological Survey. Mr. C. T. Trechmann, of Castle Eden, County Durham, who was mentioned in last year's report as a visitor to the Dominion, has done a considerable amount of work on New Zealand Mesozoic fossils, and has lately written several papers dealing with them. One of these, entitled "The Age of the Maitai Series of New Zealand," was published in the *Geological Magazine*, N.S., Decade VI, vol. 4, pp. 53–64, February, 1917. Another paper, "The Trias of New Zealand," was read before the Geological Society of London on the 7th February, 1917. A summary of this paper has been given in the Abstracts of the Proceedings of the Society, and probably it will be published in full before this report appears. Still another paper by Mr. Trechmann, with the title "Cretaceous Mollusca from New Zealand," appears in the July number of the *Geological Magazine*.

Publications.

The only publications actually issued during the year were the Tenth Annual Report of the Survey, and Bulletin No. 18, entitled "The Geology and Mineral Resources of the Reefton Subdivision," by Dr. J. Henderson, Mining Geologist. This bulletin, which contains 232 pages of letterpress, in addition to introductory matter, numerous maps, and many photographic illustrations, deals in full detail with the general and economic geology of an area of 1,046 square miles which contains important mineral resources in the form of gold—both vein and alluvial—and of coal. At the moment of writing three palæontological bulletins are almost ready for issue, two areal bulletins are in course of publication, and others are in preparation.

Office-work.

During the year numerous requests for information concerning New Zealand minerals and ores have been answered by the Director and other members of the staff. A considerable amount of information has been furnished to the Board of Agriculture and to representatives of the farming industry concerning New Zealand limestone and phosphate deposits. Brief reports have been supplied to various Government Departments on matters concerning which inquiry was made. Some information concerning those subjects in which most interest has been shown is published on later pages of this report under the headings of "Potash," "Clay," "Talc," "Sulphur," "Fluor-spar," "Molybdenite," "Antimony," "Mercury," and "Manganese." Mr. F. Fulton-Wood has attended to most of the miscellaneous office-work, and has also acted as librarian during the year.

Maps, &c.—Mr. G. E. Harris, Draughtsman, during the year drew seven maps to be reproduced by photo-lithography for the bulletins on the Tuapeka, Gisborne, and Egmont districts. He prepared three mining maps for the Reefton Bulletin, one showing the lodes of the Tuapeka district, two for the Geological Survey Annual Report, and two that appeared in the Mines Statement. He also revised two survey district maps for republication. He prepared fifty-one drawings for line-blocks in connection with the Oamaru, Tuapeka, and Reefton reports, and five field-maps for use in the Egmont and Te Kuiti districts. In addition to miscellaneous draughting Mr. Harris read proofs and undertook some office-work.

Staff.

At the end of October, 1916, Mr. W. Gibson, B.E., resigned as Assistant Geologist in order to take up more remunerative employment on the staff of the Broken Hill Associated Smelters Proprietary (Limited), Port Pirie, South Australia. Owing to war conditions it has not been considered advisable to fill the position thus vacated, or that of Palæontologist, which has now been vacant for three years. The Director having been appointed Under-Secretary of Mines, the Geological Survey has been deprived in large measure of his services also. As another member of the staff will shortly join the military forces, and as the one remaining technical officer is a member of the Second Division, it is obvious that no settled plans for next season's field-work can be made. It therefore becomes my duty to point out that, in view of this fact and of the want of laboratory accommodation as described in the next paragraph, a stage has been reached at which the work of the Geological Survey is threatened with extinction. Opinions among the uninformed may differ as to the necessity for geological survey either in times of peace or of war, but my conviction is that, in the case of a prolonged world-war waged with all the appliances and artifices that the ingenuity of man can supply, the scientific survey of mineral resources is as much a necessity as the munition-factory. This fact has been recognized in Great Britain, and an organization to promote the survey and development of the Empire's mineral resources has been formed under the auspices of the Imperial Government. If New Zealand is to do her part in this work a strengthening of the technical staff of the Geological Survey, and probably also of the Mines Department proper, is required.

Office and Laboratory Accommodation.

Never in its history has the New Zealand Geological Survey been provided with proper facilities for performing office and, more especially, laboratory work. For many years the officers have struggled against adverse conditions, but there has now come a time when I am compelled plainly to state that either better facilities must be given for the proper performance of the scientific work that falls to the lot of the officers or the official geological survey of New Zealand must be abandoned. The latter alternative, in view of the importance of a full and systematic investigation of the natural resources of this country, and in view of the knowledge now brought home to all classes of the community by the present war that scientific research of all kinds is an essential factor in the material progress of all civilized nations, can hardly be seriously entertained by any one.

As stated above, geologic research in connection with mineral resources is a war necessity, but until the war ends an increase in the permanent staff of the Geological Survey is not advocated. The strengthening of the staff by the temporary appointment of suitable men does appear desirable, but the point I wish to make in this part of my report is that any attempt to enlarge the scope of the Geological Survey, or even to continue work on the same scale as during the past ten or twelve years, will be almost useless unless the survey staff is placed in offices provided with the laboratory facilities indicated in the next section of this report.

Scope, Organization, and Policy of the Geological Survey.

Naturally the first duty of a national Geological Survey is systematically to investigate the rocks and minerals of the country with a view of obtaining a full knowledge of its general and economic geology; its second and not less important duty is to make the information obtained available to the community at large. The field-work necessary in geological investigations requires the exploration of the whole country by trained scientists, and special technical knowledge is necessary where underground researches have to be made. In all cases, before full information can be obtained, field-work has to be supplemented by investigation in the laboratory and thorough study of scientific literature. The necessary data having been collected, its presentation to the public has to be undertaken. This involves the preparation of geological and topographical maps and the writing of clearly worded reports. It is not possible, however, to write a detailed geological report so that every part of it can be understood by the layman, but it is possible to write such reports so that technical and scientific men can obtain the information they require without difficulty. Miners, prospectors, and others, however, if without a good general education, may need to have considerable portions of even a well and clearly written report explained to them.

For this and other reasons it is desirable that a Geological Survey should undertake a considerable amount of educational work, by arranging (1) to compile and publish general as well as special reports, and (2) to collect and distribute typical minerals, fossils, rocks, and other geological material to museums, to universities, and to schools—technical, secondary, and even primary. Requests for mineral specimens are frequently received from prospectors, and to satisfy these is desirable. In order that educational and other publications may be satisfactorily written the use of a large library of scientific books and periodicals is indispensable. In order to provide

for the distribution of mineral specimens to the institutions mentioned, not only is collecting on a large scale necessary, but also accommodation for storing, sorting, labelling, and packing the specimens. At present, owing to the lack of storage room, the Geological Survey collects only the material necessary for its own special work, and much of this which could be preserved with advantage is ultimately discarded or in some way or another lost. Thus during the past year it was discovered that two thousand specimens or more had been removed without the knowledge of the Geological Survey officers from the shed in which they were stored and placed in the open air. The result was the loss of at least five hundred valuable specimens, many of them irreplaceable, and the expenditure of a considerable amount of labour in relabelling and repacking the material saved.

Conclusion.

In last year's report the advisability of undertaking a soil-survey of the Dominion was urged, and it was suggested that the work, in its early stages at least, could best be done by the Agricultural and Geological Departments working in conjunction. Representations in favour of a soil-survey have, I think, been lately made by the Board of Agriculture and also by the Agricultural Department, but nothing has yet been done towards utilizing the services of geologists in this direction.

The necessity of a thorough mineral survey has been mentioned in an earlier part of this report, and it is to be hoped that, even before the conclusion of the war, provision for extending and accelerating the work of the Geological Survey in connection with our mineral resources will be made.

SPECIAL REPORTS.

1. NOTES ON SOUTHERN PART OF EGMONT SUBDIVISION.

(By M. Ongley, Assistant Geologist.)

Economically considered the examination of Opunake, Kaupokonui, Ngaire, Oeo, and Waimate survey districts did not disclose much of importance. Nearly all the area is covered with fragmental volcanic material, and only in two small patches—one in the east of Ngaire Survey District, the other in the south of Waimate Survey District—were the underlying sedimentary strata seen. The mudstone exposed in these localities was lying flat or inclined at a very low angle, so that no structures of any significance in the consideration of the accumulation and storing of oil could be made out. Fossils collected from the mudstone in two localities on the south coast contain 42 and 53 per cent. of Recent species. This mudstone is therefore probably slightly older than any fossiliferous bed in the area previously examined by Mr. Gibson, and closely corresponds in age with Clarke's Onairo beds as developed in the New Plymouth Subdivision. As no oil or gas indications are known in this area, and as no favourable structures were located, it would be inadvisable for any one to extend oil-prospecting into this part of Taranaki. No metallic ores except small patches of ironsand on the coast are known. Agriculturally the district is well endowed, the soil and topography being well suited for farming. Over practically the whole area the soil is a brown loam formed from decomposed volcanic dust, underlain by a similar subsoil. Stony and swampy patches occur in places. In the east of Ngaire Survey District over a small area the soil is derived from the mudstone ("papa"). Further work on the soils is now being done by Mr. B. C. Aston, of the Department of Agriculture. Within the area examined only small deposits of limestone occur, and on that account lime and limestone for use on the soil are at present imported from Napier. In several places in the east of Ngaire Survey District an impure calcareous bed has been quarried for use on the roads, but the beds are thin, the stone is not of good quality, and the quarrying-conditions are bad. It is probable that more outcrops will be found, but this bed is not likely to yield much stone. In the north-east of Ngaire Survey District several quarries have been opened on a thicker bed of better stone. About a mile north-east of Gordon Road Railway-station three quarries have been opened in a bed of shelly limestone 8 ft. thick. The quarrying has been carelessly done, the stripping from the top being thrown on the limestone underfoot; but in any case as work proceeds the overburden must increase in thickness, and the position of the stone near the foot of the hill is not suitable for quarrying. Near Wawiri Road, and alongside Ahuroa Road near its junction with Wawiri Road, four quarries have been opened. The stone is 15–20 ft. thick and of better quality, but it is patchy and in places about one-third of its bulk consists of greywacke pebbles. Here also careless work in the past has made present work difficult. The quarries have been opened in the outcropping edges of the bed, the overburden is thick, and it is not known how much shell-rock occurs. Probably more outcrops will be found, but owing to the bad position of the stone no large quarries can be worked.

In Opunake Survey District deposits of calcareous sinter occur near Wiremu Road, the largest known deposits being on the farms of Messrs. G. Looney and H. Bartle. At Looney's the swampy stream is surrounded by conical hills of volcanic material, and in many places where the water trickles through the low ground sinter has been deposited. Mr. Looney has quarried and burnt some of this, but as only a small quantity of stone is known the erection of a kiln is not justified. Where Mr. Looney piled the stone the grass has made a good growth over it, and there seems no necessity either for burning the sinter or for crushing it to fine powder. It is generally full of holes, and is easily penetrated by the roots of grass, &c.: hence the sinter, if

broken small and applied to the ground, will give good results. At present the expenditure necessary to set up a crushing plant is not justified. More outcrops will probably be found, but the sinter is a surface deposit, and no extensive body of it occurs.

At Bartle's the stream flows through felled bush, and the seepage from the conical hills on the banks has formed a ledge of sinter overhanging the stream for 2 chains, and from the bottom of the ledge stalactites hang down. But this again is only surface sinter, and is very limited in amount. Probably more patches will be found, as in many places the conditions are suitable for its formation. It has been suggested that the sinter is derived from some bed of limestone in the vicinity, but thick deposits of volcanic material cover the whole district from Egmont to the coast. It has been shown* that the volcanic rock contains up to one-tenth its weight of lime (CaO), and it is not necessary to look further for the source of the lime.

In the north and east of Ngaire Survey District the shell-rock is used on the roads; it does not last well, but suitable volcanic rock does not occur in the vicinity. In the other parts of the area examined macadamizing material is obtained from the andesite boulders in the streams, on the beaches, or in the conical hills. Much of the andesitic rock is scoriaceous, and therefore not as dense as could be desired, but it makes a good tar-macadam road, and the main Taranaki roads are the best in New Zealand.

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2. BORING NEAR KAITOKE, HUTT COUNTY.

