1908.
NEW ZEALAND.

NEW ZEALAND GEOLOGICAL SURVEY DEPARTMENT
(SECOND ANNUAL REPORT (NEW SERIES) OF THE).

Presented to both Houses of the General Assembly by Command of His Excellency.

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REPORT.

SIR,— Geological Survey Office, Wellington, 1st July, 1908.

I have the honour to present to you the second annual report (new series) of the Geological Survey Department.

I have, &c.,
J. M. BELL,
Director Geological Survey.

Hon. James McGowan, Minister of Mines, Wellington.

INTRODUCTION.

DURING the season 1907–8 the general arrangements of the Geological Survey have remained almost the same as those described in the first annual report of the Department, which gave details of the work up to the end of 1906.

The operations of the Geological Survey comprise geological investigations of various kinds, and topographical surveys. The results of these labours for this season will be given in succeeding pages in this report.

In order that the results of our investigations may be made available at as early a date as possible after the completion of the field-work, it has been decided that the annual report shall each year cover all our operations up to the 31st May. This is the date at which suspension of our field-work generally takes place, and is as late in the year as is convenient for the completion of our report before presentation to Parliament. Consequently the present report deals with all operations of the Survey between the 1st January, 1907, and the 31st May, 1908.

STAFF.

Mr. Kenneth M. Graham, Assistant Topographer, resigned his position on the 31st March, 1907, to enter the service of the Federated Malay States, and Mr. John A. Bartrum, M.Sc., who had been on probation for four months, was permanently appointed as an Assistant Geologist on the 1st April, 1908. Besides the officers in the following list, Mr. G. E. Harris has been employed as a temporary draughtsman since the 1st October, 1906, and Mr. H. Richardson as temporary assistant topographer since the 1st November, 1907.

The *personnel* of the Department is now as follows:—

Position.	Name of Officer.	Date of Appointment.
Director of the Geological Survey	James Mackintosh Bell, M.A., Ph.D.	21st January, 1905.
General Geologist	Percy Gates Morgan, M.A.	19th May, 1905.
Assistant Geologist	Edward de Courcy Clarke, M.A.	1st January, 1907.
"	John A. Bartrum, M.Sc.	1st April, 1908.
Mining Geologist	Colin Fraser, M.Sc.	28th March, 1905.
Assistant Mining Geologist	Ernest John Herbert Webb, B.E.	1st November, 1906.
"	James Henry Adams, B.Sc.	1st April, 1907.
Topographer	Reginald Palmer Greville (Licensed Surveyor)	Transferred from Lands and Survey Department, 1st April, 1906.
Draughtsman	Robert James Crawford	Transferred from Lands and Survey Department, 1st August, 1905.
Assistant Draughtsman	Owen Ambrose Darby	Transferred from Lands and Survey Department, 1st September, 1906.
Correspondence Clerk	John Thompson	5th February, 1906.
Clerk	Peter Clarke	Transferred from Post and Telegraph Department, 1st November, 1906.

SUMMARY OF OPERATIONS.

During the past season the operations of the Geological Survey have been extended to many parts of the Dominion.

Early in July, 1907, work was commenced in the Whangaroa Subdivision, Hokianga, Auckland, and is still being continued. Investigations were completed in the Coromandel Subdivision, Hauraki, in March, 1907, and started in the adjacent Thames Subdivision in November last, where they are still being vigorously conducted. A bulletin, giving the results of our labours in the former area, was published during November.

In January, 1908, a systematic survey of the Poverty Bay oilfields lying in the Raukumara Division was begun. Our initial operations in this locality were commenced in the Whatatutu Subdivision, including the survey districts of Waingaromia and Mangatu. The survey of this area will be completed before a bulletin descriptive of this portion of the petroliferous country is published.

A detailed bulletin on the work in the Parapara Subdivision, Karamea, Nelson, which was started in September, 1906, and finished in March, 1907, was presented to Parliament during last session. This season much topographical work, as well as geological, has been carried on in the Heaphy Subdivision, also in Karamea, on the opposite coast of the South Island, and since the beginning of the present year we have had a geological party in the Mount Radiant Subdivision, in the south-western part of the Nelson Land District.

The survey of the Mikonui Subdivision of Westland has just been finished, and a bulletin on this mountainous area will be presented to Parliament this session.

Professor Park, who was again engaged during five months of the past season—from the 1st November, 1907, to the 31st March, 1908—conducted field operations in the Queenstown Subdivision, Western Otago, and his report thereon is now being prepared.

Dr. P. Marshall under special arrangement carried out palæontological investigations for the Department during the months of January, February, and March, 1908.

In addition to the systematic and detailed work in the several subdivisions above mentioned, reconnaissance surveys were made during the past season to the head of the Landsborough River, South Westland; from the mouth of the Heaphy River, Karamea, Nelson, to the headwaters of the Roaring Lion, a tributary of the Karamea; and through the southern part of the Urewera country; while special topographical work was conducted at the Franz Josef Glacier and in the surrounding mountains.

The accompanying general maps of the North and South Islands of New Zealand show graphically the areas in which systematic surveys have been conducted during the past three seasons.

PUBLICATIONS.

Last year the first annual report of the Geological Survey Department was issued as Parliamentary Paper C.-9. Besides containing a detailed account of the operations of the reorganized Survey during the year 1906, and a summary of the work accomplished during the year 1905, a brief description was also given of the Geological Survey prior to its reorganization in 1905.

Bulletins Nos. 3, 4, and 5 were also presented to Parliament last session.

Bulletin No. 3, written by myself, with the assistance of Messrs. E. de C. Clarke and E. J. Webb, Assistant Geologists, bears the title "The Geology of the Parapara Subdivision, Karamea, Nelson."

Bulletin No. 4, entitled "The Geology of the Coromandel Subdivision, Hauraki, Auckland," was written by Mr. Colin Fraser, Mining Geologist, with the assistance of Mr. J. H. Adams, Assistant Mining Geologist.

Bulletin No. 5, from the pen of Professor James Park, of the Otago University School of Mines, is entitled "The Geology of the Cromwell Subdivision, Western Otago Division."

In all 4,644 copies of bulletins have been distributed since the 1st January, 1907, and 446* copies of the first annual report.

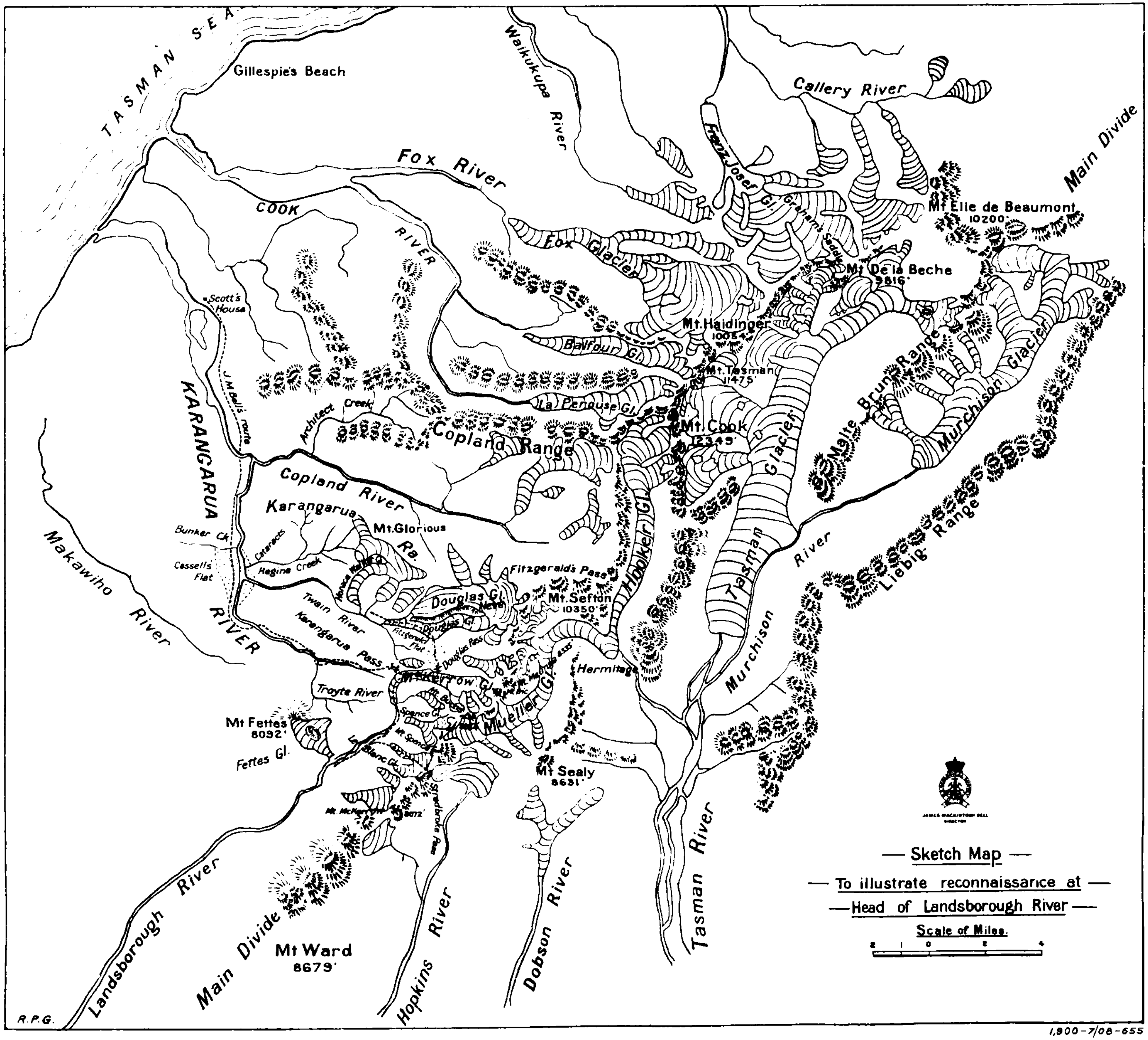
LIBRARY.

A good library is absolutely essential in a scientific department, so particular care is taken that all the latest text-books, written by eminent scientists, are obtained. In pursuance of this policy eighty-seven standard works have been added to the library since the 1st January, 1907. In addition, we have received exchanges from nearly all the geological surveys in the world, and from almost every scientific society or institution of note.

FIELD AND OFFICE WORK OF THE DIRECTOR.

During the period between the 1st January, 1907, and the 31st May, 1908, most of my time while in New Zealand was spent in the field. I was constantly engaged in field operations from the 1st January, 1907, to the 27th March of the same year. Between the latter date and the 29th June, I was employed at headquarters in Wellington, aiding in the preparation of the first annual report of the reorganized Geological Survey and the bulletin on the Parapara Subdivision, Karamea, Nelson. From the 10th July, 1907, to the 1st January, 1908, I was absent from New Zealand

* Does not include copies distributed at Parliament Buildings.



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on a tour round the world. On my return office-work detained me in Wellington till the 7th of the month. Since that date up to the very end of the season I have, save for two brief business visits to Wellington, been occupied in field operations in several parts of New Zealand, to be later detailed.

At the beginning of 1907 I was engaged in field-work, in company with Messrs. E. J. H. Webb, E. de C. Clarke, and K. M. Graham, in the Parapara Subdivision, Nelson. A bulletin on this interesting area, which contains extensive and valuable deposits of iron-ore, gold-bearing-quartz veins, and other minor deposits of economic value, was published in July, and presented to Parliament last session. Since the detailed description of the subdivision is given in that report, it will not be necessary for me to give further details here.

Reconnaissance of the Landsborough and Karangarua Valleys.

Narrative.—From the 30th January to the 11th March, 1907, my time was employed in making a reconnaissance up the valleys of the Karangarua, Landsborough, and Twain rivers, in South Westland. My route from Nelson to the base of operations at Scott's Homestead, near the mouth of the Karangarua, was by coach through the Buller Gorge to Reefton, thence by rail to Hokitika, and onward by vehicle and on horseback down the Great South Road. From Scott's Homestead supplies and equipment were carried up the Karangarua on horseback as far as Cassell's Flat, some eleven miles above the mouth of the stream. From Scott's the route follows the north or right bank of the river, crossing to the left bank just below the mouth of the Copland. At Cassell's Flat we pitched a base camp, from which all supplies had to be carried on our backs.

A rough foot-track made by the Lands and Survey Department follows the left bank of the river from Cassell's Flat to the mouth of the Troyte Stream, which enters the Karangarua on the left side, some six miles above Cassell's Flat to a point just above the "Cataracts." The route follows the left branch of the stream; then it crosses and recrosses the river, taking advantage of flats on either side. Travelling is by no means easy—the fords are often deep, and the frequent smoothness of the rock renders jumping from boulder to boulder in the rapid stream precarious and often dangerous. Where the gorges occur advance is especially difficult. It is frequently necessary to leave the river-bed and make one's way as best one can along the steep and even precipitous slopes by clinging to the scant vegetation.

Above the Troyte the rough track ceases, but travelling from this point to Karangarua Saddle, a distance of some three miles and a half, is not very difficult. The river has frequently to be crossed, and in places it is necessary to take to the thick and matted bush, though scrambling over the huge boulders in the river-bed is generally preferable to that operation.

Being delayed by rainy weather, we had to pitch three temporary camps before reaching Karangarua Pass, over which we crossed into the McKerrow Glacier valley on the 13th February. Karangarua Pass has an altitude of a little over 5,000 ft., and is nearly always free from snow at midsummer. The descent from the Karangarua Pass to the smooth surface of the McKerrow Glacier, first down a short arête and then down a snow slope, presents no difficulty.

Continuing up the McKerrow Glacier from Karangarua Pass we crossed over Douglas Pass, and descended into Fitzgerald Flat on the northern side of the pass. Douglas Pass, which is somewhat higher in altitude than Karangarua Pass, is well snow-covered. The short descent to the McKerrow from Douglas Pass, down a smooth slope, is easy, but the much longer descent to Fitzgerald Flat, down very steep grass slopes, after traversing the gradually sloping snow-patches near the summit of the pass, is attendant with some danger.

Fitzgerald Flat is a stretch of gravel a little over a mile in length, and rather less than half a mile in width. At the north-western corner of the flat, at an altitude of some 4,500 ft., we found a sheltered place for a camp on a tussocky spot beneath the high lateral moraines of the Douglas Glacier. Here, with sufficient mountain dracophyllum for firewood, there was a convenient base for exploring the valley portion of the Douglas Glacier, the Twain Valley beyond, and the wonderful Douglas Ice-fall.

On the 15th February we left Fitzgerald Flat in a fine rain, and, recrossing Douglas Pass, descended the McKerrow Glacier to the Landsborough. About two miles below the frontal face of the McKerrow we found a good camping-place on a terrace on the southern side of the stream. For several miles below the McKerrow Glacier there is no large timber, but almost everywhere there is enough small scrub for firewood. Our explorations extended down the Landsborough as far as the entrance of the Fettes Glacier, or about five miles below the frontal face of the McKerrow. In addition, an examination was made of the Le Blanc Glacier, one of the main tributaries of the Upper Landsborough. An unsuccessful attempt was made to cross from the Landsborough Valley to the Mueller Glacier, but, owing to the thick weather prevailing during our entire stay in the Landsborough country, we chose a route to Canterbury by the Le Blanc Glacier, instead of the Spence, which is apparently that tributary of the Landsborough which heads with the Mueller. The Le Blanc led us to a lofty col over 7,000 ft. high, but on our arrival at that point, which we have named Stradbroke Pass, we beheld far beneath us, in the blizzard raging at the time, not the smooth upper snow of the Mueller, but, flanked by snow slopes and precipices, the rocky bottom of a tributary of the Dobson.

Travelling in the Upper Landsborough Valley is rendered somewhat difficult by the numerous large glacial streams which have to be forded in ascending or descending the river. The absence of flats along the river offers no change from the monotony of scrambling over the large boulders which fill the river-bottom.

On the 21st February, after the disappointment attendant on not being able to cross into Canterbury by Stradbroke Pass, we left the Landsborough to return the way we had come by the McKerrow Glacier and Karangarua River. On the 23rd, after a trip in exceptionally bad weather, we reached Scott's Homestead safely. Next afternoon we left for the Hermitage, and, travelling by the route up the Copland River over Fitzgerald Pass into the valley of the Hooker Glacier, we arrived there on the evening of the 25th February.

The journey up the Copland is now easy, owing to the construction of a track up the valley and the bridging of Architect Creek, which once formed the most serious obstacle in the trip from Scott's to the Hermitage.

General Geology.—From a purely geological standpoint there is little of interest in the valleys of the Karangarua, Copland, Twain, and Landsborough. The solid rocks of the area are all metamorphic, and show a gradually decreasing metamorphism in passing from west to east. Thus, in the lower part of the Karangarua, the rocks show coarse mica-quartz schists—often garnetiferous—chlorite and biotite amphibole schists, and various other crystalline schists; while in the upper reaches of the river the rocks are phyllites and schistose grauwackes, often containing lenses and ribs of quartz. The gradation from highly metamorphic strata to less metamorphosed is gradual and not abrupt. However, the highly crystalline schists may be said to have practically ceased at the mouth of the Troyte. A few miles below the Troyte, greenish serpentinous schists appear as huge erratics in the river-bed, and the solid rock is evidently exposed on the southern slopes of the lofty ridge between the Karangarua and the Twain. In the Karangarua the rocks strike in general about 20° west of north, but variations from 41° west of north to 30° east of north occur.

In the Twain-Douglas Valley the rocks, so far as seen in the limited investigation made, are practically identical with those in the Karangarua. Epidote schists and serpentinous schists, containing idiomorphic crystals of magnetite and of pyrite, are exposed on the northern side of the Douglas Glacier, just below the great ice-fall.

In the Copland Valley the solid rocks are also similar to those of the Karangarua. The remarkable hot springs, depositing brownish sinters, occurring in this valley were described in my last annual report.

Along the McKerrow Glacier and in the Upper Landsborough Valley, which are in the less metamorphosed portion of the area under consideration, phyllites and schistose grauwackes are mainly in evidence.

Heavy morainic débris, both relatively ancient and modern, is visible in all the valleys, being especially conspicuous in the Douglas-Twain Valley and in the McKerrow-Landsborough Valley.

From an economic standpoint the area under consideration presents few features of interest. In the Upper Karangarua, along the McKerrow Glacier, and near Fitzgerald Flat, small veins appear in the schistose grauwackes and phyllites. Most of them are composed of very hungry quartz, though some are slightly rusty owing to the oxidation of pyrite. Samples were taken from several of the most promising veins, but the assays showed merely traces of the precious metals or none at all. A sample from a vein in friable phyllites and schistose grauwackes, which strike at 56° and dip south-east, occurring at the prominent rock buttress on the north side of Fitzgerald Flat, was found to contain no gold, but 3 dwt. 3 gr. of silver per ton.

In the past alluvial gold has been mined in the lower part of the Landsborough River, but careful prospecting in the upper part of the stream failed to reveal any of that metal.