(By W. Gibson, formerly Assistant Geologist.)

During 1916 drilling operations were undertaken by a small syndicate (Kaitoke Prospecting Syndicate) near one of the branches of Hill's Creek, itself a tributary of the Pakuratahi, which is a tributary of the Hutt River. The site of the bore is on Section 28, Block 16, Akatarawa Survey District, that section being about four miles and a half east and south of Kaitoke, on the main road from Upper Hutt to the Wairarapa district. It is about 8 chains east of the road, and at an altitude of 980 ft. above sea-level.

The drilling operations were begun in the first place with a diamond drill lent by the Mines Department, and were under the supervision of Mr. W. Carter. The syndicate hoped that boring would indicate the exact depth of a coal-seam the existence of which under the surface-material was strongly asserted by Mr. W. Platt, a so-called "coal-diviner." The casing and drilling-tools belonging to the Mines Department were removed after 112 ft. of boring, mainly through shattered greywacke, had been accomplished. The syndicate at the time of my visit, 20th September, 1916, had resumed drilling with a chisel bit of 8 in. diameter. The only information given as to depth reached was that the syndicate's bore had attained a greater depth than the bore drilled by Mr. Carter. The chips and grains from the bore, however, disclosed the fact that the rock being passed through was the same as that which outcropped at the surface, a fine-grained greywacke.

At 5 chains east of the bore and on the same level this rock outcrops in both banks of the small creek which runs from east to west. At 300 ft. above the bore and 8 chains south more outcrops of massive greywacke are seen in another small creek. The whole mass has, however, been so smashed that no trace of bedding is to be observed. A small fault, having a strike of 11° (magnetic), occurs at 1 chain almost due south of the bore. The pug of this fault being black-coloured when wet, and in layers with a somewhat shaly appearance, may have given rise to the opinion that coal exists on the property. Red argillaceous rocks in boulders occur in places on the hillsides.

The nature and geologic age of the rock being drilled, the field evidence indicating its probable continuance in depth, and the absence of coal-outcrops all combine to destroy any hopes of a workable coal-seam being found underground in the locality. The whole scheme is another example of the reckless folly of investors trusting to the opinion of a "diviner," when expert opinion, if sought, could have readily shown the hopelessness of the venture.

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3. NOTES ON THE GEOLOGY AND MINERAL OCCURRENCES OF THE WAKAMARINA VALLEY.

(Summary of Report by J. Henderson.)

Alluvial gold was discovered in the Wakamarina Valley in 1864, and for many years the winning of it was the principal occupation of the inhabitants of the district. Quartz lodes were first prospected in 1874, but the amount of gold contained in the ore was not sufficient to pay for its mining and treatment. Within the last few years, however, mining operations on the main lode have been successful owing to the enhanced prices of scheelite, a mineral which, in small quantities, also occurs in the ore. During the last seven years the Dominion Consolidated Developing Company has crushed 62,500 tons of ore for a yield of over £36,000 in gold and nearly £48,000 in scheelite. The main lode traverses subschistose greywacke, and is known to carry ore for a distance of 90 chains. It strikes north-north-westerly and dips easterly. The nature of the ore and its distribution in the fissure suggest that it represents a concentration, formed by means of circulating meteoric water, of tungsten-bearing material contained in the country.

With this summary are published plans showing the locality, the claims, and the underground workings of the Dominion Consolidated Developing Company's mine in plan and section. The full report will appear as an article in the *New Zealand Journal of Science and Technology*, the first number of which is expected to appear very shortly.

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* N.Z. Geol. Surv. Bull. No. 14 (New Series), p. 23.

4. MARBLE IN RIWAKA–TAKAKA DISTRICT.

(Summary of Report by J. HENDERSON.)*

The Pikikiruna Range is in great part formed of massive layers of marble. In general this rock is medium to coarse grained in texture, and in colour varies from white to black. The Kairuru Quarry, from which the marble used in the Parliamentary Buildings is obtained, is about ten miles by road from Motueka. Close at hand is the Ngarua Quarry, belonging to the Nelson Marble Company. Here many large blocks at least 5 ft. cube occur on the surface as the result of weathering, and it is highly probable that the marble beneath is massive and will yield large-dimension blocks. Along the Takaka Valley are many outcrops of marble. The rock near the road is usually dark-coloured and fine-grained, and does not appear to occur in such large blocks as the lighter-coloured marble at Kairuru and Ngarua.

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5. NOTES ON THE GEOLOGY OF THE MURCHISON DISTRICT.

(Summary of Report by J. HENDERSON.)*

The main geological features of the Murchison district are similar to those of the Westport and Reefton districts, which lie to the south-westward, and are described in Geological Survey Bulletins Nos. 17 and 18. Several great zones of fracture traverse the district meridionally and divide it into a number of earth-blocks which have been warped and tilted. The western portion of the area mapped consists of an elevated mass, which extends southward as the Brunner-Victoria Range. Eastward the land surface is lower, and this portion of the area mapped is structurally depressed between the range just mentioned and a similar block lying to the eastward. The rocks that occur within this depression consist, in upward sequence, of conglomerate, grit, sandstone, and limestone. Coal exists towards the base of this series, but so far only comparatively thin seams have been discovered. Another unfavourable feature is that over large areas the coal-measures dip at high angles. Granite forms nearly the whole of the uplifted mass to the westward. Ordovician greywacke, metamorphosed by the intrusive granite, outcrops along the western boundary of the area shown in the accompanying map.

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6. TE KUITI DISTRICT.

(Summary of Report by J. HENDERSON.)†

The oldest rocks of the Te Kuiti district are intensely folded greywackes and argillites. Involved with them are less indurated shales and sandstones containing Inoceramus and other fossils, indicating probably a middle Secondary age for the rocks in which they are found. Overlying these with great unconformity are Tertiary strata, which occur in at least three sets of beds. Still younger are rhyolitic tuffs, the greater part of which was deposited subaerially during post-Tertiary times.

The Tertiary beds consist in part of thick layers of limestone. Plants for crushing this rock for railway-ballast and for grinding it for agricultural purposes have been erected near Te Kuiti.

The beds below the limestone are known to be coal-bearing in many parts of New Zealand, and since coal also outcrops eastward of Te Kuiti an examination of the district was considered advisable. This has shown that the beds underlying the limestone are but scantily developed, and that extensive seams of coal do not exist in those parts of the measures exposed on the surface.

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7. NOTES ON THE GEOLOGY OF THE WAIKATO VALLEY NEAR MAUNGATAUTARI.

(Summary of Report by J. HENDERSON.)*

The Waikato River southward from Cambridge has a remarkable course and valley. In the neighbourhood of the old volcanic cone of Maungatautari it flows in a general northerly direction for some miles, but at a point about ten miles from Cambridge it turns abruptly westward and reaches the lowlands of the Middle Waikato basin by way of a gorge between the northern spurs of Maungatautari and the Maungakawa Hills. The valley of the river east of Maungatautari is cut 500 ft. below the general surface, and is fringed with three well-marked terrace sets. The Waikato enters this mature valley after flowing through the Arapuni Gorge, and leaves it by the Maungatautari Gorge referred to above. The Arapuni Gorge is a narrow trench edged for several miles with vertical cliffs up to 200 ft. in height. On the eastern side of the southern end of the mature part of the valley the middle terrace widens into a high-level flat known as the Waipa Plain. Opposite, on the other side of the river, the same terrace is continued southward for several miles as the floor of a valley half a mile in width. From the bend in the Waikato just above the Maungatautari Gorge a similar depression, known as the Hinuera Valley, extends in a north-easterly direction towards Matamata. There is no doubt that when the Waikato formed the middle set of terraces its course was along these old valleys.

Rhyolite tuffs of late Tertiary and early Quaternary age cover the greater part of the area examined. Greywacke, presumably of Trias-Jura age, outcrops for over a mile at the eastern end of the Maungatautari Gorge. The same rock is reported two or three miles west of Putaruru Railway-station. Various details of the topography and geology of the district are indicated on the sketch-map published with this summary.

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* Dr. Henderson's full report is to be published in the *New Zealand Journal of Science and Technology.*

† A somewhat fuller report by Dr. Henderson is to be published in the *New Zealand Journal of Science and Technology.*

8. NOTES ON THE GEOLOGY OF THE CHEVIOT DISTRICT.

(Summary of Report by J. HENDERSON.)*

Greywackes and argillites are the oldest rocks of the Cheviot district, where they constitute the hills between the township of Cheviot and the sea. Southward they are concealed by younger strata, but reappear at Port Robinson in the form of a fault-breccia. The oldest rocks overlying the greywackes are soft sandy claystones containing spherical concretions and darkened by carbonaceous matter. According to von Haast these are of Secondary age. Above them is a series of sandstones and mudstones that are in places calcareous and that close with a band of white limestone. The only fossil found in these rocks belongs to a living species, a fact indicating their Tertiary age. Von Haast's "*Scalaria* beds" overlie without angular unconformity, but there is some evidence to show that they were laid down on a denuded surface. Still younger, and undoubtedly unconformable with the "*Scalaria* beds," are thick layers of conglomerate which are evidently beach deposits. These ancient gravels are probably of the same age as the soft, horizontally bedded sandstone occurring at Port Robinson, and called by von Haast the *Turritella* beds.

At one or more horizons in the rocks described above are thin beds of phosphatic material similar to those described by P. G. Morgan† in last year's report as occurring at Kaikoura and Amuri Bluff. Though no workable deposit has yet been discovered, the occurrences are well worthy the attention of prospectors.

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9. COAL AT MACLENNAN, CATLIN'S DISTRICT.

(By Professor JAMES PARK.)

In consequence of a communication announcing the discovery of coal at Maclennan made last February by Messrs. Ollerenshaw and Roxburgh, Professor James Park, of Otago University, was asked to inspect the locality. His report, dated 19th March, 1917, is as follows:—

"The seams of coal reported by Messrs. Ollerenshaw and Roxburgh as occurring near their property are seams of black carbonaceous shale containing streaks of bright bituminous coal. They crop out in the road-cutting on the road reserve lying between Sections 3 and 8, Block IX, Woodland Survey District, on the north side of the Maclennan River, about half a mile from Maclennan Railway-station.

"The rocks in which the carbonaceous beds occur are brown sandstones of Jurassic age. Their strike is about E.–W., and their dip north at angles varying from 25° to 30°.

"The lowest bed of black carbonaceous shale varies in thickness from 6 in. to 15 in. It is soft and friable, and contains only a small amount of intercalated coal. About 40 ft. above this seam there is another shaly seam from 2 ft. to 3 ft. or more in thickness, also consisting of black carbonaceous clays and irregular streaks and nests of black bituminous coal. The thickest band of bright coal is about 9 in. wide, but it is not continuous. Between these two seams and the upper one there are several thin streaks of black carbonaceous shale that vary in thickness from 1 in. to 3 in. or 4 in.

"These shale-seams are of no commercial value, and the prospect of their passing into seams of coal are so remote that I cannot recommend boring with a view of cutting them at a greater depth. Beds of coaly shale occur wherever Jurassic strata are found in Southland. During the past forty years considerable sums of money have been spent without success in prospecting them at Waikawa and elsewhere."

Analyses of two of the samples forwarded by Professor Park were made at the Dominion Laboratory, with the following results:—

	(A)	(B)
Fixed carbon	23·47	55·60
Volatile hydrocarbons	19·86	30·38
Water	6·32	3·42
Ash	50·35	10·60
	100·00	100·00
Sulphur (per cent.)	0·283	0·721

(A) Sample No. 2: Carbonaceous shale.
(B) Sample No. 3: Nests of coal in upper beds.

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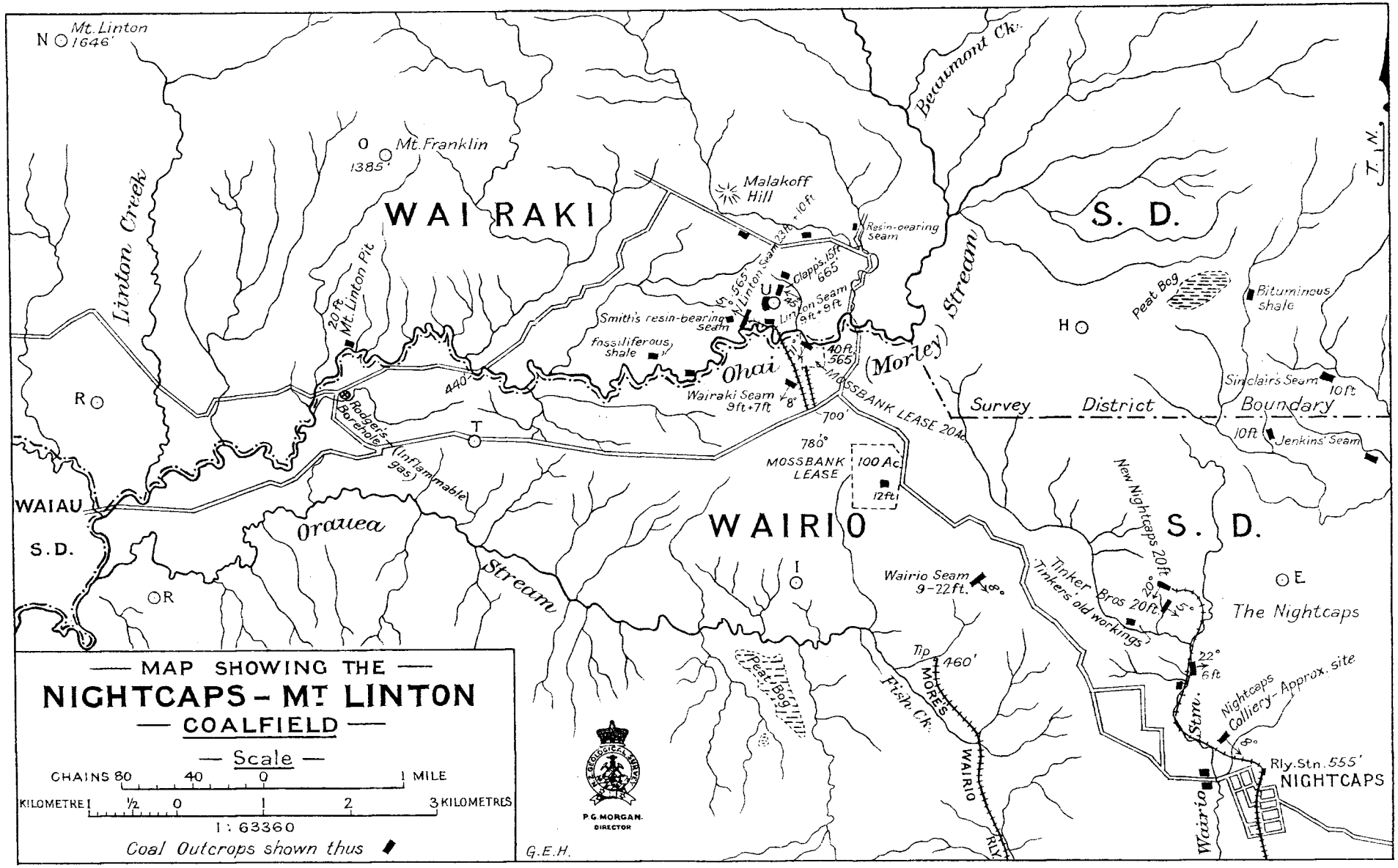
10. COAL OF WAITEWHENA DISTRICT, NORTH TARANAKI.

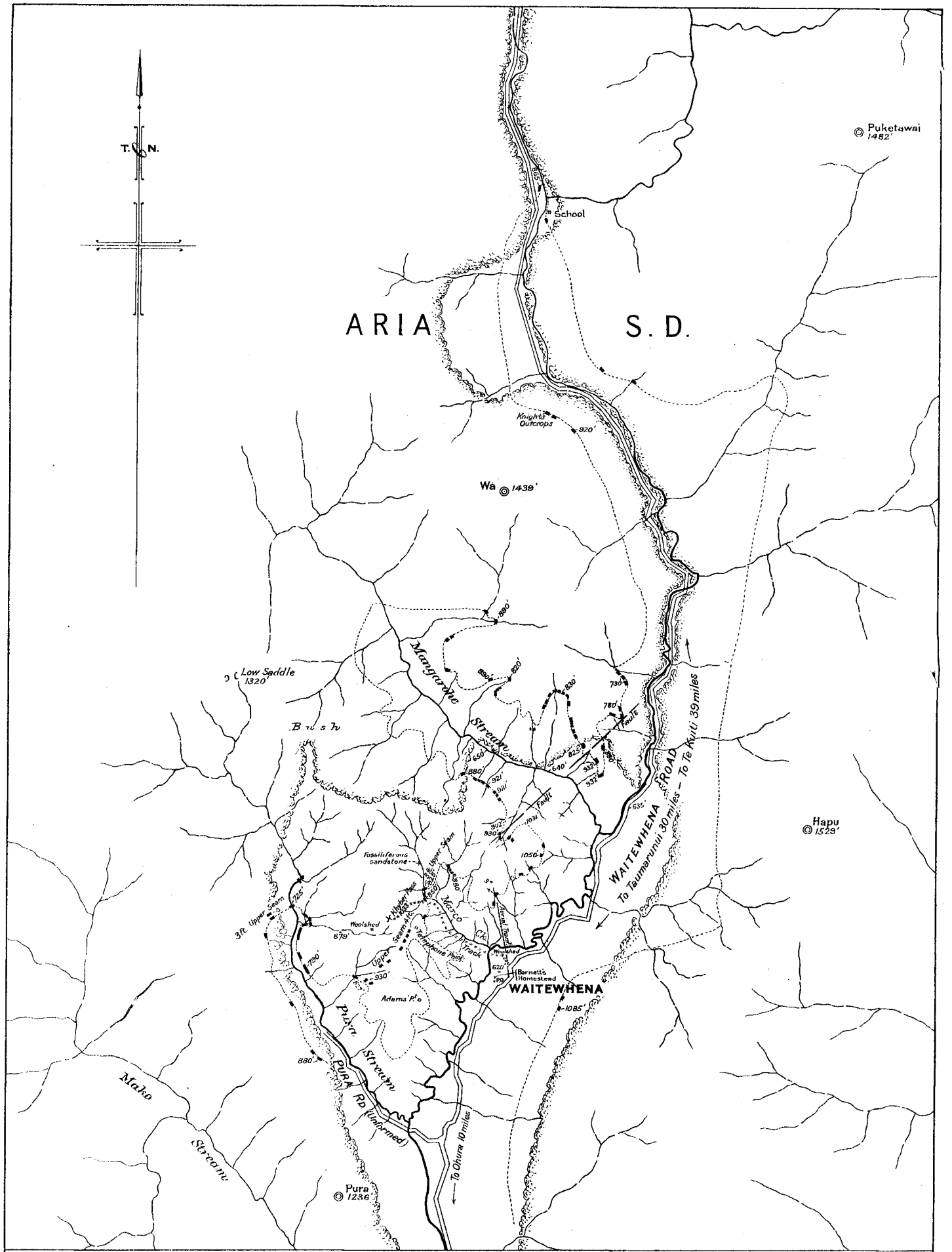
(Summary of Report by M. ONGLEY.)

Waitewhena district consists of a number of steep submature ridges cut from a thick series of almost horizontal beds of sandstone and mudstone by the southward flowing Waitewhena Stream and its tributaries. No underlying formation is exposed, and the sedimentary strata, striking 30° and dipping westward 3°, rise from stream-level (620 ft.) to 1,440 ft. above sea-level, exposing a thickness of almost 1,000 ft. Most of the beds are fine-grained sandstone and form steep faces, in which at many places seams of coal crop out, but it is only occasionally that the roof and floor are exposed, so that the full thickness of the seam is not readily ascertained. At one outcrop in a north-east branch of the Mangarohe Stream the coal is at least 18 ft. thick, at five other outcrops 15 ft., and at twenty-four more the thickness is at least 10 ft. North

* Dr. Henderson's full report is to be published in the *New Zealand Journal of Science and Technology.*
† Tenth Annual Report, N.Z. Geological Survey, C.–2B, 1916, pp. 23, 25.


Mt. Linton
1646'
Mt. Franklin
1385'
Linton Creek
WAI RAKI
S. D.
Malakoff Hill
Beaumont Ch.
T. L. N.
Resin-bearing seam
Clapp's 6ft
665
Linton Seam 9ft + 9ft
Smith's resin-bearing seam
fossiliferous shale
20 ft Mt. Linton Pit
440'
Ohai (Morley) Stream
Wairaki Seam 9ft + 7ft
8°
40ft. 565'
MOSSBANK LEASE 20Ac.
700'
780°
MOSSBANK LEASE
100 Ac.
12ft
Rodger's Borehole
(Inflammable gas)
Peat Bog
Bituminous shale
Survey District Boundary
Sinclair's Seam 10ft
10ft Jenkins' Seam
New Nightcaps 20ft
Tinker Bros 20ft
Tinkers' old workings
WAIAU S.D.
Orawea Stream
WAIRIO S. D.
Wairio Seam 9-22ft.
Tip
460'
MORES
Prish Ck.
WAIRIO
RLY
The Nightcaps
22° 6ft
Stm.
Nightcaps Colliery - Approx. site
Rly. Stn. 555'
NIGHTCAPS
Wairio
MAP SHOWING THE
NIGHTCAPS - Mt LINTON
COALFIELD
Scale
CHAINS 80 40 0 1 MILE
KILOMETRE ½ 0 1 2 3 KILOMETRES
1 : 63360
Coal Outcrops shown thus
P.G. MORGAN. DIRECTOR
G.E.H.

C-2B



Coal Outcrops
Probable Coal

— Map of —
WAITEWHENA DISTRICT
— Showing Coal Outcrops —

— Scale —

80 CHAINS 40 0 MILE 1 | 1 KILOMETRE ½ 0 KILOMETRE 1

1 : 31680

P.G. MORGAN DIRECTOR

G.E.H. 1917.

and south of Mr. A. Barnett's homestead the coal crops out at short intervals for two miles approximately along the strike, and in an east-and-west direction the coal is exposed for nearly a mile; but the coal extends farther than it was followed, and the area of the coalfield is not known. To the northward of Mr. Barnett's farm the coal outcrops almost continuously as far as the school, where stream-level rises above the coal horizon; other outcrops were visited two, seven, and nine miles farther north. The coal crops out on the hill east of Waitewhena Valley, but was not followed farther. Here the coal is near the hilltop, and as it is rising to the east it cannot extend much farther unless preserved by downfaulting. To the south the coal was followed to Pura Hill, where it had not thinned at all, and to the west the coal was followed up the tributary streams till the stream-level rose above the coal horizon. The Waitewhena area is thus only the outcrop part of a much larger coal-bearing area which extends farther northward and southward along the strike, and as the beds dip to the westward an extensive body of uneroded coal may reasonably be expected to exist in that direction. Within the Waitewhena area the outcrops are numerous, because the streams have eroded their valleys through the seams; as a result the coal has been washed away from the valleys, and is preserved only in the spurs. In the upper part of Marco and Pura streams, and in the north branch of Pura Stream half a mile south-south-west of Khyber Pass, two seams crop out, but the upper is not more than 4 ft. thick. Along the south of Mangarohe Stream there is a difference of level of 100 ft. between two neighbouring outcrops, but as the higher seam cannot be found to the west, and the lower cannot be found to the east, it is better to regard these as parts of the one seam that have been separated by faulting. In no locality are two thick seams exposed in the same vertical section.