Physiography.—It is from a physiographic and scenic standpoint that the area between the Karangarua and the Landsborough rivers presents most interest. The main part of the Karangarua Valley may be considered as the portion occurring between the mouth and the great bend at the Cataracts, some sixteen miles up the stream. The Copland Valley, the Twain-Douglas Valley, and the Upper Karangarua Valley, which are nearly parallel, may be described as the principal branches of this main trunk. Of the three streams occupying these valleys the Copland is undoubtedly the largest, while the other two are of approximately equal volumes. Regina Creek, which enters the Karangarua just south of the Twain, is a fair-sized stream, and, as judged by the width of its U-shaped valley, it formerly contained a large glacier. Since, however, it was not visited in the present reconnaissance, it cannot be further described in this report.

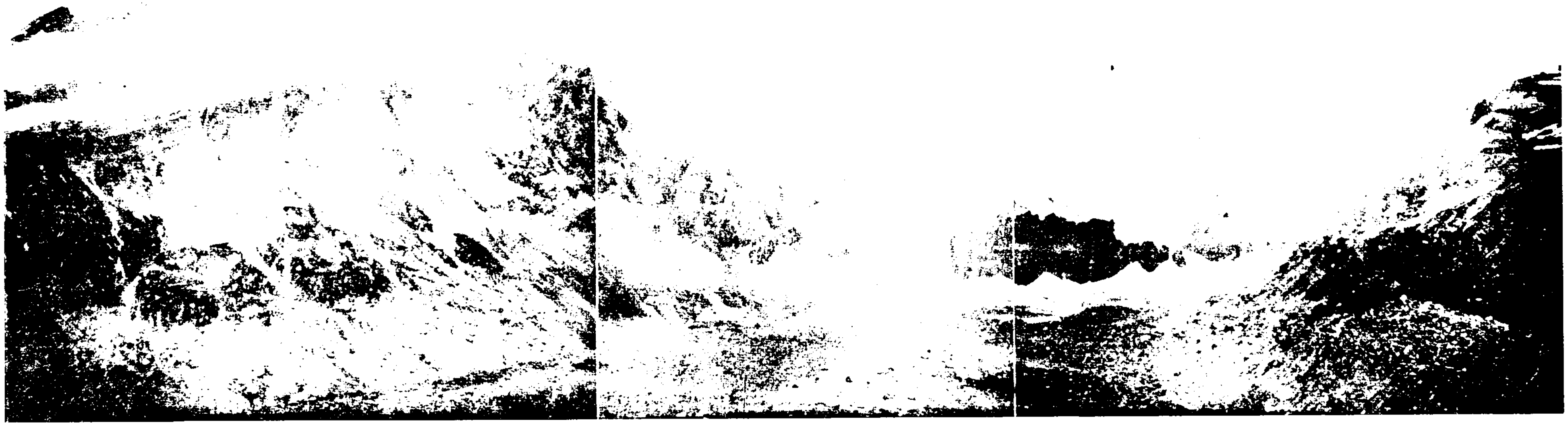
The Copland River, which rises in the Marchant Glacier, near Fitzgerald Pass, was briefly described in the last annual report of the Geological Survey. It has a long straight valley, exhibiting strongly the influence of past glaciation.

The Twain-Douglas Valley contains not only the Twain River and the Douglas Glacier, but also Fitzgerald Glacier. The latter was formerly directly connected with the Douglas Glacier in one continuous ice-river, but now Fitzgerald Flat, through which meanders the small stream of the same name, separates the two features.

The Twain-Douglas Valley is remarkably straight. The prominent knob close to the Karangarua, known as Conical Hill, which sentinels the ridge between the Twain River and Regina Creek, can be clearly seen from a point on Fitzgerald Flat near the frontal face of the Fitzgerald Glacier. The valley is relatively broad and U-shaped, and shows very abruptly truncated spurs on either side. Precipices are pronounced and decided on both sides of the valley. Over these precipices small streams, generally rising in small ice-blocks, in places leap hundreds of feet into the valley beneath.

Fitzgerald Glacier is formed by the consolidation of the ice, which descends into a spacious cirque from many small glaciers perched at high altitudes on the main alpine divide. The glacier, which is about two miles long, is well shrouded in moraine, especially near its frontal face.

PLATE 1



G[illegible] Douglas G[illegible] Neve

The Douglas Glacier consists of two distinct parts—the glacier proper or valley portion, and the névé—which are separated by a rock precipice of magnificent proportions, over 1,000 ft. in height. Above this rock precipice rises a splendid cliff of solid ice, marking the southern face of the névé. Every few minutes immense avalanches descend from the face of the névé over the rock precipice, and it is mainly their union which produces the valley portion of the Douglas Glacier. The névé, which is about three miles and a half long by two miles wide, has a gradual descent from a ridge of inconspicuous peaks lying between the prominent peak of Mount Sefton on the east, and the Sierras—a continuation of the Karangarua Range, with its fine peak of Mount Glorious—on the westward. The surface of the Douglas névé shows comparatively few large crevasses, though a large bergschrund occurs round the eastern base of Mount Sefton. Since the precipice varies in height, and the base of the ice-cliff descends to various altitudes, the actual contact of the névé with the rock precipice is not a horizontal line. Sometimes, just after a huge avalanche has broken away, part of the rock beneath is exposed, with a gradual and apparently much-smoothed slope upward from the crest of the precipice. No fewer than thirty-three streams issue from beneath the Douglas névé, and descend abruptly as waterfalls.

The valley portion of the Douglas Glacier rises in a spacious cirque near the base of Mount Brunner, and, receiving the ice derived from avalanches from the névé all along the great precipice, is a typical reconstructed ice-river. It has a length of about five miles, and exhibits a generally uniform and gradual descent from a point near its source to the frontal face. The surface of the ice is broken by crevasses, roughened by irregular séracs and much stacked with moraine.

At the time of our visit the lower part of the Douglas Glacier was well covered by accumulations of an immense avalanche. The soft snow and ice of which it was composed were in places coloured a dull pea-green by comminuted serpentinous rock, evidently derived from the heights to the northward, whence the material came.

Lying between the frontal face of the Douglas Glacier and an old terminal moraine, is a small pond a few hundred yards in length. From this pond the Twain River issues and flows for some miles in narrow flats shrouded in places by old terminal and lateral moraines.

Several tributaries enter the Twain below the frontal face of the glacier, the most important being the Horace Walker Stream. This stream, bordered by prominent fluvio-glacial terraces marking incision in old ground moraine material, flows from the glacier of the same name. The Horace Walker Glacier is a typical valley glacier, relatively narrow and long, and exhibiting beautifully crescentic crevasses across its course. It carries considerable morainic material, but relatively much less than the valley portion of the Douglas. This difference is apparently due mainly to the relatively greater endurance of the crystalline schists through which the Horace Walker passes than that of the friable phyllites and schistose grauwackes traversed by the Douglas trunk. It is also undoubtedly partly due to the erosion which takes place along the great precipice, the crest of which is being steadily worn away by the sweep of the enormous weights of avalanche continually descending. The precipice marks the edge of the deeply corraded valley produced by the ancient and powerful glacier, which descended from the Fitzgerald down the Douglas-Twain Valley to join the Karangarua Glacier. The valley having been much more deeply incised, either by this ice-action or by the pre-existing fluviatile action, than that of the tributary ice-stream entering where the Douglas névé now lies, the marked discordance in grade at their junction at the great precipice is easily explicable.

A steep hanging valley enters the Twain just below the frontal face of the Douglas on the southern side, and shows along its course many fine ice-smoothed surfaces.

The Karangarua, unlike the Copland, Twain, and Landsborough, cannot be said to rise in a glacier, though its several headwater streams, uniting in the ancient glacial cirque just below Karangarua Pass, do originate in snow-patches, and even small permanent ice-blocks. Formerly, however, a great glacier descended the Karangarua, and, uniting with the various ancient ice-streams of the Twain Valley (still represented by the shrunken Douglas and Fitzgerald glaciers), and of the Copland (now shown by the diminished Marchant and Strauchon glaciers), passed seaward and deployed on the narrow coastal plain—a fact well evidenced by the abundant old moraines near the sea-coast. As this glacier retreated, successive terminal moraines, marking where the recession of the ice was temporarily delayed, were left at various points along the courses of the several streams. These are especially conspicuous in the upper part of the Karangarua, and are in places shown topographically by waterfalls or rapids. These moraines also acted as dams, producing either ponding or at least diminution in the strength of the current behind them. The aggradation of these stretches of slackened water has produced the numerous flats on the Karangarua. It is quite possible that the aggradation of the glaciated valley proceeded synchronously with the gradual retreat of the ice.

Evidently the corrasion of the old Karangarua Valley floor by the Karangarua Glacier was not uniform, since at approximately the same altitude occur both rock gorges and gravel-filled flats with terraces, which, as mentioned before, represent aggraded areas. It may be, however, that in some cases warping has altered the valley-grades, and so produced the flats under discussion. Both the gorges and the terraces exhibit the dissection by the rivers beneath the valley-floor as it was when the glacier retreated. The meanderings of the stream across the aggraded gravel stretches brings the course in places on either side against the old rock wall of the valley. Thus gravel bars alternate with rock cliffs often overhanging on either side of the stream.

The Cataracts are the most conspicuous waterfalls on the Karangarua itself, and mark the point where the river descends over a marked ancient terminal moraine. Cassell's Flat, which marks the point where the ancient main Karangarua, Twain, and Regina Creek glaciers formerly united, is the largest flat, but there are many others above this point on the Karangarua.

The upper part of the Karangarua exhibits most beautifully the effect of glaciation. From Karangarua Pass the broad U-shaped valley is well displayed from the cirque at its head to the great bend at the Cataracts, west of which stands out clear against the sky—straight down the valley—the snowy crest of Mount McGloin. Bordering the upper valley to the east and west are mural precipices rising to bare rocky ridges, over which small streams fall hundreds of feet from their source in snow-patches or ice-blocks into the bush-clad valley beneath. At the junction with the main river these streams in places descend vertically over rock cliffs in falls of a hundred feet or more.

Below the great bend, as far as the mouth of the Copland, numerous small streams descend abruptly into the Karangarua from hanging valleys on the ridge of aiguille-shaped peaks extending north from Mount McGloin, giving falls of exquisite beauty. Below the junction of the Karangarua and Copland the united river flows almost at grade, and in places anastomoses in many channels through broad alluvial flats.

The lower slopes of Conical Hill, between the mouths of Regina Creek and the Twain, show rounded rock-surfaces beautifully smoothed and striated by ice.

The McKerrow Glacier rises in many small ice-falls, descending from lofty peaks on the main divide—Maunga Ma, Mount Eric, and The Dwarf. It is some four miles long and about half a mile in width, though this latter dimension varies. The glacier has in general a gradual and uniform descent from the great cirque near its head, though there are minor irregularities. The ice is much crevassed and morained below Karangarua Pass, but above that point only a very few moraines are visible, and the ice is almost unbroken. Numerous small ice-blocks appear on the steep cliffs which border on either side, but there is only one cliff glacier of any size—Maori Glacier. The latter is a fine piece of much-séraced ice. Near the frontal face of the McKerrow steep precipices of phyllite appear on the westward, while ancient lateral moraines are conspicuous on either side. A low rocky ridge separates the upper part of the McKerrow from the basin of Fitzgerald Glacier.

In former times the greater part of the upper ice of the McKerrow Glacier probably flowed over Karangarua Pass and down the Karangarua Valley, while relatively only a small portion flowed by the present channel—a fact which is shown by the narrowing of the glacier below Karangarua Pass. Even at the present day but a slight elevation in the ice-level would turn part of the glacier over the two passes.

The Landsborough River gushes forth from beneath the fine ice cliff forming the frontal face of the McKerrow Glacier, and from its inception is a large and powerful stream, practically unfordable for many miles. Like the Copland, Twain, and Upper Karangarua, the Upper Landsborough forms a remarkably straight, broad U-shaped valley. It is noteworthy that its course is almost at right angles to that of the three parallel streams already described—the Copland, Twain, and Upper Karangarua. Running parallel to the splendid chain of the Southern Alps, which rise majestically on its eastern side, the Landsborough forms apparently in the main a strike valley, though it is possible also that its course is along a great rift-line.

The numerous terraces stacked with old lateral and terminal moraines, both of the ancient Landsborough Glacier (a continuation of a portion of the McKerrow) and of the many tributary glaciers, form the most conspicuous physiographic feature of the Upper Landsborough Valley. The terraces represent the incision by the Landsborough and its tributaries into the débris left by the retreating ice in the old glacial floor. Above these terraces rise steep grass inclines to the rock precipices descending from levels of perpetual snow. Many glaciers, some of notable size, descend from either side of the valley.

In the upper part of the Landsborough the most prominent of the tributary glaciers on the eastern side of the Alps are Le Blanc and Spence glaciers; while the Fettes Glacier is the most conspicuous tributary on the western side. The Spence Glacier, as already mentioned, was not carefully investigated by the writer, but the Le Blanc was followed from the Landsborough to Stradbroke Pass, heading into Canterbury. The Le Blanc Glacier does not directly enter the Landsborough, but is joined to the latter by a small but very rapid and almost unfordable stream, about half a mile in length. The glacier, which carries considerable moraine near its frontal face, is a typical valley glacier. It is formed by the union of several steeply descending ice-falls flowing from the névé in the neighbourhood of Stradbroke Pass, from the rugged slopes of Mount Spence, and from other lofty peaks of the main divide further south. The lateral moraines bordering Le Blanc Glacier, both ancient and comparatively recent, are very prominent. Smoothed and striated rock-surfaces are visible on the hills to the north of the glacier.

Fettes Glacier, descending from the fine conical peak of Mount Fettes—the most prominent elevation on the ridge to the north-west of the Landsborough—forms an imposing sight. It is a steeply falling glacier of much-crevassed and séraced ice, and enters the Landsborough in a great cliff of solid, well-banded ice, some hundreds of feet in height, from beneath which the water gushes forth with geyser-like fury. On either side at its frontal face the Fettes Glacier is bordered by recent and relatively ancient moraines, the latter being covered with a luxuriant forest-growth.

The scenery of the area covered by the Karangarua and Landsborough reconnaissance is everywhere grand and impressive. It is particularly fine in the wild valley of the Karangarua. There from an open grassy flat one may contemplate the luxuriant forest, with its many shades of green, gay in summer with the brilliant scarlet flowers of the rata; the stately rock precipices, with their numerous waterfalls; the occasional patches of tussock brightened by alpine flora; and the matchless array of snow-covered peaks and hanging glaciers visible in the background.

Some of the gorges of the Karangarua are of great beauty, Dovetail Gorge, with its overlapping fern-festooned rock sides and its low rock-pierced pot-holes, being especially fine. Nevertheless no sight in the area is so imposing as the wonderful Douglas Glacier, nor can one imagine a finer alpine view than that obtainable of this great feature from Fitzgerald Flat. The splendid rock precipice, the magnificent cliff of broken ice above, the great fields of névé, and the ridge of lofty peaks culminating in the splendid crest of Sefton beyond, form a spectacle never to be forgotten. The majesty of the scene is heightened by the almost unceasing noise of the avalanches, which descend in quick succession every two or three minutes with deafening and awe-inspiring roar. In that strange, wild, rock-girt valley, with its heaps of moraines and its desolate treeless gravel stretches, no other sound is heard save the strident shriek of the kea or the weird cry of the weka.

I was preceded in my investigations in the Landsborough, Karangarua, and Twain valleys by several gentlemen, among whom may be mentioned Messrs. G. J. Roberts, the present Chief Surveyor and Commissioner of Crown Lands for Westland; G. Mueller, formerly Chief Surveyor in Westland; C. E. Douglas; and A. P. Harper.

The bibliography descriptive of the area under review is limited, and is practically confined to "Pioneer Work in the Alps of New Zealand," by Mr. Harper, though many years ago some accounts of explorations in the Landsborough Valley by Mr. Mueller were published in the newspapers of the Dominion.

Reconnaissance of Mount Radiant Copperfield.

From the Hermitage, where we completed the reconnaissance of the alpine area adjoining the Karangarua-Landsborough valleys, I travelled northward to Karamea, arriving at that place on the 4th March. While in the neighbourhood of Karamea a rapid preliminary inspection was made of the deposits of copper and molybdenum ores recently discovered in that locality.

The ores occur at the headwaters of the Mokihinui and Little Wanganui. At the time of my visit, the ore-bearing veins had already been discovered occurring at intervals over an area three miles and a half long and one mile and a half in width. Roughly speaking, the general trend of the veins is north-north-east and south-south-west.

The geology of the area is simple. The veins occur in greyish granite, often porphyritic, and are sometimes associated with veins of coarse greisen, into which they not infrequently grade. To the eastward the granites cut argillites, which are sometimes schistose, and to the westward are overlain by limestones and claystones. Much of the granite is massive and well jointed, and, in consequence, would be eminently suitable for heavy masonry, as well as for finer purposes.

The principal copper mineral occurs in the form of chalcopyrite, which contains when pure 34·5 per cent. of copper. With the chalcopyrite are associated malachite, melaconite, and bornite. The chief molybdenum mineral is molybdenite, but there is generally a little molybdite present. With the molybdenum and copper minerals there is always more or less pyrite or marcasite, and these probably carry the small values in gold and silver which most of the ore contains. The gangue-minerals are chiefly quartz and feldspar.

Owing to the wooded nature of the country the outcrops of the veins are in general poor, though some are well exposed, chiefly in the creek-beds. The walls of the deposits are very irregular, especially when the veins become greisen-like. Some six or seven reefs, supposed to be all separate and distinct, had been discovered at the time of my visit, but it was uncertain whether or not some of the outcrops might not be of the same lode.

As the area in which the copper-ores occur has, since my cursory examination, been carefully investigated by Mr. E. J. H. Webb, Assistant Geologist, and is described by him in another portion of this report, it will not be necessary for me to give further details of the geology here.

Karamea to Parapara.

Leaving Karamea I proceeded northward to Parapara, by travelling along the coast as far as the mouth of the Heaphy, whence the old track constructed in 1888 was followed up the Heaphy Valley for some eleven miles, and then across the Gouland Downs to the valley of the Aorere.

At the time of my visit the track was in very bad repair in the valleys of the Heaphy and Aorere, where it was much overgrown, but across the open stretches of the Gouland Downs, though practically unused for years, was still in fair shape. After my return to the work being carried on in the Parapara Subdivision, I remained there with my assistants, Messrs. Clarke and Webb, for about two weeks, when I proceeded to Wellington.

Inauguration of Whangaroa Work.

On the 29th June I left Wellington, and in company with Mr. E. Clarke, Assistant Geologist, proceeded to the Whangaroa Subdivision, Hokianga, North Auckland. This area contains deposits of copper, iron, and mercury ores, which it was advisable to investigate. A casual inspection of the main geological and geographical features was made with Mr. Clarke, and the principal occurrences of minerals of economic importance visited. The area, which contains Mesozoic, Tertiary, and Pleistocene sedimentaries, and various igneous rocks, is of great scientific interest. A brief statement on the area by Mr. Clarke will be found later on in this report.

Reconnaissance in the Heaphy Subdivision.