Eight samples taken from Waitewhena area by the writer and one from Morgan's, nine miles to the north of Waitewhena, were analysed in the Dominion Laboratory and found to be brown coals of good quality. The results are shown by the following table, which includes also analyses of Waikato and Mokau coal for comparison :—

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Fixed carbon ..	39·95	39·09	34·55	39·40	42·68	42·29	42·61	42·78	42·45	40·60	42·92
Volatile hydrocarbons	40·68	43·90	44·77	42·40	41·24	38·86	39·23	39·41	37·96	40·51	42·12
Water	14·87	14·23	13·07	14·98	15·15	15·89	15·23	15·65	17·09	16·52	12·96
Ash	4·50	2·78	7·61	3·22	0·93	2·96	2·93	2·16	2·50	2·27	2·00
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Sulphur (per cent.) ..	1·44	2·34	3·34	2·90	1·19	1·49	1·10	1·37	0·57	0·86	0·35

(1) Marco Creek, 27 chains from Waitewhena Stream; 13 ft. seam.
(2) Marco Creek, 27 chains from Waitewhena Stream; 5 ft. seam.
(3) Marco Creek, 30 chains from Waitewhena Stream; 3 ft. seam.
(4) Half a mile east of Barnett's homestead; 5 ft. seam.
(5) Pura Stream, west of the wool-shed at outcrop No. 68; 6 ft. seam.
(6) Upper seam on ridge east of the wool-shed; 3 ft. seam.
(7) Pura Stream, across stream from (5) at outcrop No. 84; 15 ft. seam.
(8) Knight's outcrop 87, north-east of Trig. Wa; 10 ft. seam.
(9) Morgan's outcrop, two and a half miles south of Aria, Totoro S.D.; 12 ft. seam.
(10) Mokau coal. Quoted from 46th Annual Report, Dominion Laboratory, 1913, p. 13.
(11) Huntly coal. 46th Annual Report, Dominion Laboratory, 1913, p. 12.

11. NIGHTCAPS–MOUNT LINTON COALFIELD.

(Summary of Report by M. Ongley.)

The coal-measures of the Nightcaps - Mount Linton district were deposited over a large area, and in patches in this area several coal-seams were formed, lenticular in shape, overlapping, thickening, thinning, and dying out in different directions. At a later time the whole area was disturbed by faulting, the sedimentary beds were broken into separate pieces and tilted at low angles in different directions, thus turning up the broken ends of the coal-seams to the surface and affording numerous coal-outcrops. But the abundance of outcrops, far from indicating that the whole area is underlain by continuous seams, actually shows that the original coal-patches have been broken into several smaller areas, so that now the seams are continuous for only short distances. One of the coal-patches has been mined at Nightcaps for thirty-six years, and from seams aggregating 36 ft. in thickness 1,181,011 tons of coal have been won; another patch, where the coal varied from 9 ft. to 22 ft. in thickness, has been worked for eleven years at Wairio - New Brighton, and 95,000 tons taken out. Other patches are now being opened, but in all cases the work is being done at or near the outcrop or opening; no systematic prospecting has been done, and, apart from what can be seen in the quarries opened, the thickness of coal and the extent of the patches are unknown. At the patch now being opened by Tinker Bros. and by the Nightcaps Coal Company the coal is at least 20 ft. thick; at the Wairaki patch the seams are 9 ft. and 7 ft. thick; at the Mossbank patch the coal is 40 ft. thick; at the Linton patch the lower seams are 9 ft. and 9 ft. thick; another is in two splits 10 ft. and 23 ft. thick, with a 2 ft. parting of mudstone, and two more seams 6 ft. and 8 ft. thick are known; at the Mount Linton patch the coal is at least 20 ft. thick. Between these known coal-patches the country has in many places been shown to be coal-bearing, and in no place has it been proved barren. Outside the area containing the coal-patches now being opened many other outcrops of coal are known, but owing to the lack of means of communication no work has been undertaken at these outlying outcrops. Promising coal-mines, with thick faces of coal already opened, and a good coalfield are being held up for want of a railway. More geological work is required in this district.

12. NOTE ON TERTIARY FOSSILS AT WANGALOA, NEAR KAITANGATA.

(By P. G. Morgan.)

In 1872 Hector* reported that Upper Tertiary marine shells occurred in a sandy limestone five miles northward of Coal Point, and some years later Hutton† mentioned that beds belonging to the Pareora Formation were present at Wangaloa or Measly Beach. In 1892 Sir James Hector‡ again referred to the fossiliferous beds on the coast at Measly Beach. On this occasion he expressed the opinion that they were not of Miocene age, as he had previously supposed, but belonged to some part of his Cretaceo-Tertiary formation. In later years Professor J. Park, Dr. P. Marshall, and Mr. A. G. Macdonald collected from what is probably the same locality. In 1916 Dr. Marshall§ published a list of fifty-two species collected by him, and determined by Mr. H. Suter. He expressed the opinion that the Wangaloa fauna indicates an earlier age than the ordinary Tertiary of New Zealand. It is evident that Dr. Marshall considers the Wangaloa beds to be part of a conformable series ranging in age from Cretaceous to Tertiary, and to contain a fauna such as might be expected in strata intermediate in age between the European Cretaceous and Tertiary—that is, they are pre-Eocene. Although it may be well not to pronounce an adverse judgment on Dr. Marshall's main thesis of a perfectly conformable Cretaceo-Eocene-Miocene sequence until his evidence has been thoroughly discussed, yet there does not seem to be any good reason for believing the Wangaloa fauna to be older than the European Eocene. It is by no means closely related to the Senonian faunas of Amuri Bluff, the Waipara district, the Malvern Hills, &c. With these faunas it has probably no species in common and only a few genera. The Wangaloa beds and the underlying Kaitangata coal-measures may therefore tentatively be correlated with the bituminous coal-measures of the west coast of the South Island, the marine portion of which has already been determined by the writer as of Early Tertiary—that is, of Eocene—age.

In May last Mr. M. Ongley, Assistant Geologist, was instructed to visit Wangaloa in order to ascertain the exact locality of the fossiliferous beds and to make a collection therefrom. He reported as follows:—

"No coal can be seen at the promontory marked 'Coal Point' on the map of the district published in 1883; the outcrop observed by Sir James Hector is at the point half a mile to the north. The coal is contained within beds of clean white quartz gravel without any clay. The coal-seam and the containing beds strike south-east and dip north-east at a low angle; the overlying beds are horizontal, and the discordance in dip is clearly shown for some distance along the cliff-face. There is, however, no marked lithological difference between the beds below and above the unconformity.‖

"The fossiliferous beds occur at tide-level in the sea-cliff at Mitchell's Point, four miles north-east of the point where coal outcrops. The rocks are very hard, and it is difficult to collect many varieties, but *Turritella semiconcava* Suter¶ is extremely abundant. Professor Park states that fossils also occur two miles to the north-east in the Wangaloa Stream near the mouth, and that Mr. A. G. Macdonald made a collection in this locality a few years ago."

The fossils collected by Sir James Hector in 1891, those collected by Professor Park in 1912, and those lately collected by Mr. Ongley have been submitted to Mr. H. Suter for determination. His results will probably be published in a few months' time. In the meantime it may be stated that Mr. Suter's determinations indicate a post-Cretaceous and pre-Miocene age.

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13. FLOOD AT THAMES, 21ST FEBRUARY, 1917.

(By J. Henderson.)

The Town of Thames is built for the most part on a flat raised very little above high-water mark, and backed by steep hills which, within a distance of one mile and a half, attain a height of over 1,500 ft. Four small streams, Karaka, Te Hape, Waiotahi, and Moanataiari creeks, named in order of size, drain the front of the range. The first two flow through the town in open concreted channels, while the water from the others is carried across the flat in wooden aqueducts raised about 20 ft. above the level of the streets. Prior to the 21st February, 1917, except on one or two occasions, these had been found sufficient to carry all the water discharged by the creeks even in times of flood. During the early hours of the morning on the above date the channels became choked with timber, stones, &c.; the streams overflowed, and deposited on the streets of the town and on private property a great amount of gravel, sand, and mud. This flood occurred after a considerable period of wet and showery weather; but according to the statements of the borough foreman of works and his assistant the rainfall in the town preceding and during the flood, though heavy, was not extraordinarily so. The flood-waters were contained within the stream-channels until blocking of the culverts and damming at the bridges occurred. The blockage appears to have taken place about the same time in all the streams. It is surmised that something in the nature of a cloud-burst occurred in all the headwater valleys, and that the debris, by this means discharged into the streams, caused their blockage as soon as their gradients lessened or bridges and culverts were reached. Shingle-

* Hector, J.: "Report on the Clutha and Green Island Coalfields." Rep. Geol. Explor. during 1871–72, No. 7, 1872, p. 168.
† Hutton, F. W.: "Geology of Otago," 1875, p. 57.
‡ Progress Report in Reports of Geological Explorations during 1890–91, No. 21, 1892, p. lviii.
§ "Relations between Cretaceous and Tertiary Rocks." Trans. N.Z. Inst., vol. 48, 1916, pp. 114–115.
‖ This unconformity was described by Sir James Hector in 1872. See his report of that date, already cited, p. 126
¶ Trans. N.Z. Inst., vol. 43, 1911, p. 595.

fans up to 8 ft. or 10 ft. in depth were built at the points where the streams issue from the hills, and the flood-waters inundated the town. The railway-line is on a low embankment along the shore, and when the stream-channels were choked the low-lying portion of the town was covered with water, which, before receding, deposited silt and mud to a depth of from 3 in. to 18 in.

With the exception of Te Hape Creek, the stream-beds are steep, and along them little loose material naturally occurs. Into all the creeks, but notably into Moanataiari and Waiotahi creeks, debris from mine-workings has found its way. In the case of the Moanataiari this material has in some parts of its course raised the stream-bed several feet, while along parts of the courses of all the streams the tips from the adits have so encroached on the narrow valley-floors as now to form the banks of the streams.

The debris deposited by the streams in their lower valleys or on the flat was either scoured from their beds and banks or derived from slips from the hillsides. In the case of Moanataiari Creek very little of the coarse material carried down originated from slips; probably 90 per cent. of it was mining debris. There are many slips in the upper part of the Waiotahi basin, and two large ones at the time of the writer's visit on the 3rd April, 1917, had not reached stability. Many hundreds of yards of spoil will reach the stream-bed from these slips during the next year. Much debris from mine-tips was also removed by this creek during the flood, and probably a third of the material deposited was derived from this source. In the upper part of the basin of Karaka Creek there are many large slips, and much timber, soil, &c., found its way into the stream. Of the material deposited by this stream not more than a fifth came from mine-tips. When compared with the other streams little mining has taken place along the Te Hape Valley, and the spoil brought down by this creek contains little mine-debris.

Mr. E. F. Adams, Thames Borough Engineer, estimates the quantity of debris deposited in the town by the streams at 69,586 cubic yards, made up as follows:—

	Cubic Yards.	Area of Watershed. Square Miles.
Moanataiari Creek (in shingle-fan)	7,500	0·47
Waiotahi Creek (in shingle-fan)	7,666	0·54
Karaka Creek (in shingle-fan)	10,520	2·13
Te Hape Creek (in shingle-fan)	2,000	1·40
Silt on streets, reserves, &c.	41,900	...
	69,586	

The silt on the streets varied in depth from 3 in. to 18 in., and cannot be distinguished from ordinary river-silt. No doubt, however, a proportion of it consists of finely divided rock from the mine-tips. The rest of the material brought down ranges from coarse gravel to sand.

Tararu Creek, which enters the sea one mile and a half north of Thames and is larger than any of the streams mentioned above (area of watershed 6·50 square miles), was also in high flood on the 21st February, 1917. Mr. Adams estimates that 35,200 cubic yards of material was deposited by this stream in its lower course and on the flat it crosses before reaching the sea. The flood-plain, which forms part of this area, narrows to insignificant dimensions 10 chains from the sea, and the scouring of the stream-channel becomes prominent 10 chains above its upper end. The road-bridge on this low-lying area was not injured by the flood, the stream overflowing its banks and taking a more direct route to the sea. Many logs and large stones were deposited, both in the stream-channel and on the flood-plain. The largest boulder observed by the writer is on the roadside about 5 chains south of the bridge and 2 chains from the nearest point of the bed of the creek. It is a rounded boulder of andesitic breccia, with axes of 5 ft., 4 ft., and 3 ft., and must weigh considerably more than 2 tons. Another large stone, at least 1½ tons in weight, lies on the opposite side of the road more than 3 chains from the stream-channel. In addition, there are at least a dozen stones close at hand of from 15 cwt. to 20 cwt. in weight, while a few of about 10 cwt. have been transported by the flood-waters 7 chains or 8 chains from the bed of the stream.

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14. ERUPTION AT FRYING-PAN FLAT, NEAR WAIMANGU, ROTORUA DISTRICT.

[This and the following reports have been written or compiled by P. G. MORGAN.]

During the past year an eruption, which may be classed as a true volcanic outburst, took place at Frying-pan Flat, near Waimangu Geyser. The locality was not visited by any member of the staff, but there is good reason for keeping a watch on the danger-points of the so-called "thermal district" of the North Island, and therefore attention is called to the occurrence.

Waimangu Geyser was first observed in eruption in January, 1900, and for several years thereafter almost daily outbursts of great intensity took place. These eruptions so far exceeded ordinary geyser activities that they might well be considered true volcanic manifestations. Towards the end of 1904 Waimangu became almost quiescent, but several spasmodic outbreaks at somewhat long intervals have since occurred.

During the more violent eruptions of Waimangu vast quantities of water, mingled with solid debris, were thrown into the air to a height of 1,000 ft. or more, and clouds of vapour rose to heights which at times may have been as much as 12,000 ft. On one occasion two sight-seers and the two attendant guides unfortunately lost their lives, and the recent eruption at Frying-pan Flat was unhappily fatal to the wife and infant child of the guide at the neighbouring accommodation-house, whilst the guide himself, Mr. McCormick, was severely injured.

The eruption, according to newspaper accounts, began on the morning of Sunday, 1st April, at 6.20 a.m. Stones, mud, water, and steam were shot up to a height of 600 ft. to 800 ft. A

portion at least of Frying-pan Flat was blown up, and a "blast," presumably of air, but carrying with it much watery vapour (or "steam") and fine debris swept up the neighbouring valley, and in its course wrecked the accommodation-house. Parts of the building were carried a distance of a mile. Some hours later the violence of the eruption had lessened, but much steam was escaping from Frying-pan Flat. During the next few days several paroxysmal eruptions took place. One on the evening of the 3rd April lasted for three hours. The next day, following several small outbursts, there was a violent eruption from ten minutes past 12 to 1 o'clock. On the 3rd April five "blowholes" were visible on Frying-pan Flat. At least two of these had been violently active on the preceding Sunday, and had thrown boulders of all sizes to a height of possibly half a mile or more. All the vents were active at intervals during the 3rd April, and some of the "shots" reached a height of 800 ft. or 1,000 ft. Much of the material thrown out on that day was described as dry. During the eruptions the pool to the south of Frying-pan Flat, the site of the old Waimangu Geyser, was, it is stated, quiescent.

At the entrance to Frying-pan Flat debris was piled to a depth estimated at 100 ft. One observer stated that the country to the south for a distance of three miles was covered by a deposit of dirty-whitish mud, varying in thickness from many yards to an inch or two. Another observer estimated the debris-covered area as four miles long by two miles wide.

Outbursts on a small scale appear to have continued at least into the month of June, when a fiercely boiling pool was observed at the south end of Frying-pan Flat. Round this lake were several vents, from which at intervals mud was thrown in geyser-like fashion to a height of 60 ft. or 70 ft., and occasionally to much greater heights. It is worth noting that during several days in May White Island is said to have been "most active," a statement which presumably means that a cloud of steam was rising continually from the crater. One night "vivid flashes of blue flames" were observed from Whakatane.

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15. PETROLEUM.

During the past few months the Blenheim bore of the Taranaki Oil Lands Acquisition and Development Company (New Plymouth), according to information obtained from the company, passed from bluish claystones and sandstones into dark carbonaceous shale, alternating with highly calcareous claystone or marl. At the time of writing (July, 1917), the bore was reported as 5,021 ft. deep. It is thus evident that the geological estimates of at least 5,000 ft. of sedimentary rocks being present at New Plymouth below the surface deposits of volcanic debris are not under the mark.

The Huiroa bore, drilled fifteen miles north-east of Stratford by the Consolidated Oilfields of Taranaki, on the 2nd May, 1917, had reached a depth of 4,921 ft. The strata penetrated consisted almost entirely of bluish mudstone.

At Kotuku, in North Westland, a prospecting-bore was drilled during the year somewhat to the west of previous bores. The indications of petroleum obtained were somewhat favourable. It may here be pointed out that the Kotuku district is by no means unpromising as an oilfield, and deserves further prospecting. Here are the largest oil-seepages in New Zealand, while bores have shown the presence of abundant salt water and carbon dioxide. Recent investigations have shown that under certain conditions carbon dioxide may be regarded as an indication of the occurrence of petroleum.*

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16. POTASH.

During the past two years various inquiries for information concerning potash were received by the Geological Survey. Much information concerning this substance has been given in the *Journal of Agriculture*, and a few months ago the Director of the Geological Survey wrote an article for that journal, which was published in the April number under the title of "Potash in New Zealand and Other Countries."

In that article it was pointed out that potassium oxide, according to F. W. Clarke, forms 3 per cent. of the earth's solid crust, so that if chemists can indicate practical methods of making the potash-contents of rocks and soils "available" for plant-growth a real potash famine is not possible. That this can be done need not be doubted. The average potassium-oxide content of seventy-five New Zealand igneous rocks, analyses of which are published in Geological Survey bulletins, is 2·26 per cent., and fifty analyses of sedimentary rocks, selected from the same publications, show an average potash-content of 2·76 per cent. The combined average is 2·46 per cent., which is decidedly below Clarke's estimate for the earth's crust; but it is fairly safe to say that a properly weighted average would show at least 2·8 per cent. of potassium oxide in New Zealand rocks.

There is no ground for expecting that large deposits of soluble potash salts such as those of Stassfurt, Germany, will ever be found in New Zealand. Therefore, if potash is to be produced in New Zealand, it must be obtained from the suint of greasy wool, from wood-ashes, burnt seaweed, insoluble potash minerals, or potash-bearing rocks. Another source, theoretically as available to New Zealand as to any other part of the world, is sea-water. The investigation of the potash in organic materials such as suint, wood-ashes, or burnt seaweed (kelp) is, of course, a work outside the province of the Geological Survey, and must be left to others.

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*Rogers, G. Sherburne: "Chemical Relations of the Oilfield Waters in San Joaquin Valley, California." U.S. Geol. Survey Bull. 653, recently published. No copy of this bulletin has yet reached the New Zealand Geological Survey Office, and the title is quoted from the *Mining and Scientific Press*, 28th April, 1917, p. 588.

Alunite, a hydrous sulphate of aluminium and potassium, containing when pure 11·4 per cent. of potash, yields this constituent in a soluble form by means of the comparatively simple process of calcining the crushed mineral mixed with powdered coal. The potash can then be extracted as potassium sulphate by digesting with water.

Alunite has been found at Ohinemutu, near Rotorua, and its occurrence in workable quantity in the Hot Lakes district is not unlikely.

In the case of potash feldspar or rocks high in potash-content various processes, more or less successful from the experimental point of view, have been suggested. With potash at its present high price several of these processes in localities where conditions are favourable could be made profitable. With the return of peace German producers will be able to flood the market with potash, and by temporarily reducing prices crush even the most vigorous competitor obtaining potash from rocks or insoluble minerals. In some cement-works a considerable amount of potash in a soluble form is volatilized during the calcination of the materials, and may be collected with the flue-dust by suitable arrangements.

New Zealand is not rich in rocks with a high potash-content. Pegmatite dykes, with 10 per cent. of potassium oxide, occur on the west coast of the South Island, and probably in Stewart Island. According to F. W. Hutton considerable amounts of potash feldspar may be collected on the beach at Port Adventure, Stewart Island.*

The volcanic rocks highest in potash-content occur near Dunedin, but none of these appear to contain over 7 per cent. of potassium oxide, so that the prospects of producing that substance from them are not very bright.

In the gneissose rocks of the Paparoa Range, south of Westport, bands locally 20 ft. in thickness and consisting almost wholly of biotite in soft flexible scales frequently occur. Specimens of a somewhat similar rock, but composed mainly of white mica or muscovite, have been found near Taipo, North Westland. No analyses of these mica rocks are available, and they occur in such remote situations that their value as potash sources may be considered negligible.

The mineral glauconite, which is a hydrous silicate of iron and potassium, usually contains from 6 to 8 or 9 per cent. of potassium oxide. At the present day glauconite is forming in some abundance on portions of the ocean floor, mainly in moderately deep water (500 fathoms) not far from rock shores. Much has yet to be learnt concerning this mineral, and a discussion of the possible mode of formation from what is perhaps a new viewpoint will be found in the article† of which the present statement is largely a summary. Glauconitic greensands occur in many parts of New Zealand—for example, at Burnside, near Dunedin; at Seacliff, north of Dunedin; near Palmerston South; in the Oamaru district; in South Canterbury; at Weka Pass and other localities in North Canterbury; and in the Gisborne - East Cape district, at Raukawa, Whangara Island, Takapau, &c.

Although the extraction of potash from greensands is not likely ever to be a commercial success, yet, owing to their potash, lime, and phosphate content, and owing to their friability, they are valuable as a soil-dressing, and could well be so used in those parts of New Zealand where they occur in abundance.

Other soft rocks, such as marine claystones of Tertiary age, may also be suggested as useful for soil-dressing, and have actually been so used in New Zealand on a small scale. Claystones of marine origin may contain as much as 3 or 4 per cent. of potassium oxide, but perhaps owe most of their value as soil-dressings to their carbonate-of-lime content. If necessary lime, sulphur, or gypsum may be used as an additional dressing in order to promote the liberation of potash in a form available for plant-food.

The Geological Survey library contains the following recent publications dealing with the occurrence and uses of potash. The reader will notice that of late years much attention has been given to this subject by the United States Geological Survey:—

1911. Phalen, W. C.: "Potash Salts, their Uses and Occurrence in the United States." "Mineral Resources of the United States for 1910," Part II, pp. 746–767. Similar articles appear in the succeeding issues of "Mineral Resources" published by the United States Geological Survey.

1911. Phalen, W. C.: "The Occurrence of Potash Salts in the Bitterns of the Eastern United States." U.S. Geological Survey Bulletin 530B. See also "Contributions to Economic Geology" (1911), Part I, 1913, pp. 313–330.

1911. Gale, H. S.: "Potash." U.S. Geological Survey Bulletin 530A. (Advance chapter from "Contributions to Economic Geology.") A revised version appears in "Contributions to Economic Geology" (1911), Part I, 1913, pp. 295–312, under the title of "The Search for Potash in the Desert Basin Region."

1912. Phalen, W. C.: "Potash Salts: Summary for 1911." "Mineral Resources of the United States for 1911," Part II, pp. 888–917.

1912. Butler, B. S., and Gale, H. S.: "Alunite, a Newly Discovered Deposit near Marysvale, Utah." U.S. Geological Survey Bulletin No. 511.

1912. Schultz, A. R., and Cross, Whitman: "Potash-bearing Rocks of the Leucite Hills, Sweetwater County, Wyoming." U.S. Geological Survey Bulletin No. 512.

1913. Gale, H. S.: "The Search for Potash in the Desert Basin Region." "Contributions to Economic Geology" (1911), Part I, 1913, pp. 295–312.

1913. Phalen, W. C.: "The Occurrence of Potash Salts in the Bitterns of the Eastern United States." "Contributions to Economic Geology" (1911), Part I, 1913, pp. 313–330.

* "Geology of Otago," 1875, p. 150.

† Morgan, P. G.: "Potash in New Zealand and Other Countries." *Journal of Agriculture*, vol. 14, No. 4, April 1917, pp. 261–262.