Soon after my return to New Zealand from my trip abroad I left for the Heaphy Subdivision, an area of country in the Karamea Division of Nelson, extending to the south and west from the Parapara Subdivision to the valley of the Karamea River. In my absence from New Zealand the track from the valley of the Aorere to the mouth of the Heaphy had been cleared of scrub and re-formed, while a hut, known as Whakapoai, had been constructed near the mouth of the Heaphy, to facilitate our operations in that locality. The track from the Aorere to the Heaphy, across the wide open stretches of the Gouland Downs, offers a ready ingress into the heart of the Heaphy subdivision, while Whakapoai, to which supplies can be brought by steamer, forms a convenient base of operations throughout the area.

Owing to the fact that the topographical surveys being conducted in the Heaphy Subdivision under our Topographer, Mr. Greville, were not sufficiently advanced to undertake detailed geological work, it was decided to limit my investigations of that nature to a brief reconnaissance into the least-known parts of the area.

Physiography.—The Heaphy River and its principal tributary, Gunner Creek, present an excellent section through the south central part of the subdivision. The Heaphy is of a very extraordinary shape — its main headwater branch forming an almost complete circle. Rising within ten miles of the sea, it flows first east, then north-east, and finally almost south-west to the sea, having a total length of nearly forty miles. The Gunner, which is a large stream, rises close to the headwaters of the Heaphy, and also has its upper branches interlocking with the Kowhai, a stream which enters the sea some ten miles south of Whakapoai. To the east of the prominent ridge bordering the upper waters of the main branch of the Heaphy lies the chief headwater stream of the Aorere, rising in the beautiful Heart Lake, and flowing at this point to the north-eastward. Cutting deeply into the ridge between the Heaphy and the Aorere is the deep valley of the Ugly River, flowing southward, or in the opposite direction from the Upper Heaphy and Aorere, to join the Karamea.

To the eastward from Heart Lake rise close together several tributaries of the Karamea. A stream, which is apparently the Roaring Lion, flows first north-easterly, then easterly, and finally southerly; while another branch, either entering the Karamea nearer the sea than the Roaring Lion or joining that stream near its mouth, has in general a southerly course, its headwaters draining the lofty ridge immediately south of the Roaring Lion. Some of these headwater streams rise in small mountain tarns of great beauty, showing ancient glacier cirques.

As the result of the deep dissection of the country by the numerous interlocking streams, in conjunction with the complication of past glaciation, the interior of the area exhibits a maze of ridges often showing pronounced aiguille topography. The country is not very high, the greatest elevation in the subdivision—that of Mount Domett, lying just to the south-west of Heart Lake—scarcely exceeding 5,200 ft.

The most interesting physiographic feature of the Heaphy Subdivision is shown in the ancient peneplain of the Gouland and the Gunner Downs. The Gouland Downs lie north of the Heaphy, the Gunner Downs south of that river and west of its tributary, the Gunner. They represent the south-western continuation of the old arm of the sea, which in Miocene times stretched up the valley of the present Aorere as far as Brown's River, while the ridges to the north-westward and south-eastward exhibit the higher country which stood above the sea of that period.

The Gouland Downs are a large stretch of elevated, very gently undulating country, with a length of about five miles from north-east to south-west, and about three miles in width. Their general elevation is fairly uniform, ranging from 2,000 ft. to 2,500 ft. It is remarkable that the old drainage flowing north-east along the old valley to the Aorere should have been captured by the Big River and other streams flowing directly westward to the ocean.

The Gunner Downs are of about the same extent as the Gouland Downs, being about five miles from north-east to south-west and four miles from north-west to south-east. Their elevation is somewhat greater than the Gouland Downs, averaging about 3,000 ft., and their surface is more irregular and rolling.

The small streams on both the Gunner and Gouland Downs are generally of gentle gradient, and flow in open valleys. On leaving the uplands the descent towards grade, either at sea-level or at the main rivers, is very rapid, a feature which makes nearly all the streams difficult to traverse as their headwaters are approached.

There is practically no low-lying flat land in the Heaphy Subdivision. At the mouth of the Heaphy there is a very limited area of good flat land, and for some distance up that river there are at intervals small patches. At the mouths of the smaller streams the amount of flat-lying land is practically negligible. Generally the elevated mountain country descends abruptly to the sea, and in places cliffs occur, though for the most part the sea front of the subdivision is relieved by sand beaches or gravel banks. The strong sweep of the powerful northward current prevents the rapid growth of these very narrow beaches into coastal belts.

Means of communication in the Heaphy Subdivision are poor. It is an unpleasant trip on foot from Whakapoai along the generally soft sand beaches and rolling boulder banks to the Kowhai Stream. From a few miles south of the Kowhai the sand beach as far as the Karamea Settlement is much harder, and horses can be used for this distance. From Whakapoai to Karamea the shore-line is followed all the way, save at a point just north of the Kowhai Stream, where a pronounced cliff, known as the Kowhai Bluff, necessitates leaving the beach.

The north-western part of the subdivision is reached by a rough track leading from the settlements and mines near Mangarakau to the Kahurangi lighthouse. As already remarked, the north central part of the subdivision is easily entered by the track from the Aorere to Whakapoai. At present much the most inaccessible part of the area is the south central part. It now takes three days' hard travelling from Whakapoai, through dense forest, over the rolling Gunner Downs, and along serrate mountain ridges, to reach Heart Lake. It is proposed to improve this route during the coming winter by making a rough horse-track from Whakapoai to the saddle at the head of the Kowhai and Gunner Streams. Here a small hut will be erected, whence supplies brought to that point (a day's journey from Whakapoai) can be relatively easily swagged along the ridges to the remote parts of the subdivision.

PLATE II.

Headwaters of Heaphy River from Gouland Downs.

Gouland Downs and Whakamarama Range.

PLATE III

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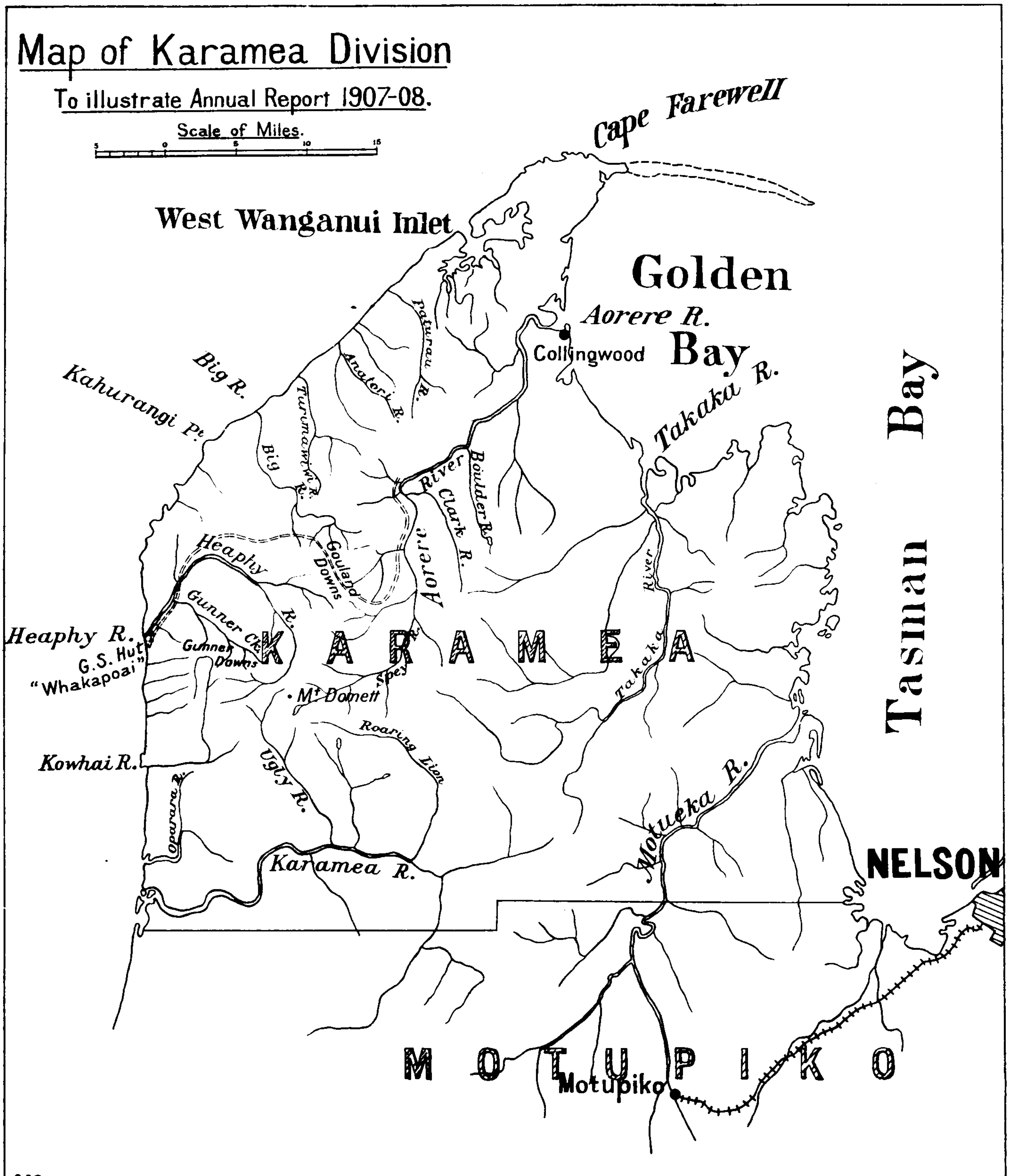

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By Authority: John Mackay, Government Printer.

General Geology.—During my sojourn in the Heaphy Subdivision somewhat hurried journeys were made across the Gouland Downs; along the sea-shore south from the Heaphy to Karamea; northward for a few miles from the Heaphy along the coast; up the Gunner to its headwaters, and thence down the Heaphy to its mouth; across the Gunner Downs to the valley of the Ugly, along the ridges to the west of Heart Lake, and southward from the Roaring Lion; and finally down the Aorere from Heart Lake to Eliot's Homestead, near the mouth of Brown's River. The splendid weather which prevailed during the whole summer greatly facilitated these journeys, and we were thus able in a short time to consider a large area of country, and gain a general idea of the geology.

The north-western and the south-western parts of the subdivision are composed mainly of metamorphosed argillaceous and arenaceous sedimentaries—mainly schistose grauwackes, quartzites, and phyllites. The exact age of these strata is not yet known. They may not all belong to the same period, though it is probable that they are all Early Palæozoic, and may be Ordovician, like those in the Parapara Subdivision farther northward.

The great central part of the subdivision is occupied by a belt of granites and allied plutonics. These rocks appear along the coast for almost the entire length of the subdivision, and extend north-eastward to and beyond the valley of the Aorere. They occupy much the greater part of the Heaphy area.

Occurring in small patches along the coast, in the valleys of the Heaphy and Gunner streams, and in the valley of the Karamea, and in an even more limited way on the surface of both the Gunner and Gouland Downs, are Miocene strata—conglomerates, sandstones, shales with coal-seams, and limestones. Recent fluviatile deposits occur along the various rivers, and very limited amounts of morainic débris at the headwaters of the Roaring Lion and Aorere rivers.

During the course of our very cursory investigations we learned that coal was of fairly general occurrence in the western parts of the subdivision, where Miocene strata outcrop. Before our investigations commenced it had been known to exist on the Aorere–Heaphy track about eight miles from Whakapoai, and also at a point on the sea-coast about nine miles north of Karamea Settlement, where a seam about 3 ft. thick has been worked in a small way for some time. Coal was discovered during the past season in Pitt Creek, about three-quarters of a mile from Whakapoai. Though there are large fragments of good coal in the creek-bed, the seam itself does not outcrop. It is proposed to carry on prospecting investigations on the coal-bearing strata exposed in the immediate locality in order to locate the seam. The coal, as shown by the following analysis by the Government Analyst, is a high grade lignite of good quality for household purposes:—

Fixed carbon	36·46
Volatile hydrocarbon	47·19
Water	14·66
Ash	1·69
	100·00

Total sulphur, 2·36 per cent.

Fragments of coal occur in the valley of Gunner Creek and elsewhere along the lower Heaphy, so it is hoped that our future detailed investigations in this area will reveal new and strong seams.

Quartz fragments, containing ores of copper and molybdenum like those of Mount Radiant, were picked up in the Upper Aorere and Heaphy streams, and have been reported from the mouth of the Roaring Lion. Numerous quartz veins, generally, though not always, small and irregular, were seen in the country at the head of the Roaring Lion. It is hoped that the detailed examination to be conducted later in this wild and mountainous part of the Heaphy Subdivision may be productive of economic results.

The Heaphy subdivision contains a promising asset in the Gouland and Gunner Downs. While poorly timbered in the gullies and where limestone outcrops, these uplands are mostly open, and are clothed with tussock grass and alpine flowers. Though the herbage is often scanty, in places it is excellent. It would seem that these relatively large stretches of open country are well suited for sheep-grazing.

The Urewera Country.

Narrative.—During the last two weeks of February and the first few days of March I made a hurried journey through the Urewera country in order to get a general idea of the country lying to the westward of the Poverty Bay oilfields, which are at present being investigated. Our route from Galatea, at the eastern edge of the Kaingaroa Plains, lay by graded road to a point about sixteen miles south-east of Te Whaiti, or just beyond the crossing of the most westerly branch of the Whakatane. From this point we pursued our way by a narrow track, well graded in places but elsewhere very poor, through the Maori pa of Ruatahuna to a place where the track forked about eight or nine miles beyond that settlement. Here we left the graded track leading onward to Lake Waikaremoana, and followed what is known as the Ruatahuna section of the Gisborne–Rotorua stock-track. The latter, descending into valleys or rising over ridges, leads to and just beyond the pa of Rua, the Maori tohunga, situated at Maungapohatu, a distance of about ten miles from the junction with the Waikaremoana track. The Ruatahuna section of the stock-track is considerably overgrown, and the path along its course is not always easy to follow. From the end of the Ruatahuna section of the stock-track to the beginning of the Wharekopae section our route lay for about ten miles along the northern crest of the Huiarau Range. Here the track is very poor, and pursues a devious course through innumerable bog-holes and among roots of trees. The Wharekopae section of the Gisborne–Rotorua stock-track is also badly overgrown in places. Its course rises and falls, down into valleys and up over hills, though in general there may be said to be a gradual descent from Maungapohatu eastward. The principal streams traversed after leaving Maungapohatu were the Anini, Hangaroa, and Wharekopae.

Physiography.—The part of the Urewera country through which we passed is deeply dissected by numerous streams, chiefly the tributaries of the Whirinaki, Whakatane, Ruakituri, and Hangaroa streams. The hills are rounded, subdued forms, well covered with creeping waste of local origin or with extraneous volcanic dust, and seldom showing very pronounced rock ledges. The pronounced cliff of Maungapohatu, at the northern end of the Huiarau Range, forms an exception. Along the various streams are narrow flats, and in a few localities, as in the neighbourhood of the settlements of Ruatahuna and Maungapohatu, these are fairly extensive, rising in broad terraces from the Mimiha and Mahakirua streams respectively, both tributaries of the Whakatane.

Nearly all of the Urewera country traversed is bush-clad, and only at the few Maori pas are there any clearings. The large rimu-trees are of great value as milling-timber. The soil improves in quality towards the eastern part of the area, being less volcanic than nearer Galatea. The gently flowing streams, the deep valleys, and the rolling forest-clad hills lend great charm to the soft picturesque scenery of the Urewera country.

General Geology.—The geology of the area is simple. Argillites and grauwackes, of uncertain but probably of Triassic or Jurassic age, are the prevailing rocks almost as far as Maungapohatu, whence later rocks continue to the eastward. These later strata are probably Early or Middle Tertiary and are most likely Miocene, though some of them have been described as Cretaceous. Patches of these later rocks occur to the westward of Maungapohatu, between Rua's pa and Ruatahuna.

The argillites and grauwackes are intensely corrugated. Their outcrop is often exceedingly rusty owing to the oxidation of contained iron-pyrites. In places calciferous zones occur in the argillites, and these are occasionally pyritous. The brecciation of the grauwackes interstratified with narrow argillite layers has in places produced a pseudo-conglomerate. Quartz is exceedingly rare.

The later and supposedly Tertiary rocks consist of claystones, sandstones, and impure arenaceous and argillaceous limestones. It is said by the Maoris that coal has been found in these strata at Maungapohatu.

The soft tuffs, which form thick beds near Galatea, gradually become thinner in passing eastward, but they occur in small patches almost as far as the Hangaroa River.

Detailed Work in Poverty Bay Oilfields.

Altogether some six weeks were passed in the Poverty Bay oilfields. Our systematic geological operations in this locality are confined to an area in the Raukumara Division, containing the survey districts of Waingaromia and Mangatu, and called the Whatatutu Subdivision. Prior to my arrival operations had been carried on for two months in this area by Mr. J. H. Adams, Assistant Geologist, whose co-operation I had during my sojourn in the subdivision. In former years geological surveys have been conducted in this locality by the late Sir James Hector, by Mr. Alexander McKay, and by Mr. H. A. Gordon. As Mr. Adams is submitting a somewhat lengthy preliminary report on the locality, it will be unnecessary for me to elaborate his description of the general geology and geography. Suffice it to say that the rocks exhibit a series of glauconitic sandstones, claystones, conglomerates (rare), argillaceous sandstones, and arenaceous limestones, which are crumpled into open but very irregular and broken folds, and are in many places faulted.

The country is deeply incised by numerous streams—the Waipaoa, Mangatu, and Waingaromia rivers and their tributaries. The larger rivers flow at grade, and are bordered by wide and fertile flood plains. The hills, which show no very conspicuous altitudes (the highest in the Whatatutu Subdivision being Arakihi, 2,302 ft.), represent a subdued topography, and are completely cloaked with waste derived from the decay of local strata, a feature which greatly enhances the value of the area from an agricultural standpoint. Outcrops of solid rock are very rare, excepting along the watercourses, but the country being almost entirely free from bush is well exposed for geological investigation.

Geologically, economic interest centres around the occurrence in the area of oil and gas springs, especially in the neighbourhood of Waitangi Hill. In order to indicate areas in which petroleum may be expected to occur geological work must be done with the utmost detail and care, and outcrops of solid strata must be most accurately located on a plan. Consequently, the work is of necessity slow and tedious, and our operations up to the present have been confined mainly to an area within a radius of six miles from Waitangi Hill.

In examining a petroleum-bearing country the theoretical questions to be considered are,—

(1.) The surface indications of petroleum in the presence of petroleum-springs, gas-springs, &c.

(2.) The presence or absence of a porous stratum of such material as sandstone or limestone, which might act as a storehouse or reservoir for petroleum.

(3.) The presence or absence of an impervious stratum such as a bed of shale or claystone disposed above the porous stratum to serve as a barrier to the upward movement of the petroleum.

(4.) The structure of the country, in order to locate the upward folds or anticlines.