1913. Phalen, W. C.: "Potash Salts: Summary for 1912." "Mineral Resources of the United States for 1912," Part II, pp. 877–908.
1914. Phalen, W. C.: "Potash Salts: Summary for 1913." "Mineral Resources of the United States for 1913," Part II, pp. 85–107.
1915. Phalen, W. C.: "Potash Salts, 1914." "Mineral Resources of the United States for 1914," Part II, pp. 9–33.
1915. Butler, B. S.: "Potash in certain Copper and Gold Ores." U.S. Geological Survey Bulletin No. 620J (pp. 227–236 of "Contributions to Economic Geology").
1915. Loughlin, G. F.: "Recent Alunite Developments near Marysvale and Beaver, Utah." U.S. Geological Survey Bulletin 620K (pp. 237–270 of "Contributions to Economic Geology").
1915. "Report on Mining Operations in the Province of Quebec during 1914," pp. 82 *et seq.* (under heading of "Potash in Feldspar"). Published by Mines Branch, Department of Colonization, Mines and Fisheries, Province of Quebec.
1915. Aston, B. C.: "Potash and the Great War." *Journal of Agriculture*, vol. 11, No. 1, July, pp. 18–19.
1915. Aston, B. C.: "Potash in Agriculture." *Journal of Agriculture*, vol. 11, No. 4, October, pp. 283–295.
1915. Hicks, W. B.: "The Composition of Muds from Columbus Marsh, Nevada." Advance chapter, U.S. Geol. Survey Prof. Paper 95, pp. 1–11 (Prof. Paper 95A).
1915. Hicks, W. B.: "Evaporation of Potash Brines." Advance chapter, U.S. Geol. Survey Prof. Paper 95, pp. 65–72 (Prof. Paper 95E).
1916. Hicks, W. B. "Evaporation of Brine from Searles Lake, California." Advance chapter, U.S. Geol. Survey Prof. Paper 98, pp. 1–8 (Prof. Paper 98A).
1916. Wells, Roger C.: "Experiments on the Extraction of Potash from Wyomingite." Advance chapter, U.S. Geol. Survey Prof. Paper 98, pp. 37–40 (Prof. Paper 98D).
1916. Aston, B. C.: "Potash in Agriculture." *Journal of Agriculture*, vol. 13, No. 6, December, pp. 446–454.
1916. Katz, Frank J. "Feldspar in 1915." "Mineral Resources of the United States for 1915," Part II, pp. 43–53.
1916. Phalen, W. C., and Hicks, W. B.: "Potash Salts, 1915." "Mineral Resources of the United States for 1915," Part II, pp. 95–133. Pages 129–131 describe simple tests for potash. These are quoted by Winterbottom (see below).
1916. Winterbottom, D. C.: "Potash." Part of Bulletin No. 2, Dept. of Chemistry, South Australia. This publication gives an excellent summary of the sources of potash. Pages 27–29 describe simple tests for potash.
1917. "Potash." *Mining and Scientific Press*, 9th June, 1917, vol. 114, pp. 789–790.

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17. CLAY.

There can be no doubt that clay industries in New Zealand will become more and more important as time goes on. At present only common bricks, drainpipes, tiles, and some classes of fireclay goods are manufactured in the Dominion, but a recent investigation of various sources of information, more especially the annual reports of the Dominion Analyst, show that clays capable of yielding by grading and mixing material suitable for the manufacture of all classes of pottery (including porcelain), and of many other articles, are to be found in this country. Of the other materials needed for pottery-manufacture flint occurs in some abundance, and feldspar is also obtainable. Silica in the forms of sand and sandstone is abundant. Most of the minor substances used in clay industries are also found in New Zealand.

Attention may be drawn to a report on fireclay in the Greymouth district, which is published in the appendices to this year's Mines Statement.*

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18. TALC.

The mineral talc or steatite is also known in commercial circles as soapstone, French chalk, &c. In practice the name "talc" is applied to the finest grades of the mineral, used for special purposes, usually in a powdered condition. The term "soapstone" refers to massive, more or less impure talc, and articles made from it by cutting and carving processes. Potstone is the same thing as soapstone or talc. In New Zealand small quantities of high-grade talc are found in various localities from Collingwood to western Otago. The ordinary grade, such as would commercially be called "soapstone," occurs in the Collingwood district; on the north side of the Taramakau River near Jackson's; at Taipo Gorge; on the Griffin Range; in the Kokatahi River valley; on Mount Jumbletop; in the upper Hokitika River valley; on Mount Bowen, and elsewhere in North Westland; near Jackson's Bay; near Martin's Bay; at the head of the Springburn Stream, and in other western Otago localities. So many inquiries have

* Parliamentary paper C.–2, 1917, pp. 82–83.

lately reached the Geological Survey Office concerning the uses and the price of talc that the following information is here given :—

Talc (in general ground) is used—

(1.) In the manufacture of paper :
(2.) In the rubber industry as a filler or adulterant (it is also used to free the rubber from the moulds) :
(3.) As an adulterant of soap and many other articles :
(4.) In the sizing of cotton-cloth :
(5.) In the manufacture of mineral and waterproof paints :
(6.) In many kinds of electric insulators :
(7.) As a foundry facing in the casting of iron :
(8.) For wall-plasters :
(9.) For steam-pipe coverings :
(10.) For dressing skins and leathers :
(11.) As a toilet-powder :
(12.) In the manufacture of slate-pencils, tailors' pencils, gas-tips, and many other articles.

Soapstone, potstone, or steatite is used—

(13.) In the manufacture of laundry-tubs :
(14.) In the manufacture of tanks, table-tops, &c., for laboratories of every description where chemicals are employed :
(15.) For electric switchboards :
(16.) For fireless cookers and other heat-insulating apparatus (see 17) :
(17.) For "soapstone" stoves and foot-warmers (these retain heat for a long time) :
(18.) For stove and furnace linings (as a refractory substance) :
(19.) As a building-material (formerly in the eastern United States window caps and sills, door-sills, hearths, and even whole buildings were made of soapstone) :
(20.) For ornaments of various kinds.

In 1912 the average value of rough steatite in the United States reduced to English units was about £1 per long ton, and that of ground talc about £1 18s. 8d. per long ton. In 1914 the corresponding prices were £1 7s. 2d. and £1 18s. 10d. In 1915 the average value of Californian steatite was about £2 1s. 5d. per long ton. These data are obtained from technical journals. During 1915 prices in the United States were, if anything, lower than in 1914. Crude talc sold at 15s. to £1 2s. 6d. per ton, and ground talc at double those prices. Soapstone in the rough brought 10s. or less per ton, when sawn into slabs nearly £3 10s. per ton, and when made into laundry-tubs nearly £7 per ton. During 1916 the price of talc rose, but definite data have not been obtained.

It should be noted that the best grades of talc, used for toilet-powder, electric insulators, pencils, gas-tips, &c., may be worth £20 per ton or more, and the articles manufactured from them £60 to £100 per ton.

19. SULPHUR.

During the past year, owing to inquiries from London, an investigation of the sulphur-deposits of the North Island of New Zealand was made by Mr. Frank Reed, Inspecting Engineer, Mines Department. His report will be found in the appendices to this year's Mines Statement.* Since this report was made the price of sulphur has risen greatly, and it will be of interest to give the London market prices for sulphur from June, 1916, onwards, so far as quotations are available. The source of information for the quotations from June, 1916, to April, 1917, is the *Mining Magazine*.

	Roll Sulphur. Per Ton. £ s. d.	Flowers of Sulphur. Per Ton. £ s. d.
1916—		
June	12 0 0	12 10 0
July	13 0 0	13 10 0
August	13 0 0	13 10 0
September	13 0 0	14 10 0
October	16 0 0	17 0 0
November	17 0 0	17 0 0
December	18 0 0	18 0 0
1917—		
January	19 0 0	19 0 0
February	22 0 0	22 0 0
March	28 0 0	29 0 0
April	32 0 0	35 0 0
June, July, August	21 0 0	23 0 0

The drop between April and June seems to have been caused by the Imperial Government taking over the supplies of Sicilian sulphur and fixing the prices.

Use of Sulphur in Agriculture.

It does not appear to be generally known that with many soils wonderful results may be obtained by a dressing of powdered sulphur at the rate of from 300 lb. to 400 lb. per acre. According to experiments made in Utah by the American Smelting and Refining Company†

* Parliamentary paper C.–2, 1917, pp. 22–23.

† O'Gara, P. J. : "American Smelting and Refining Company's Tests with Sulphur and Sulphuric Acids on Soils." *Mining and Scientific Press*, 16th June, 1917, vol. 114, pp. 840–843. See also pp. 825–827.

treatment with elemental sulphur at the rate of 400 lb. per acre increased the barley-yield 52·6 per cent., the oat-yield 57·3 per cent., the wheat-yield 127·8 per cent., the maize-yield (variety Milo) 182·6 per cent., the potato-yield 63 per cent., and the yield of peas no less than 383·3 per cent. Substantial increases were also obtained with other crops. Treatment with sulphuric acid equivalent to 400 lb. of sulphur per acre gave similar but on the whole lower results. Probably the experiments were made on a soil containing free alkali, and therefore peculiarly suited to the sulphur or acid treatment; but experimental work in other parts of the United States shows the value of sulphur as a fertilizer for many classes of soil, particularly when leguminous crops, such as peas, beans, clover, alfalfa, &c., are being grown. For instance, in some tests made in southern Oregon, a 500-per-cent. increase in the alfalfa cut was obtained by harrowing 300 lb. of raw sulphur into each acre. Much experimental work remains to be done in order to determine the exact value of sulphur as a fertilizer, but its addition to the soil is known to promote the liberation of potash and the nitrification of the soil. Moreover, it has been ascertained in recent years that sulphur is much more important as a plant-food and a plant-constituent than was formerly supposed.

Dr. C. B. Lipman, of the Agricultural Experimental Station, University of California, has shown that remarkably successful results follow the sprinkling of strong sulphuric acid at the rate of 1 to 3 tons per acre on alkali soils.* It is possible that such a treatment, followed by the application of lime, may be useful in some parts of New Zealand. It is certain that the bold conception of the use of a strong mineral acid, first made, or at least first practically tested, in California, will bear important results in regions with arid soils, such as those of North and South Africa, Persia, parts of India, parts of Australia, &c.

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20. BATON RIVER FLUOR-SPAR.

On the 3nd June, 1889, Professor James Park, then Assistant Geologist, discovered a deposit of fluor-spar in the Baton River district, and later he described it in a report entitled "On the Occurrence of Fluor-spar at the Baton Goldfield, Nelson," which appeared in Reports of Geological Explorations during 1888–89, No. 20, 1890, pp. 73–74. The largest outcrop, according to Park, is 60 ft. long, 30 ft. to 35 ft. wide, and forms a spur 8 ft. to 20 ft. high. Fluor-spar can be traced by loose blocks for a quarter of a mile, and is again visible farther to the south-south-west near some limestone caves.

Park mentioned barite and other minerals as associated with the fluor-spar. He quoted no analysis, but subsequent to the publication of his report a sample was analysed by Mr. W. Skey, who reported 52·43 per cent. of sulphate of barium (barite), 35·21 per cent. of fluoride of calcium (fluorite), and 12·36 per cent. of quartz.†

In April, 1916, Mr. T. O. Bishop, Inspector of Mines, Reefton, after considerable search, relocated the fluor-spar deposit on land now owned by Mr. C. H. Faulkner. He reported that the outcrops occurred on the north face of what is locally known as Thomson's Hill, about half-way between the Wangapeka and Baton rivers, and could be reached by half an hour's climb up a steep hillside from the main road. Wherever examined the fluor-spar was found to be largely mixed with barite and quartz. A sample taken by Mr. Bishop was submitted to the Dominion Analyst, who reports as follows:—

"Calcium fluoride (CaF_2)	46·20
Barium sulphate ($BaSO_4$)	27·10
Silica (SiO_2)	21·40
Alumina (Al_2O_3)	1·50
Iron oxide (Fe_2O_3)	1·30
Loss in ignition	2·50
	1 0·00

"The sample was ground to pass a 60-mesh sieve, and separated by panning into three portions, A, B, and C, which were analysed separately, with the following results:—

	Percentage of Whole.	Barium Sulphate.	Calcium Fluoride.	Silica, &c.
"A (heaviest portion)	20	62·5	25·0	12·5
B (intermediate portion)	30	22·0	60·0	18·0
C (lightest portion)	42	12·0	50·0	38·0
Loss	8	..	..	..

"These results show that the silica tends to remain with the fluor-spar, and is not readily separated by water-concentration. This would greatly detract from the commercial value of the mineral.

"J. S. Maclaurin, D.Sc., F.C.S.,
"Dominion Analyst."

The reports quoted and Dr. Maclaurin's tests as given above show that the prospect of obtaining a commercial grade of fluor-spar from the Baton River deposits so far as yet explored is small. The material, however, may have some value in the manufacture of pottery and glass.

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* See "Sulphuric Acid for Alkali Land." *Mining and Scientific Press*, 12th May, 1917, vol. 114, pp. 646–647.
† 26th Ann. Rep. Col. Mus. and Lab., 1892, p. 31.

21. MOLYBDENITE.

Molybdenite during the past year has been found in the Waihi Extended Mine. Thin irregular veins and small patches of the mineral occur in a quartz vein, 1 ft. thick, intersected in the shaft at a depth of 1,318 ft. An assay of a selected sample made at the Waihi School of Mines gave 8·7 per cent. of MoS_2, but a bulk sample forwarded to the Mines Department does not appear to contain as much as 1 per cent. The mineral molybdenite occurs also at Tararu Creek, Thames; in the Champion Mine, Neavesville; at Richmond Hill, Parapara; at Mount Radiant; at several places in the southern part of the Paparoa Range; at Dusky Sound; and at Bravo Island, near Stewart Island. Traces also occur, according to A. M. Finlayson,* in some specimens of Otago scheelite ores. It seems very probable that the sulphide ore of all the Waihi mines contains a little molybdenite, and that this mineral has not previously been detected owing to its resemblance to other sulphides, especially sulphide of silver (argentite) and galena. If so, molybdenum will be found in the cyanide solutions used for ore-treatment, and may be detected by a process described in the *Australian Mining Standard*, vol. 51, No. 1335, 11th June, 1914, p. 491; and in the *Engineering and Mining Journal*, vol. 97, No. 7, 14th February, 1914, pp. 363–364.†

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22. ANTIMONY.

During the past two years or more there has been considerable demand for antimony and its ores. Attention may therefore be drawn to the fact that antimony-ore occurs in a number of New Zealand localities, though none has been mined for a number of years. Chief among these are the Bay of Islands district, Endeavour Inlet (Marlborough), Reefton, Langdon Creek (near Brunnerton), Hindon (Otago), and Alexandra (Otago). The present London price for antimony (star metal) is £85 per ton, and 50-per-cent. antimony-ore is quoted at £17 10s. per ton (nominal quotation). Some time ago the Imperial Government offered to buy 50 to 65 per cent. antimony-ore at 10s. 6d. per unit, and to give 11s. 6d. for each unit over 65 per cent., delivery to be taken at London or Liverpool. Australian buyers will take 45-per-cent. ore, but at a lower price. The Imperial Government quotation of £26 5s. per ton for 50-per-cent. ore, and £34 2s. 6d. for 65-per-cent. ore ought to offer some attraction to New Zealand miners, notwithstanding the heavy cost of freight, insurance, &c. The antimony-market, however, has since weakened, and probably the Imperial Government is not now a buyer of the ore.

Among the chief British smelters of antimony are Cookson and Co. (Newcastle), Hallet and Son, J. J. Pratt and Son, and the St. Helens Smelting Company of Manchester. Some antimony-ore is now being treated in Australia, but details concerning the matter are not to hand. The Chapman Smelting Company, of San Francisco, which smelted antimony a number of years ago, has lately erected a new smelter designed to treat antimony-ore.

Up-to-date information concerning the treatment of antimony-ores, especially those containing gold, is not easy to obtain. A useful article on the subject will be found in the *Mining and Scientific Press* (San Francisco) of the 14th February, 1914, pp. 292–293. It is probable that smelting companies in the United States will accept 20-per-cent. ore, but the cost of shipment from New Zealand at the present time is prohibitive.

In a recent bulletin of the United States Geological Survey, Alfred H. Brooks,‡ under the heading of "Siliceous Gold-bearing Stibnite Lodes," describes occurrences that almost exactly resemble the antimony-bearing lodes of Langdon Creek, near Brunnerton,§ and have many points in common with the auriferous lodes of the Reefton district.

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23. MERCURY.

The Whangarei Cinnabar Company is endeavouring to develop promising cinnabar-deposits in the Puhipuhi district, North Auckland. The successful treatment of mercury-ores by the usual volatilization processes is far from easy, and other methods are being tried. Among these is the treatment of the crushed ore with an alkaline-sulphide solution, followed by precipitation of the mercury with zinc or aluminium. Experiments made in the Dominion Laboratory show that sodium-sulphide solution easily and quickly extracts a high percentage of the mercury from Puhipuhi cinnabar-ore. Experimental work is being continued with a view to finding a commercial process by which both the mercury can be precipitated and the sulphide solution regenerated.

Besides the Puhipuhi deposits there are several cinnabar occurrences in New Zealand that, with mercury and its compounds at their present high prices, deserve attention. Among these may be mentioned the deposits of Rahu Saddle (near Karangahake), of Mangakirikiri Stream (a branch of the Kauaeranga River, Thames district), and of Ohaeawai (Whangaroa district). Attempts to work the two last-named deposits have been made, but, owing to the poor recovery of mercury and other more or less remediable defects, were unsuccessful.

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* Trans. N.Z. Inst., vol. 40, 1908, p. 116.

† Clennell, J. E.: "Molybdenum in Cyanide Solutions."

‡ "Antimony Deposits of Alaska." U.S. Geol. Surv. Bull. 649, 1916, pp. 10–12, &c.

§ Morgan, P. G.: "The Geology of the Greymouth Subdivision." N.Z. Geol. Surv. Bull. No. 13, 1911, pp. 18–19, 84–86.

24. MANGANESE.

Manganese minerals are found in almost every part of New Zealand. The more notable occurrences are Tikiora, near the Bay of Islands; Waiheke Island, in the Hauraki Gulf; Paraparaumu, about thirty miles north of Wellington; and Taieri Beach, Otago.

For some time past manganese-ore has been quoted on the London market at 2s. 10½d. per unit, or £8 per ton of 60-per-cent. ore. Presumably the price is fixed by the Imperial Government. In June the San Francisco quotation for 45-per-cent. ore was 1s. 6d. to 1s. 7d. per unit, but in Pittsburg and Chicago similar ore was quoted at 3s. 9d. per unit (freight paid), and ore containing over 49 per cent. of manganese was quoted at 4s. 2d. ($1·00), with a penalty for silica in excess of 8 per cent. or phosphorus in excess of 0·2 per cent. It is evident that at these prices, unusually high though they are, the shipment of manganese-ore from New Zealand to the Northern Hemisphere is hardly commercially possible until ocean freights and insurance are considerably reduced.

Approximate Cost of Paper.—Preparation, not given; printing (1,350 copies, including maps, &c.), £40.

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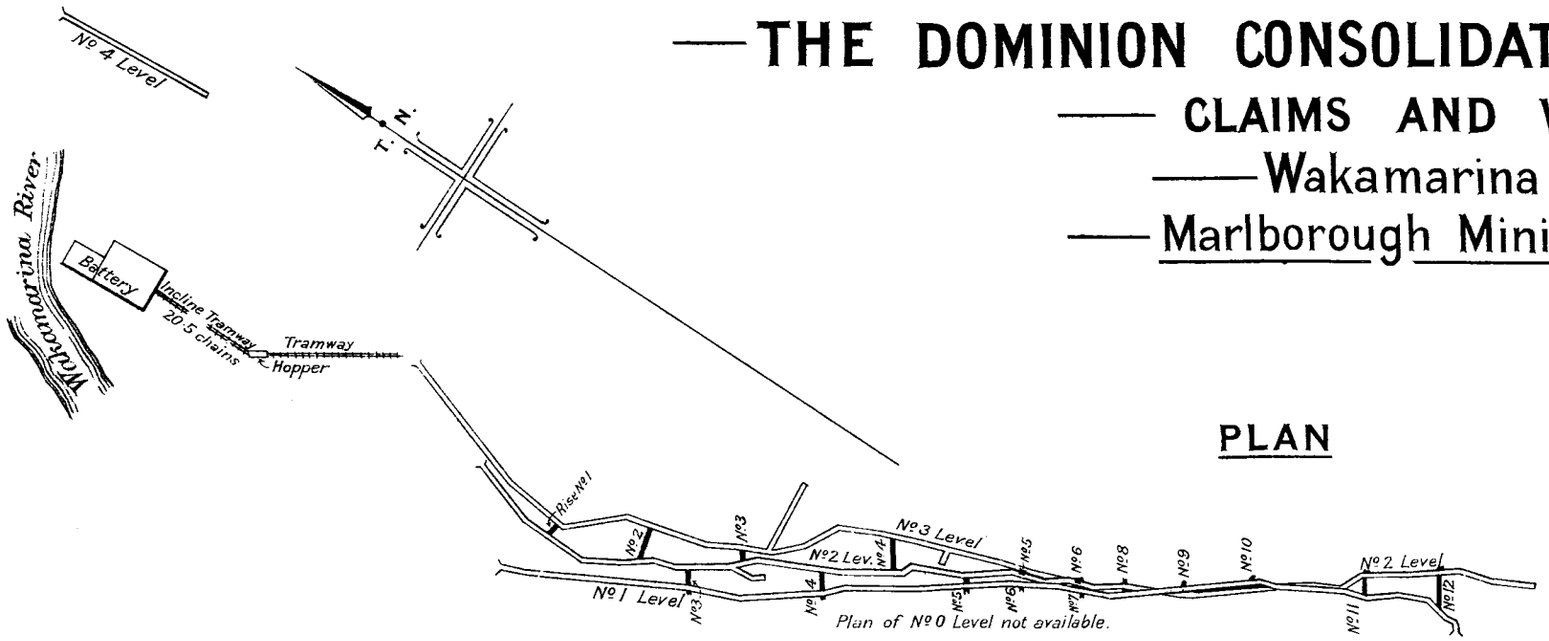

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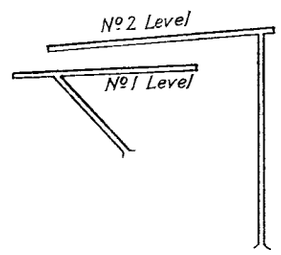