If interstratified porous and impervious strata are folded into anticlines and synclines with the impervious beds above the porous, it is natural to expect that when water is present such petroleum and gas as may be formed by natural distillation beneath the surface will be collected in anticlines in the porous layers beneath the impervious beds, for the reason that since petroleum is lighter than water and does not mix with it the oil will be buoyed or forced upward towards the anticlines, whilst the water will sink through the porous strata towards the base of the synclines. Effective water-pressure may be more particularly expected if these porous beds outcrop and form a sponge for water falling on the surface. Again, the gas confined in the petroliferous strata in many cases aids the oil in rising towards the crest of the anticline. Of course, it must be understood that there may be several successive beds of porous and impervious strata with one or more niveaux of petroliferous country.

In general it may be said that ideal conditions exist where a relatively thick porous stratum, known to be petroliferous, is overlain by a gently folded impervious stratum showing no pronounced faulting; but whether these ideal conditions obtain or not at Waitangi Hill cannot at present be stated. There are abundant surface indications of oil, as shown by natural petroleum-springs and by petroleum seepage in test-pits. From investigation up to the present time it is not clear whether the petroliferous strata are exposed at the surface at this point, or whether the presence of these indications is not due to the petroliferous strata having been tapped at some distance below the surface by a fault plane or break. It must be stated that the folding in the subdivision is most irregular and erratic, and that faulting in various parts is distinctly conspicuous. Also, it is noteworthy that the several petroleum-springs in this locality appear in general along a more or less definite line, which would suggest that they are along a fault.

In summing up it may be said that there are fair chances of discovering a reservoir of petroleum in porous strata in the locality of Waitangi Hill, though, owing to the possibility of faults in the folds having allowed much of the petroleum originally present to escape, there can be no absolute certainty on this point. The map accompanying this report indicates the point in the part of the Whatatutu Subdivision so far surveyed which we consider most suitable for a borehole. This point has been chosen for the following reasons:—

(1.) Because it lies at or near the crest of a longitudinal anticlinal fold, and near the point of transverse folding on that longitudinal fold—in other words, at or near a point of doming in the strata.

(2.) Because it is apparently removed from "slip" country, so prevalent in this locality.

(3.) Because it appears to be removed from the possible line of fault along the petroleum-springs.

This suitable position is somewhat unfortunately at a high altitude, but lower points in the immediate locality are prohibited by the broken and "slip" nature of the country.

It must be definitely understood that the point now chosen for a borehole is preliminary, though from the present state of our observations we consider it to be settled. After the further investigations, however, which will precede the publication of the bulletin on the Whatatutu Subdivision, it may be found necessary to slightly change its position.

Thames Subdivision.

I arrived in the Hauraki Division late in April, and worked in that portion of the Dominion till the end of May. My work was limited to a reconnaissance from Thames to Coromandel, thence to Mercury Bay and the goldfields of the Tairua Valley; and to detailed investigations of the gold-mines in the immediate neighbourhood of the Town of Thames. On the reconnaissance trip I was accompanied by Mr. Colin Fraser, Mining Geologist, who for some months past had been conducting detailed investigations in the Thames Subdivision, which includes the survey districts of Hastings and Thames. Mr. Fraser also co-operated with me in the work at the mines of the Town of Thames. As he is submitting a report concerning the Thames work on a later page, it is unnecessary for me to describe in detail the state and character of the operations in that locality.

Tairua Goldfield.

Since the Tairua Goldfield lies to the eastward of the Thames Subdivision, and since a detailed report on its geology will not appear for some time, a few remarks on this locality will be of interest.

Physical Geography.—The Tairua Goldfield is situated in a hilly, almost mountainous country, rapidly increasing in altitude from the shores of Tairua Harbour to the mountain-peak of Pakirarahi (2,578 ft.), on the water-divide of the peninsula, and lying near the south-western limit of the field. The hills, being cloaked by a thick covering of creeping waste derived from the decay of the various volcanics, which form the subjacent rocks, are generally smooth in outline. It is only along the crest of the very highest hills, or in close proximity to the various streams which have deeply incised and dissected the area, that ledges of solid rock are conspicuous or prominent.

A natural highway into the goldfield is afforded by the Tairua Harbour and river. The former represents a typical sunken river-mouth, and shows the former extensions of the Tairua Valley proper. Owing to this depression, boats of small draught are enabled to carry supplies to the settlement of Upper Tairua, fully six miles from the sea. From this point a rough road extends up the flood plains of the Tairua Stream for several miles, and then a corduroy or log track leads over the hills past the various mines down into the valley of the Puriri, on the western side of the divide.

The area is in great part still forest-clad, the magnificent kauri-pine growing in great luxuriance, and yielding excellent mining-timber.

General Geology.—In broad outline the geology of the area is not complicated. The solid rocks exposed consist entirely of Tertiary volcanics, the earliest having been ejected and poured forth upon an old land-surface of argillites and grauwackes, completely covered in the area now under consideration, but exposed to the northward. The oldest of the volcanics consist of andesitic and dacitic lavas, with tuffs and agglomerates of similar petrological composition. Coal partings are traceable in these rocks, and it is probable that more than one period of volcanic activity is represented. More recent than the andesites and dacites are the rhyolitic lavas, tuffs, and agglomerates, which are specially conspicuous towards the east of the area. The agglomerates of this latter period of vulcanism, as may naturally be expected, contain in places a large amount of semi-basic ejectamenta derived from the earlier volcanics. Most of the volcanics are highly altered by both meteoric and hydrothermal metamorphism, the latter being markedly apparent in the neighbourhood of the various auriferous veins to be later described. The loosely consolidated sands and gravels along the various streams consist of material derived from both semi-basic and acidic volcanics.

The Principal Mines.—In the Tairua Valley are situated the following mines, named in order of present importance: Tairua Broken Hills, Tairua Golden Hills, Tairua Triumph, Tairua Extended, Tairua Consols, and Coronation; while on the divide between the Tairua and Puriri Streams are the Golden Belt, Champion, Ready Bullion, and Brilliant. Only the four more important of these need be considered in this report—namely, Tairua Broken Hills, Tairua Golden Hills, Golden Belt, and Champion.

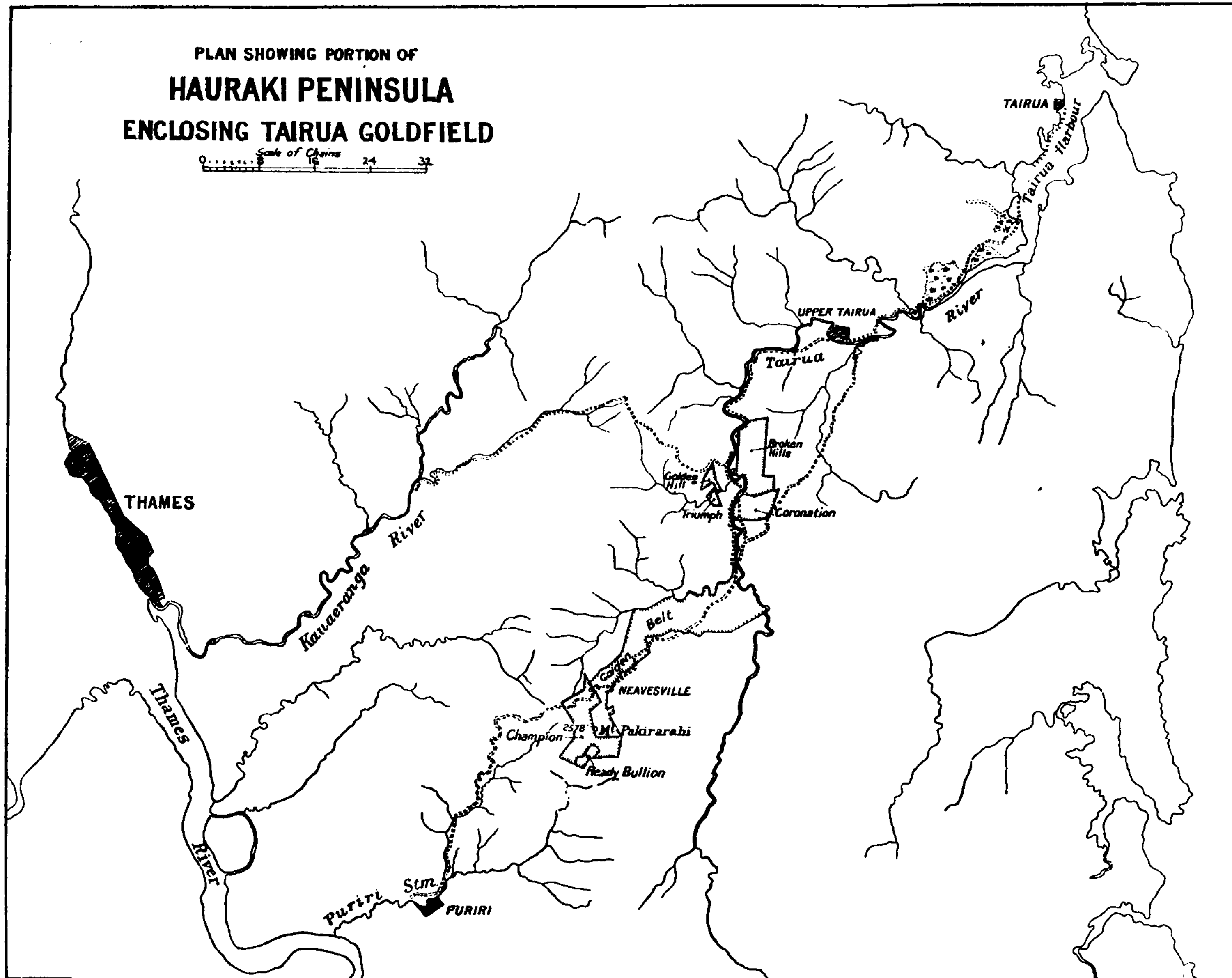
Tairua Broken Hills.—The Tairua Broken Hills Company is operating on a series of parallel or almost parallel veins in rhyolites, showing a very marked flow-structure, and situated on the south-east side of the Tairua Stream. The veins occur along somewhat intricate fault-planes, and are of various widths, in places being represented by narrow pug-seams with little or no quartz, elsewhere by definite quartz fillings up to 4 ft. in width. In the main adit level from the sloping surface facing the Tairua Stream no less than seven important veins have been intersected. It is remarkable that few, if any, of these veins were discovered actually outcropping. That they have considerable vertical extension downward is evidenced in the deepest workings on the principal vein (No. 1), which here appeared as strong and well defined as in any other part. The veins strike in a general north-and-south direction, and dip almost uniformly to the westward at high angles, crossing the trend of the flowage-planes of the enclosing rhyolites. The veinstone is characterized by a large amount of clay-like material, which apparently often carries fair values. With this is associated the quartz, which varies considerably in character, being in places finely crystalline or chalcedonic, saccharoidal, drusy with numerous quartz crystals, or platy, the latter structure being evidently pseudomorphic after calcite. Pyrite is the only conspicuous sulphide present in the ore, and even this is not very common. The pay-ore occurs in shoots, with, however, somewhat indefinite boundaries.

Tairua Golden Hills.—The Tairua Golden Hills Mine is situated on the opposite side of the Tairua Stream from the Broken Hills. The mine, which is a new and undeveloped property, exhibits geological conditions almost identical with those of the older claim. In a tunnel put in from the steep hill-slope a definite vein at least 4 ft. in width has been cut, which is reputed to show payable values for the full distance drifted upon—about 70 ft. Two other veins outcropping on the crest of the hill are expected to be intersected by the continuation of this tunnel.

The Golden Belt Mine.—The Golden Belt Mine is located on the eastern slopes of Pakirarahi Mountain, at an elevation of about 2,000 ft. The proprietary company's operations are at present confined to mining ore from a vein occurring in altered andesitic or dacitic tuffs and lavas. This vein occurs in a fault-plane along which considerable brecciation of the country rock has taken place, and is on that account decidedly irregular both in its vertical and horizontal extension. The vein-material consists in the main of quartz, silicified wall-rock, and pug, all more or less pyritous. The quartz is generally finely crystalline, shows drusy cavities, and frequently exhibits ribbon structure. It occurs as lensoid sheets or irregular-shaped bunches and streaks, associated with the softer vein-material. Recementation of fractured and displaced ribboned quartz within the vein suggests at least two periods of mineralisation, the second of these periods being probably contemporaneous with the formation of an ore-deposit of rather different nature, to be later described. The ore-body under review varies in width from a mere pug-seam to about 10 ft., and the shoot of pay-ore therein is stated to have a horizontal extension of about 600 ft. The vein, which strikes nearly north and south and dips to the eastward, is mined from an adit level. Owing to the ground being heavy and minor faults numerous, particularly in the vicinity of the vein, a considerable amount of timber is required to secure the workings.

Overlying the semi-basic volcanics enclosing the vein just described are tuffs and fine-grained agglomerates. The finer material in these rocks is mainly acidic, though probably in part semi-basic. The coarser material exhibits fragments of all subjacent rocks, those of andesite, dacite, and a highly silicified tuff being most apparent. Small pieces of silicified carbonised wood occur in places. Economic interest is attached to these pyroclastics in that they are considered to afford a payably auriferous deposit at a particular locality known as the "Bluffs." Here the rocks along a zone, the limits of which are rather indefinite, are highly silicified, contain a good deal of pyrite and its oxidation-products, and exhibit numerous ramifying stringers and also small druses of quartz. The gold-silver content in this deposit is in great part associated with the pyrite, which is especially abundant in connection with carbonaceous inclusions. In the past some of this material has been mined from open cuts, and stamped in a small battery.

Only one period of mineralisation is apparent in the auriferous agglomerates; this mineralisation evidently took place at the same time as the cementation of the much-brecciated ore in the vein occurring in the underlying semi-basic volcanics. The latter vein apparently was originally formed before the deposition of the upper agglomerates and tuffs took place, and was probably brecciated at the time of their ejection. It is significant in this connection to note that the vein in the lower volcanics is stated to cease abruptly in upward extension against the hard silicified tuffs which form the lowermost measures of the upper volcanics.



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The Champion Mine.—The workings of the Champion Mine, which is situated on the western slope of Mount Pakirarahi, are entirely in the younger volcanics—the acidic or mainly acidic agglomerates and tuffs which are all more or less silicified. Alluvial workings in the neighbourhood of the Champion Mine have in the past yielded considerable gold, and are still producing a relatively small amount of the precious metal. Some highly auriferous puggy material was mined from a fracture-plane in a mineralised zone in the upper part of the present mine-workings. The present proprietary company has its hopes centred on the mineralised zone, seemingly of considerable horizontal extension, in which the rich fracture occurred, and also on a remarkable ore-bearing pipe. Access to both these ore-deposits is afforded by an adit level.

The mineralised zone, which extends to 40 ft. in width, trends about east and west, and is disposed almost vertically. Some 8 chains east of the adit level and at a level 40 ft. lower, a mineralised zone cut in a prospecting drive is thought to be identical with that intersected in the main adit level. The highest gold-silver values in the mineralised zone in the adit level occur in small, puggy, gash seams, but the zone is said to carry gold-silver evenly disseminated throughout.

Free gold and pyrite, the latter probably auriferous, are especially visible in the neighbourhood of certain blackish inclusions of silicified carbonaceous material.

The ore pipe shows in horizontal cross-section irregular boundaries with dimensions approximately of 28 ft. by 18 ft. Its lower vertical limit has not yet been reached in the workings. The agglomerate in this pipe, though relatively fine-grained, is aparently coarser than in the mineralised zone, and has a rather earthy appearance. Quartz is more conspicuous here than in the zone, and appears in patches showing finely crystalline; drusy, or saccharoidal structures. Both free gold and auriferous pyrite occur here, as in the larger deposit, in connection with much-silicified carbonaceous material. The pipe, which carries higher values than the mineralised zone, often yields ore showing rather large, ragged particles of free gold. The mineralised pipe of the Champion bears in some ways a striking resemblance to the ore-bodies at the Bassick Mine in Colorado.

Work in the Town of Thames.

The work being conducted in and around the mines of the Town of Thames is being done with the utmost care. As far as possible all the workings beneath the surface are entered and examined, and the geological data thus obtained affixed to a plan of the mine to which the workings belong. This subterranean geology is compared with the surface geology located on a special map covering the area from the mouth of Tararu Creek to Hape Creek, and extending inland to the Lookout Rocks. This map, prepared by Mr. E. F. Adams, is on a scale of 5 chains to the inch, and shows contour intervals at every 100 ft.

The work at the Thames is not yet sufficiently advanced to report at length thereon. In general, however, I may say that it is hoped that such detailed investigations as we are conducting will throw much light on many obscure points in connection with the Thames Goldfield.

REPORTS OF FIELD OFFICERS AND SENIOR DRAUGHTSMAN.

Mr. P. G. Morgan, General Geologist.

Since the beginning of January, 1907, Mr. Morgan has been engaged in field and office work connected with the geological survey of the Mikonui Subdivision. From the 10th July to the 26th October, 1907, he also acted as Officer in Charge during my absence from New Zealand. Mr. Morgan reports as follows on his field and office work during the period under review:—

Narrative of Field-work in the Mikonui Subdivision.

At the beginning of January, 1907, my main camp was pitched near the granite gorge of the Hokitika River, at a point about twenty miles from Hokitika. From this camp as a base we had during December explored by means of flying camps a considerable area on the west side of the Hokitika. The survey of this area was completed early in January. We then temporarily camped on one of the spurs radiating from Mount Jumbletop, and made a connection with some work of the previous season which had been carried on from the Toaroha Valley.

On the 14th January we shifted our main camp to a spot near the junction of the Hokitika and Whitcombe rivers. Owing to these streams being quite unfordable anywhere near our camp, one of our first cares was to build a small flat-bottomed punt, which proved very serviceable, enabling us to cross the Hokitika and Whitcombe without trouble, except when they were in flood. Mr. James Ritchie, who, as mentioned in my last report, was still with me as field assistant, traversed most of the country within reach of the camp for some miles up the Whitcombe, and on the west side of the Hokitika. In particular he examined some very interesting outcrops of the Pounamu Formation on the western slopes of Mount Inframeta. From the Hokitika–Whitcombe junction camp I explored the headwaters of the Hokitika, crossing into its upper valley by way of Frew Saddle and ultimately reaching Mathias Pass (4,610 ft.) on the main divide. I also followed the Hokitika upwards to the Mungo junction, and the Mungo itself to its glacier source. The principal tributaries of the Upper Mungo—Park Stream and Brunswick Creek—were also surveyed. On the 11th February, I reached Mungo Pass (5,900 ft.), on the main divide near Mount Park, thus connecting with the work done in the previous year on the eastern side of the Alps in the Wilberforce district.*

Soon after my return from the Upper Mungo to the main camp, Mr. Ritchie left in order to take up another employment, and from this time till joined by Mr. Bartrum I continued field-work without any trained assistant.

The exploration of the upper part of the Whitcombe was now begun, but a prolonged period of bad weather set in, so that time after time we were compelled to fall back on the main camp without having made much progress. Finally, however, on the 21st March, Whitcombe Pass (4,025 ft.) was reached, and the survey of the Upper Whitcombe finished.

While camped at the junction of the Wilkinson and Whitcombe rivers we had a magnificent view of the Wilkinson Glacier and its ice-fall, the latter being one of the finest in New Zealand. During wet weather the roar of an avalanche descending over the great precipice on the south side of the glacier was heard every few minutes. From the same point may be obtained an excellent view of Mount Evans, which is 8,612 ft. in height, and is, with the exception of Mount Whitcombe, the highest peak in the Mikonui Subdivision. On the 25th March we pitched a camp on the west side of the Whitcombe River, near the Cropp junction. From this point we explored the upper valley of the Cropp and the south-eastern slopes of Mount Bowen, where, near some remarkable outcrops of serpentine and dunite belonging to the Pounamu Formation, we placed a flying camp. The mountain itself, which forms a rather conspicuous dome 6,516 ft. in height, and is the most northerly snow-clad peak of the Lange Range, was ascended on the 4th April.

About the middle of April camp was shifted to the upper part of the Mikonui Valley, where it was necessary to complete some work left unfinished the previous season, largely owing to a spell of bad weather. We were again unfortunate in the weather, but before the end of the month had completed the survey of the Mikonui watershed.

After spending two days in exploring Farmer Creek and other eastern tributaries of the Totara River, we shifted the main camp on the 1st and 2nd May to the Kakapotahi or Little Waitaha River, twelve miles south-west of Ross. From this base we surveyed the valley of the Kakapotahi, Mount Rangitoto, the lower Waitaha Valley, Duffer Creek, &c. The sea-coast was traversed from the mouth of the Mikonui to the Wanganui River, a distance of about twenty miles. An interesting piece of work was the sounding of Lake Ianthe, a pretty little sheet of water with an area of somewhat less than two square miles. The maximum depth of the lake when in its ordinary condition was found to be 105½ ft., but since the lake rises several feet during periods of heavy rainfall, its greatest depth at such times approaches 110 ft. Only a small part of the lake is over 100 ft. deep, and the greater part is less than 20 ft. in depth.

On the 5th June camp was broken up, and field-work for the season terminated.

Early in November field-work was resumed in Westland. My first work was at the main camp which had been established by my chainman, Mr. John Hooker, in the Waitaha Valley, a mile or more beyond the last settler's homestead. At the time of my arrival in camp the field party had made considerable progress with a compass-and-chain traverse up the Waitaha. We found this little-explored river extremely gorgy from the point where it enters the alpine chain, and above the junction with Kensington River a reach of about five miles proved very difficult to traverse. A great deal of track-cutting was necessary over the various gorges and bluffs, whilst the transport of camp-material and food involved much climbing with heavy loads, as well as travelling over some very rough river-bed.

Towards the middle of December, Mr. J. A. Bartrum, M.Sc., now Assistant Geologist, joined me as field assistant. After my departure for Wellington in March, 1908, Mr. Bartrum took charge of the party, and continued field work, as mentioned below, until the beginning of the winter season.

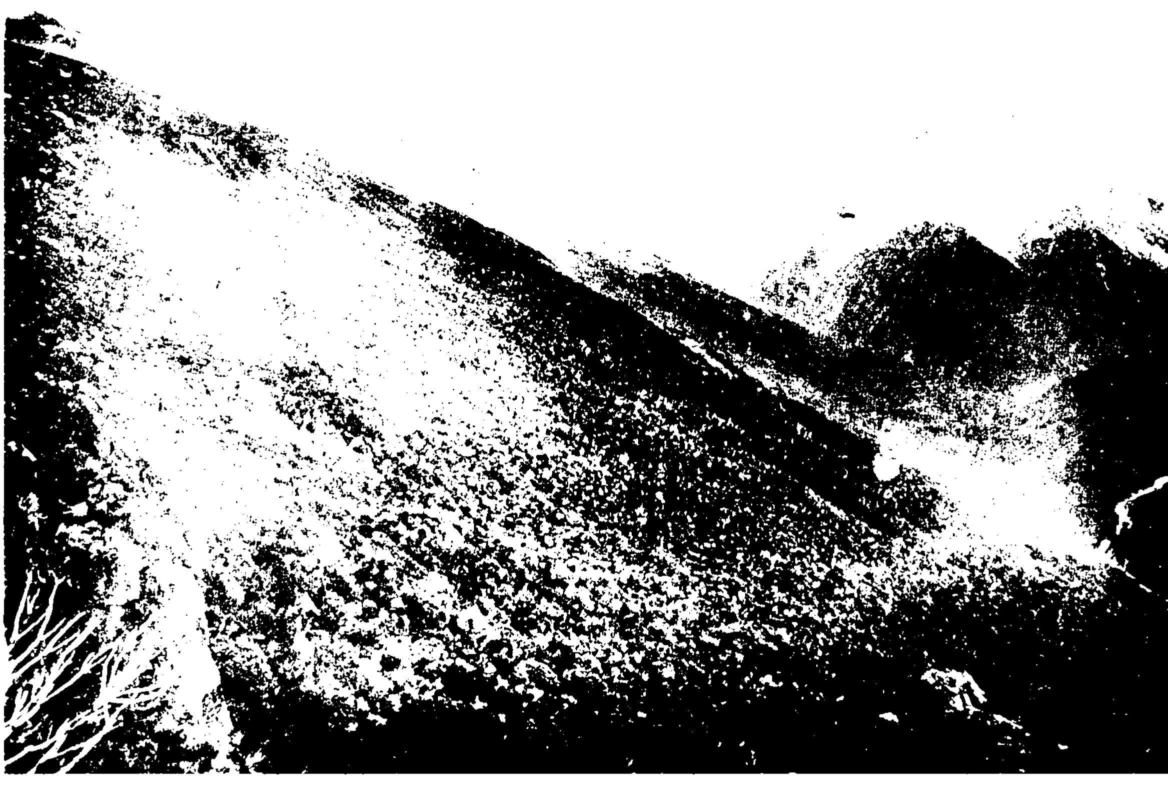
In order to reach the head of the Waitaha, a distance of about 13½ miles from the main camp, no less than four flying or temporary camps, each in advance of the preceding camp a distance of from two to four miles, were necessary.

The excellent weather which set in just before Christmas enabled us to finish the traverses of the Waitaha and some of its tributaries during the third week of January, 1908. The mountain-tops, however, were almost constantly enveloped in cloud, and in consequence I was not able to get as many cross-bearings for checking positions and filling in topographical details as were desirable. I may add that all through the summer cloud and fog proved great drawbacks, and even in the finest weather the mountains, though perhaps visible in the morning, generally disappeared before mid-day. However carefully we might select our day, we were more or less disappointed four times out of five, if not oftener, on climbing a peak or ridge for the purpose of taking cross-bearings, &c.

On the 20th January of this year we shifted our main camp to the north bank of the (Big) Wanganui River, near Hende's Ferry. From this base we established a number of minor camps and explored almost the whole watershed of the Wanganui from its glacier source to its mouth. Until the last day of February fine weather prevailed, there being only one spell of heavy rain, and we were able to survey the whole of the district within reach of the main camp, as well as to carry a chained traverse over fifteen miles in length from a point four miles above our camp almost to the névé of the Evans Glacier, the source of the Wanganui River. In addition a number of minor streams were surveyed by paced traverses.

On the 1st March heavy rain set in, and for a period of nearly three months no settled weather was experienced. Fortunately we had shifted from our top camp to one lower down the river the

* See Bulletin No. 1 (New Series), N.Z. G.S., p. 38.



afternoon before the weather broke, or else we should have been cut off from food-supplies for nearly a week. As it was we had considerable difficulty in making our way down the bank of the flooded river to our main camp.

In order to complete the survey of the Mikonui Subdivision a visit to the mouth of the Wanganui was required, but this could not be accomplished for over a week owing to the flooded state of the river. Finally, however, the necessary work was done, and on the 16th March, leaving Mr. Bartrum in charge of the party, I left camp *en route* to Wellington in order to prepare my report.

The fine weather which prevailed during January and February led me to hope that the whole of the southern part of the Wanganui watershed (in the South Westland Division) could be geologically and topographically surveyed before the close of the season. In order to traverse the watersheds of the Lambert, the main affluent of the Wanganui, and of its tributaries the Lord and the Adams, fine weather and a very low condition of the water in the streams are essential. Usually, however, these conditions obtain only in the dead of winter, when frost and snow would prevent detailed or complete work being done. It is possible, however, for ideal conditions to prevail when a fine autumn follows a good summer. In the hope that this might be the case, Mr. Bartrum was instructed to proceed with the survey of the Lambert and its tributaries, as well as of some other streams on the south side of the Wanganui.

After much trouble, occasioned by adverse weather and the difficulty of fording the Wanganui, a camp was established in the fork between this river and the Lambert. Mr. Bartrum carried a chained traverse some distance up the south bank of the Lambert, but on coming to a deep gorge was forced up by the precipices to a point above the bush-line, overlooking the inaccessible U-shaped valley of the Lord. Descent into the Lambert Valley from this point was also impracticable. Owing to both the Lambert and its northern tributary the Adams being unfordable, no route was available on the north side of the former river. Early snowfalls made the mountains difficult and dangerous to traverse, and on the approach of the winter it was deemed advisable to recall Mr. Bartrum from Westand. In April and May during intervals in his attack on the Lambert he had traversed the smaller southern tributaries of the Wanganui.

It is now evident that unless a most unusually favourable set of conditions should prevail, a detailed survey of the Lambert watershed is impossible without going to great expense in providing boats and cutting tracks.

Area of Country examined.

The country traversed during the progress of the field-work has already been indicated. The area surveyed in detail includes nearly the whole of the Waitaha and Big Wanganui watersheds, as well as the greater part of the Hokitika watershed, and amounts to over four hundred square miles. Much of this was not only surveyed geologically, but also topographically.

Physiography.

Probably quite three-fourths of the area examined is high mountainous country belonging to the alpine range, and includes such peaks as Park Dome (7,688 ft.), Artist Dome (7,061 ft.), Mount Bowen (6,516 ft.), Red Lion (7,941 ft.), Mount Evans (8,612 ft.), Mount Louper (8,164 ft.), Mount Whitcombe (8,656 ft.), and many others over 7,000 ft. in height, all far above the permanent-snow line.

The marked uniformity of the summits, more particularly on the Canterbury side of the main divide, points to the former existence of a peneplain over the whole alpine area, of which the Wainihinihi peneplain described in the "Hokitika Bulletin,"* probably formed part. The complications produced by faulting, unequal uplift, and irregular erosion render it difficult to determine whether peneplaination was ever complete or not. Further references to this subject will be found in the bulletin on the Mikonui Subdivision now being prepared.

The main river-valleys are deep, and, in some cases, gorgy, with steep grades, but without waterfalls of any size. The larger tributaries may join at grade, but these and tributaries of medium size as they are ascended enter deep gorges with waterfalls or steep grades, which at heights of 2,800 ft. to 3,000 ft. open out into wide flat hanging valleys. These have evidently been excavated by ice, or at least owe their main features to glaciers. Most of the minor streams, as well as the larger rivers, have glacier sources, maintained by snowfields of considerable size.

The lower portions of the major river-valleys were once occupied by enormous glaciers, but stream erosion has gone on to such an extent since the retreat of the glaciers that characteristic glacial topography has almost disappeared in many places. It is believed that during recent times a considerable amount of warping and perhaps faulting accompanied by uplift has taken place in the area. From these causes probably result many of the gorges and most of the rock basins which are so common in the main river valleys.

The lowland country examined includes the lower Waitaha Valley, where there are five or six thousand acres of good agricultural land, and the Wanganui Plain, a much larger area suitable for settlement. The most interesting feature of the lowlands is presented by the old morainic deposits, which cover a comparatively large area, more particularly in the Waitaha Survey District. Towards the Wanganui River the morainic hills rise to heights of over 1,000 ft., and reach the sea-coast, where they present lofty cliff-faces to the ocean. These remarkable deposits are referred to the ancient Wanganui Glacier, which must have been of enormous dimensions. Further north is Bold Head, an isolated hill over 400 ft. in height, formed of moraine deposited by the old Waitaha Glacier, which also reached the present sea-coast.

* Bulletin No. 1 (New Series), N.Z. G.S., 1906, p. 26.

General Geology.

The rocks of the Mikonui Subdivision have been classified according to the following table:—

Formation or Series.	Content.	Age.
Arahura Series	Gneisses, mica-schists, grauwackes, argillites, &c.	Probably Carboniferous and older.
Greenland (Maitai) Series ..	Grauwackes and argillites.	Probably Carboniferous.
Koiterangi Series	Conglomerates, grits, shales with coal-seams, limestones	? Eocene-Oligocene.
Upper Miocene Beds ..	Conglomerates, grauwackes, grits, sandstones, clays.	
Pliocene, Pleistocene, and Recent Beds	Older and younger river-gravels, morainic gravels, marine gravels, &c.	
Pounamu Formation ..	Dunite, serpentine and allied rocks ..	?Early Eocene.
Tuhua Formation.. ..	Biotite-granites and allied rocks ..	?Early Eocene.
Basic Dykes	Many varieties of basic dyke rocks ..	Middle or Early Miocene.

With reference to the ages of the various formations it should be explained that, with the exception of the fossils already mentioned, there is no palæontological evidence by which to fix the age of the Palæozoic formations. The Koiterangi Series may be correlated with the coal-measures of the Grey and Buller valleys, but in the absence of satisfactory age-proof of the latter beds it is not certain that the age of the Koiterangi Series has been accurately determined.

The age of the Tuhua and Pounamu formations is considered to be substantially the same as that of the first major uplift of the Alps, which probably immediately preceded the deposition of the Koiterangi rocks. An older date is possible, but no real evidence of such could be obtained.

Distribution.—The Arahura Series forms nearly the whole of the alpine range, whilst the Greenland Series forms most of the foothill country between the Hokitika and Kakapotahi (Little Waitaha) rivers. The Koiterangi and Upper Miocene beds occur in small patches in or bordering the foothill country, whilst the Pliocene and younger beds form the lowlands. The rocks of the Pounamu Formation exhibit sills or dykes in the horizon of the middle schists (Arahura Series), whilst those of the Tuhua Formation occur as large bosses penetrating the Arahura gneisses and the rocks of the foothill area. The basic dykes occur chiefly in the granitic and gneissic rocks.

Structure and other Features.—It is needless here to describe the structural and other general features of the various formations, for these have already been dealt with in the Hokitika Bulletin,* and, as regards the Mikonui area, will be further elaborated in Bulletin No. 6, which is now in the press, and will shortly be published.

Near the Mungo Saddle many silicified tubes of *Torlessia mackayi* were seen in the talus, and a short distance to the north I found this fossil annelid in solid argillite on both sides of the alpine divide. Associated with it were the curved and ribbed silicified tubes of probably a species of *Dentalium*.

Economic Geology.

The economic geology of the country examined during the period covered by this report may be briefly considered under the headings of (1) Metalliferous Veins of the Arahura and Greenland Series; (2) Asbestos and Talc; (3) Building and Ornamental Stones, Clay, &c.; (4) Alluvial Gold.

(1.) *Metalliferous Veins of the Arahura and Greenland Series.*—In the rocks of the Arahura Series very few metalliferous veins were noted during the year. With the exception of the lodes on the Whitcombe Pass track mentioned in my last report, all the quartz veins examined proved worthless, but it is interesting to note that pyritic veins and segregations occurring in the vicinity of the Pounamu Formation were found to contain gold, silver, platinum, and copper, though in less than payable quantity.

The rocks of the Greenland Series which occur in the neighbourhood of Mount Rangitoto were carefully examined, and several small lodes carrying traces of gold and copper were located. As close an inspection was made of the workings of the old Rangitoto Silver-mining Company as their condition would admit. The vein opened up by this company is at the outcrop less than 6 in. thick, and dips flatly to the north-north-west. The enclosing rock is grauwacke, but the dip observed would carry the lode into granite at no great distance from the outcrop. The lode-matter is quartz, densely impregnated with pyrite, and carrying also some galena. Samples taken from the outcrop and from a heap of loose ore near the mouth of the main adit assayed as follows:—

	Outcrop.	Ore-heap.
Gold	1 oz. 5 dwt. 5 gr.	1 oz. 3 dwt. 22 gr. per ton.
Silver	4 oz. 16 dwt. 9 gr.	1 oz. 5 dwt. 23 gr. ,,
Lead	1·37 per cent. ..	0·23 per cent.
Copper	Nil	Nil.
Zinc	Nil	Nil.
Value of gold and silver ..	£5 12s. 6d. ..	£5 1s 2d. per ton.

* Bulletin No. 1 (New Series), N.Z. G.S., 1906.

The vein is evidently valueless as a silver-lead proposition, but its gold-content deserves notice. An examination by a capable prospecting party is warranted, more particularly since the lode is stated by Cox, who examined it in 1876, to have a thickness of 10 in. in the old workings.* It should be mentioned in this connection that the ground held by the old Rangitoto Company is in private hands, and cannot be prospected without the owners' permission.

(2.) *Asbestos and Talc.*—Small amounts of asbestos of fairly good quality were found in pockets and veins in the Mount Inframeta and Mount Bowen serpentines. Extremely pure talc occurs in similar deposits, but a wide band of talcose rock which outcrops to the west of the serpentine sills on Mount Bowen is too impure ever to be of much value, even were the locality an accessible one.

(3.) *Building and Ornamental Stones, Clay, &c.*—The rocks of the Pounamu Formation are often ornamental, but are at present of little economic value, owing to the inaccessibility of the localities in which they occur. The granites of Mount Rangitoto and Purcell Ridge are of good quality, but there does not appear to be any likelihood at the present time of their being utilised as building or monumental stones.

Several of the clays which occur near Ross were examined during the past year, and samples taken for analysis. None, however, proved to be suitable for the manufacture of pottery, though the Upper Miocene blue clays are doubtless capable of making good bricks.

(4). *Alluvial Gold.*—In the valley of the Mungo and in the Upper Hokitika and Whitcombe a few colours of gold can be obtained almost everywhere, but there are probably no really payable deposits. Good gold, however, can be obtained from the bed of the Upper Hokitika about two miles above the Mungo junction, and small payable beaches form from time to time in the lower Whitcombe and along the course of the Hokitika below the Whitcombe junction. In the Waitaha and Wanganui watersheds alluvial gold was found as the colour only. The only claim in which work was going on is that of the McLeod's Terrace Sluicing Company, on the west side of the Mikonui River. The washdirt of this claim resembles that of the Mont d'Or (near Ross), and gives good prospects, apparently over a considerable thickness, but the results obtained from the working of the claim have hitherto been disappointing.

Duffer Creek, eighteen miles south of Ross, is worked out, whilst a sluicing claim at the north end of Lake Ianthe, which has yielded gold to the value of £1,700, was abandoned as unprofitable a few years ago.

It is only in connection with the deep leads near Ross that there appears to be any probability of a successful mining revival within the Mikonui Subdivision. This point is enlarged upon in the detailed report now being prepared.

Water-power, River-gauging, &c.

Within the next fifty or one hundred years water-power will prove to be one of Westland's most valuable assets, and even now there are certain possibilities connected with the conversion of hydraulic energy into electricity in connection with power purposes and the manufacture of nitrates from atmospheric nitrogen.