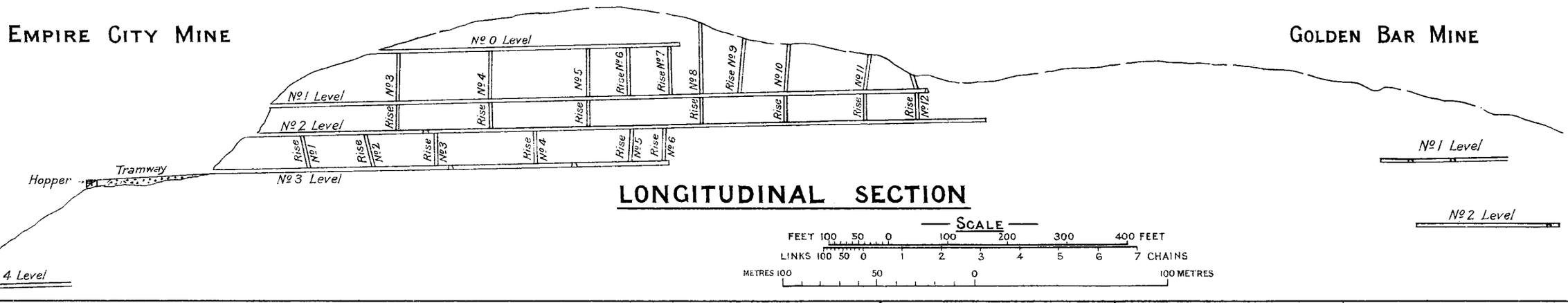

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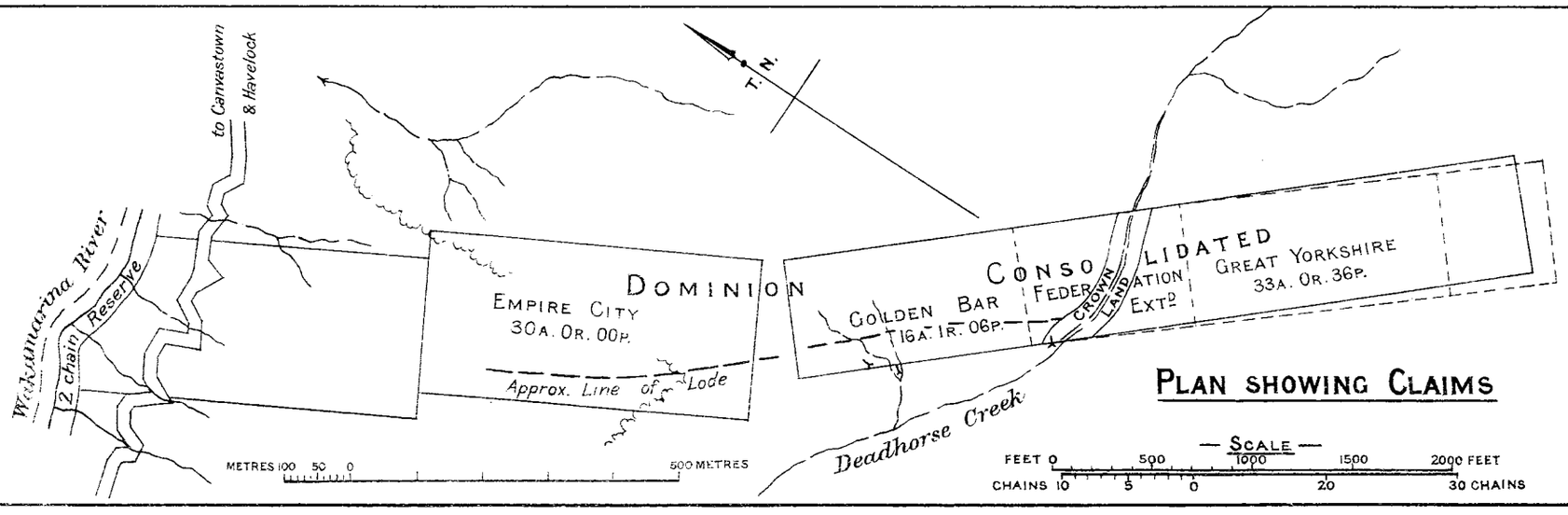

PLAN SHOWING CLAIMS

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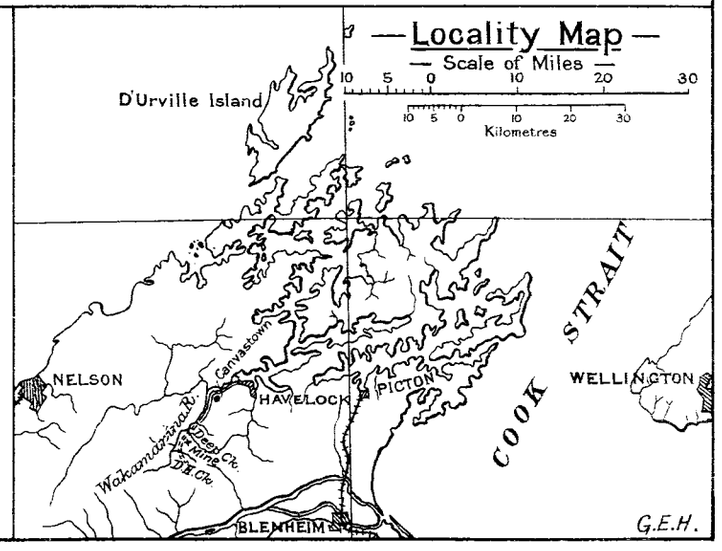

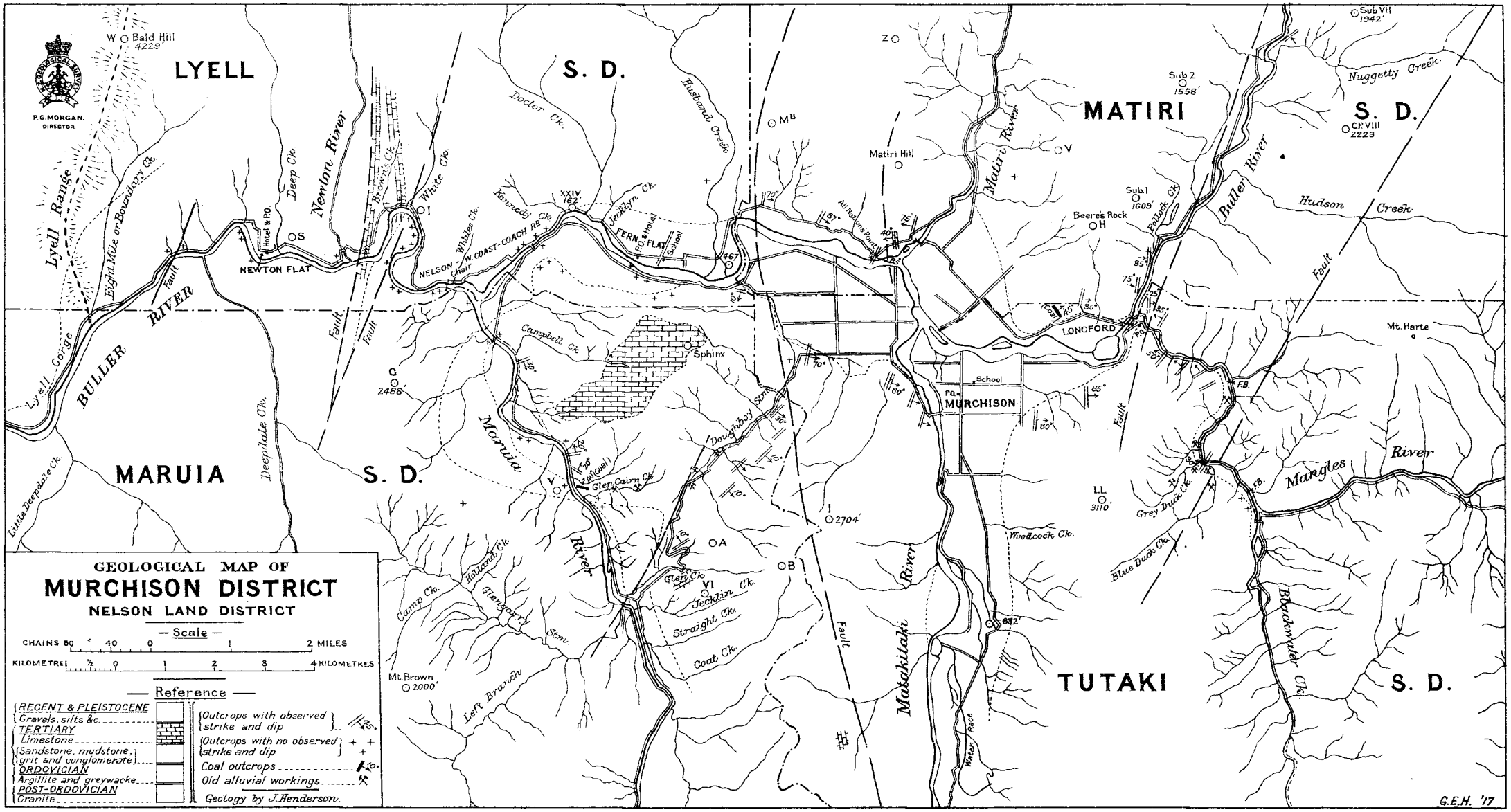
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Matiri River
Nuggetty Creek
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Deepdale Ck.
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Maruia River
Doughboy Stm.
Glen Cairn Ck.
Holland Ck.
Camp Ck.
Glengarry Stm.
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Left Branch
Glen Ck.
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Straight Ck.
Coal Ck.
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Blue Duck Ck.
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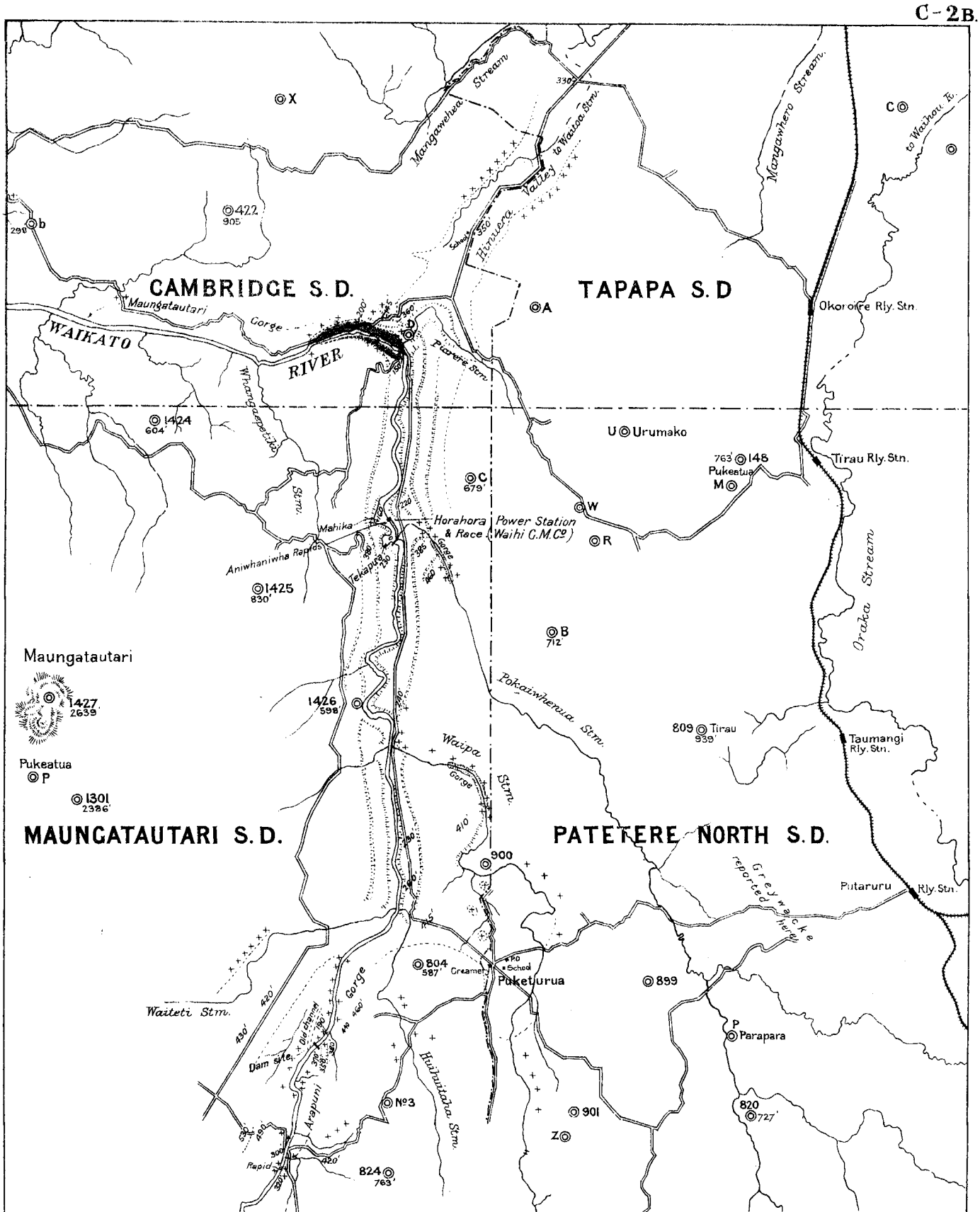
GEOLOGICAL MAP OF
MURCHISON DISTRICT
NELSON LAND DISTRICT
— Scale —
CHAINS 80 40 0 1 2 MILES
KILOMETRES ½ 0 1 2 3 4 KILOMETRES
— Reference —
RECENT & PLEISTOCENE
Gravels, silts &c.
TERTIARY
Limestone
Sandstone, mudstone, grit and conglomerate
ORDOVICIAN
Argillite and greywacke
POST-ORDOVICIAN
Granite
Outcrops with observed strike and dip
Outcrops with no observed strike and dip
Coal outcrops
Old alluvial workings
Geology by J. Henderson.
G.E.H. '17

C-2B.



— Sketch Map of —
— Waikato River near Maungatautari —
— Showing River Terraces &c. —

— Scale —

CHAINS 80 40 0 1 2 3 4 MILES

— Reference —

Lower Terrace... Middle Terrace... Upper Terrace... Rhyolite Tuffs... Greywacke...