From the Hokitika River above the Whitcombe junction a considerable amount of energy can be obtained, whilst the Whitcombe, a much larger stream, is capable of yielding at least 30,000-horse power. Before entering on any power project, however, it will be necessary to determine the winter flow, which may prove to be so scanty during periods of fine frosty weather as seriously to militate against the utility of any scheme that requires a constant supply of energy. Moreover, in the case of the Whitcombe, though water for a considerable scheme will never be lacking, development will be relatively expensive, and probably economically unprofitable.

Both the Waitaha and the Wanganui, the two principal rivers surveyed during the past season, are capable of furnishing large supplies of energy. The former river and its tributaries, it is estimated, can supply not less than 75,000-horse power, whilst the Wanganui and its branches are capable of furnishing at least double that amount. If there were any demand for power, some of the possible schemes could be easily and cheaply developed. Probably, however, it will not be economically advisable for several generations to come, if ever, to develop the power-potentialities of the main Wanganui.

The calculations of the horse-power mentioned have been based on a minimum winter flow estimated at one-half or less of the minimum summer flow. Our gaugings were all made in the latter part of the summer or in early winter, but though during cold fine weather the stream-volumes certainly diminish considerably, it is probably but seldom, and then only during short periods, that the minimum winter flow is less than that assumed. Certainly, during the past three seasons the rivers have not been noticed to fall much below the minimum summer level until the month of June is well advanced.

Office-work.

From the 12th June, 1907, until the 26th October I was engaged at the Head Office in preparing notes for a report on the Mikonui Subdivision, in reading the proofs of Bulletin No. 3 and other publications, whilst from the middle of July onwards I was also engaged in attending to the general correspondence of the office and other departmental matters during your temporary absence from the Dominion.

Again, from the 18th March of the present year until the end of May I was employed in preparing a detailed report on the Mikonui Subdivision, which is to be issued as Bulletin No. 6. The manuscript was practically completed before the end of May, and is now all in the hands of the printer. A considerable portion is in type, and the bulletin should be ready for publication before many months.

* "Report on Westland District," Geol. Surv. Rep. during 1874–76; Vol. ix, 1887, p. 87.

Mr. Colin Fraser, Mining Geologist.

During the period under review Mr. Colin Fraser has been almost continuously engaged in field and office work connected with the detailed survey of the Hauraki Division, Auckland. From January, 1907, until the beginning of April Mr. Fraser was occupied in completing the detailed survey of the Coromandel Subdivision. Assisted by Mr. J. H. Adams, he then undertook the preparation of a bulletin (No. 4) on this area. In this, with other office-work, he was occupied at headquarters till the middle of November, when he left to begin the geological survey of the Thames Subdivision, lying south of the Coromandel Subdivision. Towards the end of April I joined Mr. Fraser, and till the end of May personally supervised the field-work being conducted by him. In this work, with the exception of a short period during which he accompanied me on a reconnaissance through the Tairua-Puriri Goldfields, he has been engaged until the close of the field season at the end of May. The work in the Thames Subdivision is in a forward condition, and it is hoped that towards the end of next season Mr. Fraser and myself will be in a position to begin the preparation of a bulletin on the area. The following is Mr. Fraser's report on his work during the past seventeen months:—

Field-work in the Coromandel Subdivision, Hauraki.

The portion of the Coromandel Subdivision which in 1906 occupied the attention of the Hauraki field staff was confined to the Coromandel and Otama survey districts. These districts, together with those of Harataunga, Colville, and Moehau, which lie immediately to the northward, constitute the Coromandel Subdivision, and, having been described in detail in Bulletin No. 4,* call for no further reference here.

Field-work in the Thames Subdivision, Hauraki.

Extent and Position of the Area.—During the past season geological field-work has been carried out in both the Hastings and Thames survey districts, which together constitute the Thames Subdivision. These two survey districts, which together cover an area of some 239 square miles in extent, extending from Kirita Bay in the north to the Puriri Valley in the south, comprise the western half of the southern portion of the Hauraki Peninsula, and include also a contiguous portion of the mainland. The eastern boundary of this subdivision is a north-and-south line which passes through the central portion of the peninsula, and intersects Trigonometrical Station 97 on Table Mountain; the western limit is in part the coast-line of the peninsula bordering the Firth of Thames, and further southward a straight line passing meridionally across the Piako Plains from a point west of the mouth of the Piako River.

The portion of the Thames Subdivision already examined lies for the most part northward of a line drawn from the village of Tapu, on the western coast-line, to the trigonometrical station on Table Mountain. Detailed geological examinations have also been carried out in the special area of Thames Borough; within the watershed of Tararu Creek; and also along the coastal belt immediately to the northward.

Nature of the Work carried out.

The nature of the geological, topographical, and mineral prospecting work carried out in the Thames Subdivision is precisely the same as that described in connection with the neighbouring Coromandel area in the annual report of 1907.

The preparation by the Head Office draughting staff of accurate working-maps on a scale of 20 chains to the inch, showing the trigonometrical stations and topographical data supplied by the Lands and Survey Department, has greatly facilitated the plotting of the field-work. The valuable contour-map of the Thames mining centre, prepared by Mr. E. F. Adams, authorised surveyor, will be of great service. The gentleman named has also kindly placed at our disposal information and records connected with the underground workings of the Thames field which otherwise would be unobtainable.

Physiographic Notes.

The Thames Subdivision is in the main one of considerable general elevation, and is deeply dissected by the numerous streams which drain to both the eastern and the western coast-lines of the peninsula. The dominant physiographic feature is the Cape Colville Range, which forms the principal drainage-divide of the Hauraki Peninsula. This range, from the point where it enters the northern part of the subdivision, has a sinuous though generally southerly trend for a distance of about twelve miles, parallel to the longitudinal extension of the peninsula. Thence the main water-parting turns sharply to the eastward, and following the elevated volcanic plateau of Table Mountain continues for about two miles beyond the eastern boundary of the area. Here it once more assumes its southerly trend, in places approaching, but nowhere crossing, the eastern boundary-line of the subdivision. On this range, which has a general elevation of about 1,700 ft., Papakai (2,497 ft.), Maumaupaki (2,688 ft.), and the steep-sided flat-topped Table Mountain (2,600–2,700 ft.) are conspicuous peaks.

The numerous streams which incise the flanks of the Cape Colville Range usually present very high gradients for relatively short distances from their points of origin, but in their middle and lower courses they descend more gradually towards base-level.

Numerous spurs and subsidiary ridges have been developed as the result of stream dissection, while, as might be expected in an area formed in great part of comparatively recent volcanic rocks, groups of hills showing little definite arrangement are not uncommon.

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* Bulletin No. 4 (New Series), N.Z. G.S., 1907.

The only really large area of low-lying country (32 square miles) lies in the extreme south-western part of the subdivision, and is but a portion of the coastal fringe of the comparatively extensive plains of the Thames and Piako rivers. Small isolated areas of flat land occur as flood-plains along the main streams of the subdivision, and also as narrow belts, which here and there fringe its coast-line.

The coast-line of the part of the Hauraki Peninsula included in the Thames Subdivision is fairly straight, showing no deep indentations, and consequently natural harbours are poor. The safest anchorage is afforded by the tidal portion of the Thames River, in which there is a considerable depth of water.

General Geology.

General Classification of Rock-formations.—The following classification of the rock-formations occurring in the portion of the Thames Subdivision already examined is based on that adopted in Bulletin No. 4, dealing with the Coromandel area. Further petrographical examination of typical rock-specimens is, however, necessary for the more precise delineation of the boundaries of certain of the volcanic formations:—

(1.) Pre-Jurassic and Jurassic stratified rocks.
(2.) Tertiary volcanic rocks of the "First Period."
(3.) " " "Second Period."
(4.) " " "Third Period."
(5.) Intrusive rocks of various periods.
(6.) Loosely consolidated and unconsolidated débris.

(1.) *Pre-Jurassic and Jurassic Stratified Rocks.*—Rocks exhibiting megascopically a striking lithologic resemblance to certain of those included in the Tokatea Hill Series of the Coromandel area, and therefore tentatively correlated with them, are apparently the oldest beds exposed in the Thames Subdivision. These rocks consist of grauwackes and argillites, containing in places interstratified beds of altered rhyolitic material. They are found in the upper valley of the Manaia Stream as a small exposure continuous with an area mapped in the Coromandel Subdivision, and further southward as isolated patches in the valley of Tapu Creek, and at Rocky Point near Thames. These rocks, which have yielded no fossils, are apparently unconformably older than the Jurassic sedimentaries next to be described.

The Jurassic sedimentaries consist of fine conglomerates, grits, and argillites (Manaia Hill Series of Bulletin No. 4), and cover a fairly large area extending southward from the Manaia Valley to and a short distance beyond Te Mata Stream. The rocks are well exposed on the actual coast-line, and at several localities between Kirita Bay and Waikawau have yielded Jurassic fossils (*Belemnites* sp.) similar to those described from Manaia Hill (Bulletin No. 4). The fine conglomerates characteristic of the series again occur a short distance to the south of Rocky Point, Thames.

All the stratified rocks above described have undergone considerable folding, and are disposed at high angles. Followed eastward from the coast-line they are found in places to attain an elevation of about 1,400 ft. before passing under the Tertiary volcanic rocks which form the main range.

(2.) *Tertiary Volcanic Rocks of the "First Period."*—As in the Coromandel Subdivision, the volcanic rocks of the "First Period" are those of greatest importance, containing as they do almost all the payably auriferous quartz veins. These volcanics consist wholly of andesitic and dacitic tuffs, breccias, and lavas, no rhyolitic rocks referable to this series having as yet been identified in the Thames area.

As regards the distribution of these rocks, it is here sufficient to remark that over a considerable stretch of country from the headwaters of the Manaia and beyond the Town of Thames, they either flank or overlie to unascertained depths the Jurassic and Pre-Jurassic sedimentaries. Continuous with this major area they have extension in places to the summit and eastern flanks of the main range.

(3.) *Tertiary Volcanic Rocks of the "Second Period" (Beeson's Island Group).*—These rocks, which are all andesitic or dacitic in character, occur as lavas, tuffs, breccias, and agglomerates. Heavy fragmental material (agglomerate) is rather characteristic of the pyroclastics of this series. The lavas, on petrographical examination, are found to be on the whole less crystalline than those of the older period—that is, they more frequently exhibit the hyalopilitic type of groundmass.

Within the area already examined these rocks are found on the western side of the main range in the hilly country lying beyond the northern limits of the watershed of the Waikawau River, and again in the upper valleys of Te Mata and Tapu streams. On the eastern side of the divide they have considerable development within the watershed of the Waiwawa River and the Unuaroa Stream, and from here are probably continuous across the main divide into the valleys of Te Mata and Tapu streams.

(4.) *Tertiary Volcanic Rocks of the "Third Period."*—The rocks grouped under this heading are altogether acidic in character, consisting of rhyolitic tuffs, breccias, and lavas.

Within the area examined they are confined to the eastern side of the main water-divide, extending from the valley of the Unuaroa in the north to and beyond the trigonometrical station of Table Mountain in the south. They overlie an older eroded surface of the older volcanics, from which they are separated in many places by seams of impure coaly material and partially carbonised wood. The rhyolitic lavas and tuffs show more or less stratification, and are generally disposed horizontally, or at low angles to the horizon.

(5.) *Intrusive Rocks of Various Periods.*—Intrusive rocks of semi-basic character associated with the extrusive andesites are unrecognisable, or recognisable only with difficulty. This is mainly due to the general similarity in character of the intruded and intrusive rocks, and to the widespread alteration and decomposition which all the rocks exhibit. Dykes associated with the sedimentaries are more easily detected.

By far the largest and most conspicuous intrusive belt in the whole area is that which forms Table Mountain and a portion of the flat-topped range immediately to the north-eastward. The rock, which is a hyalopilitic hypersthene-andesite of black lustrous appearance, shows marked columnar structure, and, being intrusive into rhyolites, is probably the youngest or one of the youngest of the igneous rocks of the peninsula.

On the western coast-line between Waikawau and Te Mata streams several dykes of hornblende- and hypersthene-andesites intrude the Jurassic sedimentaries; while similar rocks and others of more crystalline character—porphyrites—occur within the drainage-areas of Tapu and Manaia streams.

(6.) *Loosely Consolidated and Unconsolidated Débris.*—The fluviatile muds, sands, and gravels which form the flood-plains of the various streams are the most important of the deposits coming under this heading; while next in order of abundance are the littoral deposits of the eastern and southern shores of the Firth of Thames. Brief reference has been made in the physiographic notes to the localities where the major areas of such deposits occur.

Economic Geology.

The economic branch of my work within that portion of the Thames Subdivision already examined may be briefly discussed under the following headings:—

(1.) Gold-silver quartz veins.
(2.) Coal.

(1.) *Gold-silver Quartz Veins.*—The only metalliferous deposits which have been or are now being worked within the area already examined are gold-silver quartz veins, and, in one or two instances, the small patches of auriferous fluviatile gravels which have resulted from their erosion. The payable veins occur in the Tertiary volcanic rocks of the "First Period," and much less frequently in the underlying sedimentary rocks. The quartz veins associated with the younger volcanics in this particular area are of no economic importance.

The andesites and dacites in the vicinity of the veins have invariably undergone alteration to the propylitic facies, while the sedimentaries also exhibit alteration due to the same agencies as those which have effected the propylitisation of the volcanics.

Special attention has been given to the mapping of the auriferous belts occurring within that portion of the subdivision examined in detail. It would appear from indications which have been noted that the discovery of payably auriferous areas altogether independent of those already known is unlikely.

Manaia.—Within the Manaia Valley the veins occur in the stratified rocks of the Tokatea Hill Series, and in the propylitised andesites which here overlie them. The stratified rocks at Manaia, with which are associated numerous intrusives, bear a striking resemblance to those which constitute the country rock of the Royal Oak and neighbouring mines of Tokatea Hill. In the Golden Hill (Old Victoria) Mine, on the south side of the lower Manaia Valley, rich "specimen stone" has been obtained from time to time, but, as further development would entail the cost of shaft-sinking and pumping, this prospecting venture has been abandoned. It would seem that the Manaia Valley in general has not received the attention from those interested in mining that the nature of its rock-formation and its general prospects warrant.

Waikawau.—Southward of the Manaia the country lying between the western coast-line and the crest of the main range affords no mineral indications until the upper valley of the Waikawau is reached. Here detrital gold is obtainable over a limited area of country extending from McLaughlin's Freehold to Hunt's Creek, on the north side of the valley. Near the right bank of the Waikawau on McLaughlin's Freehold the hanging-wall portion of a vein or mineralised zone of unascertained dimensions, associated with grits and argillites, is exposed. A general sample of the available material, which was highly pyritised, showed on analysis,—

Gold	0 oz. 4 dwt. 10 gr. per ton	Value, £1 4s.
Silver	2 oz. 13 dwt. 12 gr. ,,	

Further prospecting of this vein is advisable, considering that along its supposed northerly strike very finely divided gold is obtainable from the hillside débris as far as the headwaters of Wakarewa Creek. In Hunt's Creek the marks of the prospector of the early days are noticeable; prospects of gold obtainable from the creek-débris led to exploration of the valley, without, however, payable results forthcoming. Compact vein-quartz is here rarely encountered, and mineralisation seems to have been mainly confined to silicification of the andesites along certain narrow zones of fracture, with the introduction of pyrite and to a less extent of stibnite. The highest assay obtained for gold-silver (5s. 10d. per ton) was afforded by a 10 ft. vein formation crossing the creek at the waterfall about half a mile from the junction of Hunt's Creek with the main Waikawau Stream.

Te Mata.—In Te Mata Valley one or two small streams entering from the south, and incising the Jurassic grits and argillites of the lower part of the valley, carry a few fine "colours" of gold, but the main auriferous area is confined to the propylitised andesite belt of Gentle Annie Creek and its vicinity. This creek, which was in the early days sluiced almost to its head, afforded a considerable amount of detrital "specimen quartz" and gold, but all efforts to find the source of the precious metal have proved futile. A large, well-defined vein, striking about north and south and carrying quartz of unfavourable flinty appearance, is traceable within the creek-valley for a distance of at least 25 chains. Assays of general samples from several portions of the vein were made, but showed a gold-content ranging only from 1 gr. to 8 gr. per ton, and silver from 1 dwt. 5 gr. to 1 dwt. 21 gr. per ton. Other small non-persistent veins occur, carrying where exposed equally low values. Whether the erosion of the upper horizon of those veins already located or of veins concealed beneath the heavy overburden of surface débris afforded the alluvial gold is impossible to determine. The fact that no samples of the "specimen quartz" won from the sluicing operations of the past could be obtained for comparison with the quartz of the veins exposed renders the problem even more difficult.

The mullock-dumps of several small drives are noticeable on the hill which rises from Te Mata Stream immediately eastward of the Gentle Annie Creek junction. Some of the drives which are still open show small non-persistent rubbly quartz veins, carrying little or no values. A small crushing and amalgamating plant was erected at the foot of this hill, but on what prospects it was impossible to determine.

Tapu.—The valley of Tapu Creek, although at present commanding little attention from a mining point of view, yielded in the past a considerable amount of gold, partly from veins and partly from the sluicing of hillside talus and stream-débris. In the lower portion of the valley the auriferous-quartz veins which have proved remunerative are genetically connected with a main line of faulting, and occur both in the stratified rocks (Tokatea Hill Series) and in the overlying volcanics. The fault or "main slide" strikes south-east from McIsaac's Claim in the No. 3 Gully, and has been located in the Golden Point, Sheridan, and Bullion claims. The veins, which were all of the bonanza type, ranged in width from a fraction of an inch to 4 ft. Very few have been worked, and none extensively developed below the adit levels. Presumably the ore-shoots became small or unremunerative in depth; but since rocks of the Tokatea Hill Series (lithologically similar to the spotted rhyolitic tuffs which have enclosed rich gold-silver veins on the Tokatea Hill, Coromandel) outcrop in the gorge of Tapu Creek not far from the main fault-line, there is no reason why other remunerative veins should not be discovered, either in these rocks or in the overlying andesite along the course of this line.

Another area of mineralisation is that in which the Mahara Royal and other claims on the southern side of the Tapu Valley below the main fork of the stream are located. The gold-silver veins here, which are of the usual bonanza type, are enclosed in propylitic andesites.

The occurrence of a different type of andesite (probably of the Beeson's Island Series) in the Tapu Valley, eastward of the main forks of the stream, probably explains the non-auriferous character of the relatively extensive area of country at the headwaters of Tapu Stream. The same rocks have continuous extension northward from the Tapu Valley into the Te Mata Valley.

Areas Southward of Tapu Stream.—As yet topographical work only has been carried out in the valleys of the Waiomo and Te Puru streams, and consequently no remarks can here be made on their geology.

Eastern Side of the Main Range.—The areas already described in this section lie to the west of the main range. On the eastern side of the range a careful examination for the presence of metalliferous veins has been made of the relatively large and in places rather inaccessible stretch of country extending from the Kaimarama Valley in the north to the source of the Waiwawa River on Table Mountain Range in the south. Without entering on a detailed description, it may be stated that, with the possible exception of the Upper Kaimarama Valley, where the rock-formation and vein-occurrences are analogous with those of the adjoining upper Mahakirau Valley of the Coromandel Subdivision, the results of our examinations do not favour the opinion that payably auriferous veins will be discovered in this particular area. In assigning reasons for the poverty of the area in economic minerals, the great development of the Beeson's Island Series of andesites, which throughout the whole peninsula contain few payable metalliferous veins, must be considered. Rhyolitic rocks and younger andesitic intrusives, neither of which are favourable for the existence of metalliferous veins, are also present.

Special Area within the Thames Borough.—At the Town of Thames geological work has been confined to making a preliminary reconnaissance of the area, and to a detailed survey of that portion including the Day Dawn and Norfolk, New Sylvia, and other mining claims, lying within the watershed of Tararu Creek. The work is, however, not sufficiently advanced to give expression to any conclusions which may have been drawn from the observations made.

(2.) *Coal.*—Within the area under review the discovery of coal-seams supposed to have some economic value has from time to time been reported. All of these, on examination by officers of the Survey, were found to occur at the contacts of volcanic accumulations of different periods of eruption. These seams, as might be expected from the fact that they overlie old eroded land-surfaces, or occur in local silted depressions which existed thereon, have little persistence or regularity. In view of this, and the fact that the coal-bearing rocks of the Torehine Series (of Coromandel Subdivision) do not exist in the Thames Subdivision, it is unlikely that workable coal-seams will be found in this area.

Stream-gauging and Water-power.

The streams of the area, owing to the relatively short distances of any portion of the water-parting from the sea-coast, normally carry rather small volumes of water. Further, their gradients, as mentioned before, are low usually right back to the junction of the rapidly descending headwater branches. These characteristics render the streams unimportant as the sources of any considerable amount of water-power.

The largest stream in the area is the Waiwawa River, flowing into Whitianga Estuary on the eastern coast-line. No measurements of any value bearing on the volume of this river could be obtained by us during the whole period that we were camped in its valley, owing to its continually swollen state as the result of constant rains. It may be stated, however, that the potentialities of this stream as a source of water-power are discussed in a special departmental report entitled "Electrical Power for Mining Machinery at Kuaotunu and Thames," by Thomas Perham.*

The Waikawau Stream and the Te Mata Stream, both on the western side of the peninsula, were gauged when each ran at its minimum volume. The points selected were in each case just below the junction of the lowest large tributary with the main stream. The Waikawau showed a discharge of 330 and the Te Mata of 135 cubic feet per minute. It is proposed to ascertain under comparable conditions the volumes of all the major streams on the western side of the peninsula from the Manaia to the Kauaeranga. The volume of two representative streams at the end of a period of drought having been ascertained, the minimum discharges of the others may be approximately calculated on a proportional basis.

Conclusion.

Field-work will be continued in the Thames Subdivision throughout the winter, and should be completed about the end of the present year, when the preparation of a bulletin giving in detail the results of our investigations will be undertaken.

Mr. Edward Clarke, Assistant Geologist.

During the early part of 1907 Mr. Clarke assisted me in the field-work then being conducted in the Parapara Subdivision. From the 12th April to the end of June Mr. Clarke was engaged in assisting in the preparation of Bulletin No. 3. He then accompanied me in a reconnaissance of the Whangaroa Subdivision, North Auckland. Thereafter Mr. Clarke began a detailed survey of that subdivision, and continued operations in the area until the end of May, 1908. He has completed the survey of the greater part of the subdivision, and hopes to bring out a bulletin thereon by the close of the year. Meanwhile he presents the following summary of the work accomplished :—

Work in the Whangaroa Subdivision.

Introduction.—The Whangaroa Subdivision comprises the survey districts of Whangaroa, Kaeo, and Omapere, and extends southward as a strip 12½ miles wide from Stevenson Island, at the mouth of the Whangaroa Harbour, to the settlement of Kaikohe.

Operations have been completed in the Whangaroa and Kaeo survey districts, and in the Omapere Survey District only forty-seven square miles remain to be investigated. Altogether, since the beginning of August, 1907, an area of about 260 square miles has been examined.

Chain-and-compass traverses have been made of all roads, tracks, and streams affording outcrops. Much light is thrown on the geological structure of the northern part of the subdivision by the extensive rock-exposures found along the sea-margin. A careful chain traverse was therefore made of the coast-line of Stevenson Island, and of the shores of Whangaroa Harbour.

The results of these surveys have been transferred on a scale of 20 chains to the inch to large sheets, on which all the data obtainable from the Lands and Survey Department had previously been placed by the departmental draughtsman.

Physiographic Notes.

The Whangaroa Subdivision is in the main an area of mild relief. Only at their headwaters do any of the streams have a steep gradient, and in many cases they are swampy to their sources.

The most striking physiographic features of the area are the deeply indented coast-line and the extensive table-land, known as the Kerikeri Plains, which occupies most of the eastern portion of the subdivision.

The rugged coast, fringed with reefs and islets, and the landlocked harbour of Whangaroa, which, reaching far into the land, is evidently a drowned river-valley, clearly indicate that subsidence has taken place within geologically recent times.

The Kerikeri Plains occupy nearly a third of the subdivision, and extend far beyond its eastern limits. They are traversed by several broad, deep valleys, and above their general level rise a number of hills. Some of these elevations are possibly the highest points of an old land-surface which has been obliterated by lava-flows, while others may be the stumps of the volcanoes from which the lavas issued.

General Geology.

General Classification.—Pending a microscopic examination of the rocks exposed in the area under review, the following classification is tentatively submitted :—

(1.) The Kiriwha Series: Cherty argillites and grauwackes: cherts and agglomerates.
(2.) The Waipapa Series: Argillites and grauwackes.
(3.) The Kaeo Series: Argillites, sandstones, mudstones, and limestones.
(4.) Tertiary volcanics: Agglomerates, tuffs, and lava-flows, chiefly basic.
(5.) Post-Tertiary rocks: Flows and puys, chiefly basic: alluvial deposits.

(1.) *The Kiriwha Series.*—These, apparently the oldest rocks exposed in the subdivision, are exhibited along the coast and on Stevenson or Kiriwha Island in a belt about two miles wide, which is interrupted for about three miles in the neighbourhood of Whangaroa Heads by an outlier of Tertiary volcanic rocks. The rocks of the Kiriwha Series are well-stratified cherty argillites and

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* C.-4, 1893.

PLATE V

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grauwackes, passing in places into cherts. Over considerable areas on the coast south of Whangaroa Heads these rocks are reddened by iron-oxide and impregnated with small seams of manganese-ore, and in places they are intruded and altered by intermediate igneous rocks. Occasionally notable developments of acidic agglomerates and tuffs occur. The beds forming the Kiriwha Series are apparently arranged in an anticlinorium, the axis of which runs west-north-west and east-south-east.

(2.) *The Waipapa Series.*—A series of rocks of probably younger age than the Kiriwha Series is exposed in the south-western portion of the Kaeo Survey District in the watershed of the Waipapa River. This series consists of greenish argillites and grauwackes, which rarely, if ever, show any trace of bedding-planes, but are traversed by several systems of joints, and in places contain seams of manganese-ore. No signs of contemporaneous volcanic activity or of alteration by intrusives have been found in these strata.

A Primary age has been tentatively assigned to the rocks of the Kiriwha and Waipapa Series, but it is quite possible that the age of one or of both of the series just described may ultimately prove to be Early Secondary rather than Primary, as in the case of the Manaia Hill Series of the Coromandel Subdivision.*

(3.) *The Kaeo Series.*—The rocks assigned to the Kaeo Series occupy the southern part of the Whangaroa and the northern part of the Kaeo Survey District—that is, the area separating the two older series of sedimentaries—and also almost all that part of the Omapere Survey District which has so far been examined.

The lowest beds of the Kaeo Series are exposed around the shores of Whangaroa Harbour, and consist of green sandy argillites, with thin inconstant beds of very fine conglomerate. Apparently overlying these beds conformably near the head of Whangaroa Harbour is a concretionary sandstone containing ammonites not yet identified. Superposed on the concretionary sandstones are green sandstones, mudstones, and shales, which are extensively developed in the central portion of the Kaeo Survey District. Limestones are found associated with these beds near Kaeo, and, further south, in the Omapere Survey District.

The green sandstones near Kaeo yield poorly preserved fossils of Tertiary character, so it is possible that they are unconformable to the concretionary sandstones, but this has not yet been established.

The copper-deposits near the head of Whangaroa Harbour occur in calcareous shales and mudstones belonging to this series.

(4.) *Tertiary Volcanics.*—In the northern part of the subdivision these volcanics are represented mainly by agglomerates, which attain a thickness of 400 ft. or more around the north-western shores of Whangaroa Harbour, but thin out rather rapidly to the south and east. The older lava-flows of the eastern and southern portions of the subdivision are provisionally assigned to the same period.

Acidic rocks are represented in the volcanics only near the settlement of Pungaere by scattered fragments of obsidian (too numerous to have been brought by Maoris), and by two outcrops of a rock which has been doubtfully identified as a rhyolite.

(5.) *Post-Tertiary Rocks.*—To the Post-Tertiary period are assigned several well-preserved puys to the east and south of Lake Omapere, and the comparatively fresh basic lava which has flowed from them. Acidic rocks are represented only by the hummock-shaped hill of Putahi, on the south shore of Lake Omapere.

Under alluvial deposits are placed the extensive mangrove swamps at the head of Whangaroa Harbour and the river-deposits, generally of small extent, which occur in the valleys of the larger streams.

Economic Geology.

The economic possibilities of the subdivision may be considered under the following headings :—

(1.) Copper-ore.
(2.) Manganese-ore.
(3.) Iron-ore.
(4.) Petroleum-shales.
(5.) Gold.

(1.) *Copper-ore.*—Some years ago large boulders, consisting mainly of pyrite and chalcopyrite, were found in a small stream at the head of Whangaroa Harbour. A considerable amount of prospecting-work has since been carried out in this neighbourhood, resulting in the location of mineralised rocks in several places. In one case a lode, yielding, it is said, 10 per cent. of metallic copper, was found. The Whangaroa Amalgamated Copper Company, on whose claim this discovery was made, are now sinking a shaft to ascertain whether the ore persists to any depth. Nowhere else has a definite lode been discovered, though zones of rock, more or less impregnated with chalcopyrite, have been encountered, and large boulders of iron gossan are rather widely distributed.

(2.) *Manganese-ore.*—Stringers of impure pyrolusite and psilomelane are fairly frequent in the primary rocks, more especially in the upper part of the Waipapa River in the rocks of the Waipapa Series, but none are sufficiently large to be commercially valuable.

(3.) *Iron-ore.*—Small deposits of bog-iron ore of good quality occur in several places on the Kerikeri Plains. The extent of the largest of these, situated about three miles from Okaihau, on the Okaihau–Kerikeri Road, is now being ascertained by means of boreholes. The average thick-

* Bulletin No. 4 (New Series), N.Z. G.S., p. 50.

ness appears to be about 4 ft., but boring operations are not far enough advanced to indicate how large an area is covered by the ore.

(4.) *Petroleum-shales.*—A light-yellow clay, containing hydrocarbons, occurs about three miles north-east of Pungaere Settlement. Analyses show that the illuminating properties of the samples so far obtained are too poor to make the deposit of economic importance.

(5.) *Gold.*—A small quantity of gold is said to occur in the Whangaroa copper-ore.

Prospecting for gold has been carried on in the country on the right bank of the Waihou River, near the Waipapa junction, but so far with unsatisfactory results.

Mr. E. J. H. Webb, Assistant Geologist.

At the beginning of 1907 Mr. Webb was assisting me in field-work in the Parapara Subdivision, and from the 5th April until the 7th September he was at the office in Wellington, aiding in the preparation of the bulletin on that area. On the 7th September he left Wellington to start operations in the adjoining Heaphy Subdivision, where he was engaged until the 7th February, 1908, save for a few days between the 28th January and the 7th February, when he accompanied me on a reconnaissance of the Mount Radiant Subdivision. Leaving Whakapoai, at the mouth of the Heaphy River, on the latter date, Mr. Webb proceeded to Parapara. He was there occupied until the 21st February in locating and mapping outcrops of iron-ore in the Washbourn Block, which had been exposed by development-work and scrub-fires since the geological survey of that area during the previous season. Mr. Webb then left for Mount Radiant, and commenced field-work in that subdivision early in March. It is expected that the investigations in the Mount Radiant Subdivision will be completed towards the close of next field season, when the preparation of a bulletin on that area will be undertaken. Mr. Webb presents the following interim report on the work carried out by him during last season :—

System of Work.

In my work in the Heaphy and Mount Radiant subdivisions chain-and-compass traverses were made of all streams and tracks affording outcrops, as well as of some of the main ridges. The coast-line in some cases, where giving information of geological interest, was also carefully traversed. This work has been plotted on a scale of 20 chains to an inch, and the results added to the topographical information available from the Lands and Survey Department.

Work in the Heaphy Subdivision.

The Heaphy Subdivision comprises the survey districts of Paturau, Wakamarama, Kahurangi, Whakapoai, Gouland, and Anatoki. Geological investigations were confined to the Paturau and Wakamarama survey districts. In the latter, however, only the northern portion as far as the divide between the Anatori and Turimawiwi rivers was examined.

Physiographic Notes on Paturau and Wakamarama Survey Districts.

Broadly speaking, the Paturau and Wakamarama survey districts present two main physiographic features—a relatively low-lying upland country close to the sea, and an elevated old land interior. The uplands, which are about a mile and a half wide, abut against the coast in a line of cliffs which are practically continuous save where broken by stream-courses, and have a gradual rise towards the interior. They represent physiographically the Miocene strata later to be described. The uplands are separated from the old land of Pre-Miocene rocks by a broad valley now occupied by minor streams and by the basin of Lake Ngutuihe. The valley, which is bordered to the west by an escarpment of calcareous sandstone forming a typical cuesta, marks the erosion in the softer Miocene strata underlying the sandstone, and indicates the extent to which the latter has been eroded from the old land against which it formerly lay.

The old land exhibits a mountainous country of relatively mild relief, deeply dissected by the numerous streams which drain it. The greatest elevation is that of Mount Stevens (3,980 ft.), which lies just beyond the boundary of the subdivision.

The cuestas are brokenly continuous in a south-westerly direction from the eastern boundary of the Paturau Survey District to and beyond the southern branch of the Anatori River.

The main watercourses of the area examined are, in the Paturau Survey District, Sandhills Creek, and, in the Wakamarama, the Anatori River. The headwaters of the latter drain altogether an area of about thirty-five square miles.

Lake Ngutuihe, a mile and a half in length, which lies near the centre of the Paturau Survey District, has an average width of 7 chains in its western portion, and a maximum of 35 chains near its eastern extremity.

Flood-plains are of small extent, and are confined to the mouths of the water-channels.

A noticeable feature of the "old land" in the south-east of the Paturau Survey District is the picturesque rift-valley of Slaty Creek, between Mount Baldy and the Golden Ridge, showing possibly by its comparatively fresh appearance that severe earth-movements have been in evidence in no very remote geologic age.

General Geology.

General Classification.—The area under examination being the western extension of the Parapara Subdivision, the rocks encountered in both districts are lithologically and stratigraphically much of the same nature, hence the following classification which was adopted for the latter subdivision applies equally well to the rocks of the Heaphy Subdivision.

(1.) Ordovician: The Aorere Series.
(2.) Miocene: The Oamaru Series.
(3.) Pleistocene and Recent: Beach-deposits and river-débris.
(4.) Post-Aorere: Igneous Rocks.

(1.) *The Aorere Series.*—The rocks of the Aorere Series constitute the oldest beds in the portion of the subdivision so far examined, and, forming as they do the mountainous "old land" of the interior, cover by far the largest portion of the area. Towards the north-west they are obscured by younger beds. The Aorere rocks consist of coarse- and fine-grained argillites and grauwackes, occasionally graphitic and sometimes extremely pyritic, with occasional bands of schist. They are intruded and somewhat altered in places by igneous rocks of both acid and intermediate nature. In appearance the sedimentary rocks are usually light greenish-grey, weathering rusty, sometimes extremely fissile, with greasy slickensided surfaces. They have a constant nearly meridional strike, and in general a steep westerly dip. Towards the east of the subdivision, however, the angle of dip lessens, and the beds become much warped, minor anticlines and synclines being of frequent occurrence.

(2.) *Oamaru Series.*—The Miocene beds of the area have their maximum development in a belt of country fringing the coast-line, and having an average width of about two miles. They also appear as isolated patches on the slopes of the "old land" to the east. The series is represented by beds of quartzitic breccia and arkositic sandstones, with shales and small coal-seams, overlain by quartzose conglomerates, followed by arenaceous limestones and calcareous sandstones. The calcareous beds forming the upper members of the series are confined entirely to the upland country flanking the coast, and bounded on the south-east by the cuestas already described. East of these, exposed by the denudation of the upper beds, the lower members of the formation are developed in an irregular belt of country, averaging about half a mile in width, and forming the valley between the "old land" and the uplands. Shales, with small coal-seams and quartzitic breccias, are exposed in patches on the hillsides still further east. The beds throughout have a nearly constant slight dip to the north-west. Occasionally, however, local flexure, the effect of faulting, is encountered where the beds abut against the "old land."

(3.) *Pleistocene and Recent.*—Deposits of Pleistocene and Recent age are encountered along and near the coast-line and in the beds of all watercourses. They consist of beach sands and gravels and river-débris.

Unconformably overlying the calcareous sandstones of the Oamaru Series, and exposed as irregular shelves on the crests of escarpments along the coast-line (sometimes at an elevation of 200 ft. above sea-level), beach boulders, gravels, and sands are to be observed. Remains of these beds are also to be found quite half a mile inland from the coast. The coarser constituents of these beds are of argillite, grauwacke, and quartz, corresponding with the rocks of the "old land." The finer sands are often extremely rusty, sometimes almost black, and frequently yield fine gold to the dish. It is probable that the fine gold found in some of the smaller creeks is a rewash from these beds.

In places the Recent beach-sands contain payable leads of gold, associated with black sand; while the gravels of some of the streams were in the early days highly auriferous.

(4.) *Igneous Rocks.*—The igneous rocks of the part of the subdivision investigated are of acidic and intermediate type. Acidic rocks are confined to a single sill of felsite of an average width of 20 ft., exposed in the headwaters of the Anatori River and extending uninterruptedly in a meridional direction for some miles. Its connection with a large granite mass lying to the south-west of the area examined is undoubted. The intermediate igneous rocks of the area appear in a dyke of diorite, about 20 ft. in width, transverse to the strike of the ancient sedimentaries, which is also exposed in the headwaters of the Anatori River. Examination has been too restricted to determine the age of these intrusives beyond the fact that they are definitely Post-Aorere, and probably Pre-Tertiary.

Economic Geology.

The economic possibilities of the portion of the Heaphy Subdivision examined are, from a geological standpoint, confined to the production of gold and the preparation of building-stone, though the agricultural possibilities are of considerable importance. The strip of country bordering the sea-coast, and formed by the decay of the calcareous beds of the Oamaru Series, affords a fine sandy soil capable of great possibilities for the agriculturist. A large area of this land is still available for settlement. Flax grows luxuriantly on the low hills near the coast, while good timber is to be found in places on the hills further inland.

Gold.—In the early days, owing to the discovery of rich gold-bearing alluvium in some of the stream-beds, the district was the scene of a diggers' "rush." Later on, auriferous veins were found; but these, though occasionally carrying high values, were unfortunately of small extent. The veins occur near the heads of Malone, Friday, and Independent creeks. In all cases the old workings were inaccessible, but our examination, which was thus necessarily confined to surface outcrops, showed that the veins are all bedded with the argillites and grauwackes of the Aorere Series, and in consequence have a north-and-south strike. Near the head of Friday Creek some small 6 in. veins are exposed in shallow prospecting-trenches. One of these veins shows a little free gold, and it is possible prospecting operations were abandoned somewhat prematurely. A picked sample of ore from this yielded on assay the following results:—

Gold	8 dwt. 19 gr. per ton.
Silver	1 dwt. 21 gr. ,,
Value	£1 15s. 3d. ,,

On the same line of strike, and about two miles further south, a well-defined vein outcrops on the top of the ridge at the head of Independent Creek. It has a maximum width of about 4 ft., but frequently breaks up into smaller irregular veins. One of these, from 6 in. to 8 in. in width, shows a little free gold, and a picked sample assayed,—

Gold	5 dwt. 16 gr. per ton
Silver	1 dwt. 21 gr. ,,
Value	£1 2s. 9d. ,,

A considerable amount of driving has been done on this vein-formation, but it is possible further investigation might be warranted.

Though a large amount of detrital gold was obtained in the early days from streams in the vicinity of these veins, there is not sufficient remaining to encourage the prospector. A little gold was traced up the main left branch of the Anatori River as far as the boundary of the subdivision.

The quartzose wash occurring in association with the sandstones and shales of the Tertiary beds is in places auriferous, though not sufficiently so to prove of economic importance.

Beach-combing has been carried on intermittently for some years on the beach between Sandhills Creek and Anatori River. Payable gold is found in places associated with black sand, but difficulty is experienced in saving it owing to the oily nature of the water available. This oiliness is probably due to decomposing vegetable matter.

Building-stone, &c.—The calcareous sandstones outcropping along the coast have proved readily workable and highly suitable for building purposes.

Some of the limestone in the upper part of the Oamaru Series would be suitable for cement-manufacture, but, generally speaking, it is too high in silica and magnesia to give a satisfactory product.

Work in the Mount Radiant Subdivision.

The Mount Radiant Subdivision lies in the north of the Westport Division, and comprises the survey districts of Kongahu and Otumahana. It thus forms an area of about 205 square miles, bounded on the west by the Tasman Sea and on the east by an arbitrary meridional line 13½ miles from the coast at its northern and 19½ miles at its southern extremity.

Geological investigations have so far been confined to the Otumahana Survey District, and, of this, mostly to the eastern central portion hitherto unmapped.

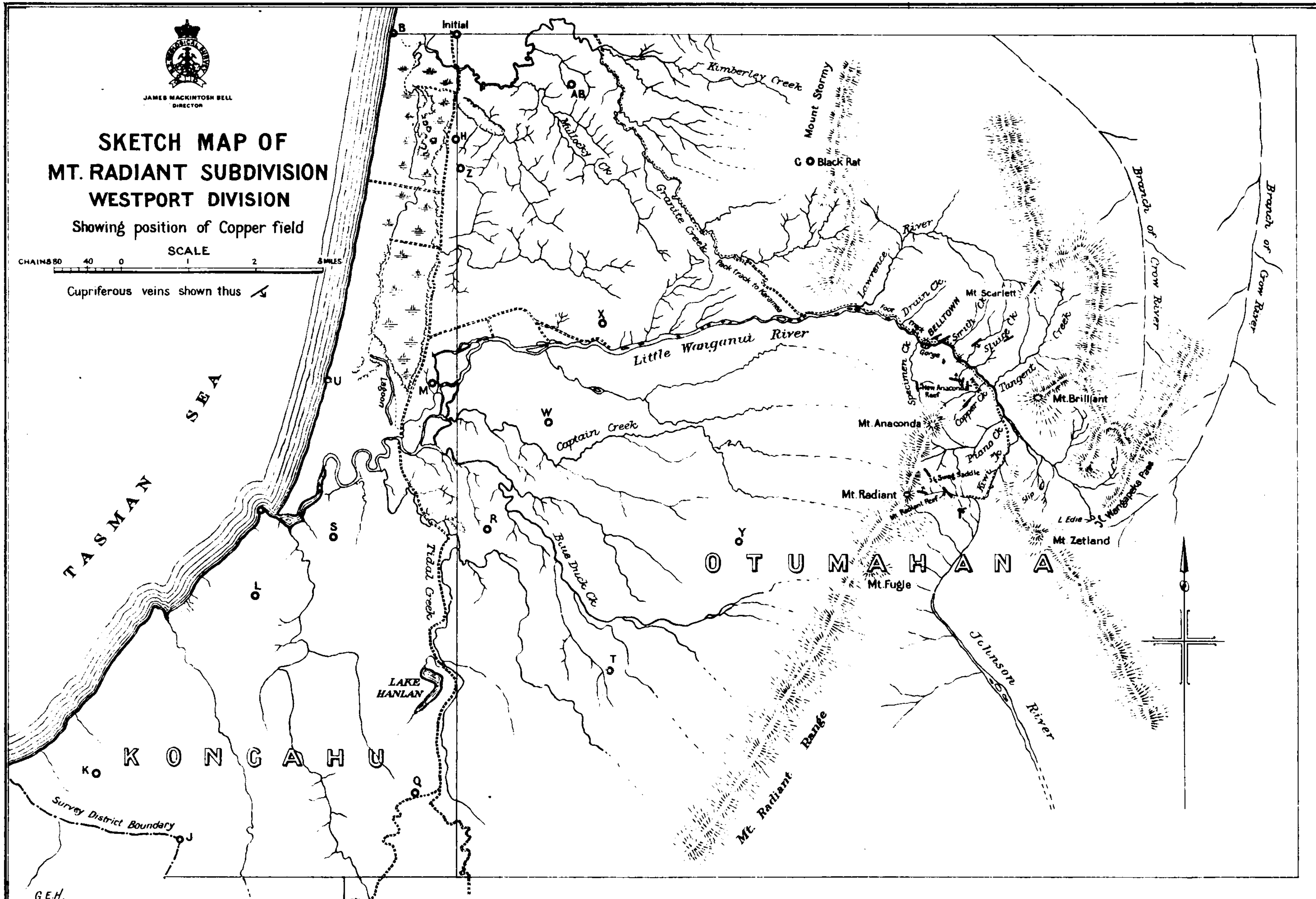
Physiographic Notes.

The Mount Radiant Subdivision shows in its western part a relatively low-lying country, rising gradually from the narrow coastal plain, and in its eastern part an elevated "old land," which is apparently an uplifted peneplain. The low-lying country, consisting of Tertiary strata, is cut by stream-courses into a series of parallel spurs, with a westerly trend. These have a minimum altitude of a few feet near the coast where they grade into the coastal plain, and a maximum of about 1,000 ft. where they abut against the mountainous hinterland. A narrow coastal plain fringing the sea-coast merges imperceptibly into the flood-plains of the entering streams. Swamps are frequent in this coastal belt, and at low water considerable expanses of mud-flat are exposed in the stream and river estuaries.

Rising sheer to an altitude of over 4,000 ft., with a relief of about 3,000 ft. above the country to the west, the deeply dissected Marine Mountains, with fairly uniform summit-altitudes, represent a portion of the ancient peneplain, now worn into a series of roughly parallel ranges. The most westerly of the ranges, known as Mount Radiant Range, follows a north-north-easterly direction near the centre of the subdivision. Its steep western slopes are probably the eroded escarpments of a fault along which took place the differential movement by which the land to the east was elevated to its present altitude.

The Mount Radiant Range is terminated near the centre of the subdivision by the Little Wanganui River, but is continued somewhat more to the west by the parallel range of Mount Stormy. East of these the mountains present a series of ridges encircling the heads of the various rivers which take their rise among them. The main peaks of the ranges are Mounts Fugel, Radiant, and Anaconda, on the Mount Radiant Range; with Mounts Scarlett, Brilliant, and Zetland further to the north-east. These all have an altitude of over 4,000 ft.; while Mount Stormy, which probably represents a separately faulted block, has a summit-elevation about 1,000 ft. lower.

The main part of the subdivision is drained by the Little Wanganui River, seventeen miles in length, which has its source in the centre of the mountainous "old land." Through this it has scoured a deeply incised channel following a north-westerly course till it reaches the foothill country. Here its course trends more to the south, and it finally reaches the Tasman Sea near the centre of the coastal margin of the subdivision. Throughout the latter part its course is somewhat sinuous, and its bed is flanked by broad flood-plains. Its left branches, Captain, Blue Duck, and Tidal creeks, flowing through deeply gorged channels, drain the southern portion of the foothill country. The northern portion of this low-lying country is similarly drained by Granite Creek and its branches. In the north-east of the subdivision the main drainage-channels are the two large branches of the Crow River, the more westerly of which probably once entered the Little Wanganui River through the broad valley now occupied by the Lawrence River. The south-eastern portion of the subdivision has for its drainage-channel Johnson River, a tributary of the Mokihinui River.



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General Geology.

General Classification.—The following classification, based on the general lithological and stratigraphical evidence, is tentatively submitted pending a microscopic and palæontological examination:—

(1.) Ordovician: Aorere Series.
(2.) Miocene: Oamaru Series.
(3.) Pleistocene and Recent: Beach and river deposits; talus slopes.
(4.) Post-Aorere: Igneous Rocks.

(1.) *Aorere Series.*—Rocks of the Aorere Series are confined within the area so far examined to a narrow strip bordering the western and southern flanks of Mount Stormy. They consist of argillites, more or less distinctly bedded, with a south-easterly strike. They are generally schistose and spotted, and occasionally brecciated, effects produced by the intrusive action of the adjacent igneous mass which now forms Mount Stormy. It is probable that further outcrops of this series of rocks will be encountered along the base of the Mount Radiant Range.

(2.) *Oamaru Series.*—The beds which constitute the foothills have been, on account of their stratigraphical relation with somewhat similar beds of known age north of the subdivision, tentatively considered as belonging to the Oamaru Series of Miocene age. The beds are in places highly fossiliferous, and a palæontological examination will remove all doubt as to age. The members of this formation are, in ascending order, calcareous mudstones, with a band of arenaceous limestone, followed by argillaceous sandstones with small coal-seams and occasional beds of loosely consolidated quartz wash, said to be auriferous in places. The maximum thickness of the series within the subdivision is probably about 600 ft. The beds have as a rule a gentle dip towards the coast. Exceptions to this general slight dip prevail, however, round the foot of the mountains, where faulting has caused monoclinal folding with the production of steep inclinations of the strata.

(3.) *Beach and River Deposits, Talus Slopes.*—Owing to the low gradients of the streams and rivers for some miles from their mouths, the coarse material is deposited before reaching the coast, and consequently sandy beaches prevail with mud-flats round the mouths of the watercourses. The flood-plains of the various streams, the occasional terraces flanking the course of the Little Wanganui River, and the narrow coastal plain fringing the present shore-line all show Recent rocks. Talus slopes are common in the mountainous region.

(4.) *Igneous Rocks.*—Intruding the beds of the Aorere Series and forming the main massif in the east of the subdivision, is a huge boss of granite overlain in places by unaltered Oamaru beds. In point of age it thus lies between Ordovician and Miocene, but it is impossible as yet to assign a definite age to its intrusion.

Biotite-granite of grey appearance is the prevailing rock in the western portion of the igneous mass, but bands of pegmatite with large muscovites are not uncommon. Towards the east dark dioritic rocks are frequently met with, and appear to be the effects of segregation from an original granitic magma. The diorites are invariably of fine texture, while the granites are generally of a porphyritic nature. The igneous rocks are of prime importance owing to the cupriferous veins which occur in them.

Economic Geology.

The economic possibilities of the subdivision may be tabulated with respect to their relative importance as follows:—

(1.) Copper and molybdenum.
(2.) Gold.
(3.) Coal.
(4.) Lime.
(5.) Building-stone.

(1.) *Copper and Molybdenum.*—Of greatest importance from an economic point of view are the copper-molybdenum veins of the subdivision. These are confined, as far as present examination has shown, to a belt of country three miles and a half long and a mile and a half in width, traversing the western portion of the granite boss in a north-north-easterly direction from the eastern slopes of Mount Radiant to near the summit of Mount Scarlett. Outcrops are said to exist still further to the south, and subsequent examination may prove their continuance in a northerly direction. Reference to the sketch-map opposite will show the general disposition of the veins, and it will be noted that those on the Mount Radiant Range have in general a north-north-west strike, while those on the slopes of Mount Scarlett trend in a north-easterly direction. It is highly probable that many of these outcrops will eventually prove to be connected, thus forming continuous vein-systems. But little work has as yet been done upon them, and there is ample scope for the location of further outcrops by means of surface prospecting.

The veins are sometimes very distinct, with both walls well defined; again, they may be somewhat irregular and greisen-like with indefinite walls, whilst yet again they may have the nature of a stockwork—a reticulated mass of small irregular veins. The vein-material is in the first case usually quartz alone, generally white, though occasionally rusty, with splintery fracture. In the griesen-like veins unaltered feldspar forms a part of the gangue-matter, while in the stockwork formation the country rock also carries values.

The metalliferous constituents of greatest economic importance are the copper sulphides chalcopyrite and bornite, with their alteration-products melaconite and malachite, while covellite, azurite, cuprite, and chalcocite are occasionally to be observed. The various copper minerals generally appear in streaks and bunches irregularly distributed in the vein-material. Not infrequently, however, the chalcopyrite is finely disseminated throughout the gangue, and may occasionally be seen replacing the ferro-magnesian constituents of the country rock.

Molybdenite is of common occurrence, and is sometimes in excess of other metalliferous constituents. In some cases it probably replaces the ferro-magnesian minerals of the greisen veins. It usually occurs as slickensided coatings on joint-faces, and also appears as stringers sometimes nearly an inch in thickness, filling fracture-spaces in the vein-material, while again it is more finely distributed throughout the gangue. The oxide, molybdite, is frequently seen on weathered surfaces.

Zinc-blende has been observed in small amount in one instance, while scheelite and galena are said to have been found also.

Description of the Outcrops.—The principal veins exposed outcrop in the beds of Silver and Specimen creeks, and are known as the Mount Radiant and New Anaconda reefs respectively. Besides these, at least nine other outcrops of mineralised vein-material have been located, while indications of copper have been observed in many places.

Mount Radiant Reef.—This vein-formation outcrops in the bed and on both banks of Silver Creek, about 50 chains east of the trigonometrical station recently erected on Mount Radiant, and at an elevation of 2,780 ft. above sea-level.* On the northern bank a small prospecting-drive shows the vein-formation to resemble a stockwork, the constituent veins varying in thickness from 4 in. to 3 ft., and the whole showing a total width of 1 chain. It is probable, however, that the north-eastern wall has not yet been reached. Prospecting-work has been carried on above the drive, showing conditions similar to those prevailing below. Indications of copper, bearing witness to the widespread nature of the mineralisation in this vicinity, are found 5 chains higher up the stream, and in the small branch stream above the drive. Owing to the nature of the outcrop its strike is difficult to determine, though the individual veins have a more or less northeasterly trend. It is probable, however, that the whole vein-formation has a north-north-west strike.

Molybdenite is here the most prominent mineral of economic value, but chalcopyrite is general, with a little bornite and stains of malachite. Iron-sulphides are also in evidence. The highest values are carried by a vein about 2 ft. 8 in. in width, split by a small "horse" of mineralised country; and appearing just at the entrance of the drive. In this vein both chalcopyrite and molybdenite are strongly developed, the latter along shear-faces sometimes 2 ft. to 3 ft. in vertical extension and nearly half an inch in width. It is frequently associated with pink orthoclase, which appears irregularly throughout the vein, but is by no means confined to the feldspar gangue. Chalcopyrite is seen in bunches and stringers, as well as in smaller particles, throughout the gangue. Samples from various parts of the formation assayed as follows:—

Locality.	Gold.	Silver.			Copper.	Molybdenum.
	Gr.	Oz.	dwt.	gr.	Per Cent.	Per Cent.
(1.) Country rock from face of drive ...	0·5	0	1	6	0·32	0·03
(2.) Vein near end of drive	...		...		0·74	0·08
(3.) Country rock between first and second veins	0·5	0	1	21	0·41	0·21
(4.) Vein at entrance to drive	6·0	2	8	13	1·20	1·76
(5.) Exposure above mouth of drive ...	15·0	0	13	2	0·46	0·82

New Anaconda Reef.—In the headwaters of Specimen Creek, and three-quarters of a mile above its junction with the Little Wanganui River, at an altitude of 1,850 ft. above sea-level,* is the New Anaconda Reef. This is a well-defined vein exposed continuously for 2½ chains, but distinctly traceable in a north-north-westerly direction for 12½ chains, while large well-mineralised "floaters" indicate a probable further continuance for an equal distance. Its southerly extension is obscured by débris. It has a width in Specimen Creek of 25 ft., and strikes about 165° (true), with steep easterly dip.

The vein-material consists principally of quartz, though feldspar is common. The metalliferous contents are similar to those of the Mount Radiant Reef, but molybdenite is much less in evidence, copper minerals being generally predominant. The highest values, showing as irregular patches and stringers of chalcopyrite up to ¾ in. in width, are carried in a 6 ft. zone near the foot-wall of the vein. Elsewhere the metalliferous constituents are not so strongly developed, bunches of ore occurring at irregular intervals throughout the gangue.

The following results were obtained from samples selected from the New Anaconda Reef:—

Locality.	Gold.	Silver.			Copper.	Molybdenum.
	Gr.	Oz.	dwt.	gr.	Per Cent.	Per Cent.
(1.) South end of reef above creek ...	...		...		0·23	0·21
(2.) Highly mineralised band in creek, south end of reef	...	0	1	21	2·37	0·05
(3.) Across face, main exposure ...	1	0	8	9	0·25	0·03
(4.) Along face, main exposure ...	2	1	5	5	2·32	0·15
(5.) Face below sample 4	4		...		0·90	0·05
(6.) Northern end, main exposure ...	2	0	18	7	0·41	0·25

*Barometric heights.

Other Occurrences.—Of the following minor outcrops the first three are probably referable to the Mount Radiant vein-formation.

On the northern slopes of a lateral spur from Mount Radiant, 25 chains south-east of the Mount Radiant reef, and at an elevation of 3,230 ft.,* is a 10 ft. vein-formation exposed along its strike for 28 ft. The formation shows many points of similarity to that of the Mount Radiant reef—the stockwork nature being evident, and both vein-material and country rock carrying more or less mineral. Molybdenite is very general, while chalcopyrite is frequently associated with it, though usually finely disseminated throughout the vein-stuff, and occasionally appearing in streaks and bunches. Melaconite is common in granular form, and crystals are occasionally seen, while stains of cuprite sometimes appear. A sample of ore gave on assay the following results:—

	Per Cent.
Copper ...	0·92
Molybdenum	0·23

On Swag Saddle, a quarter of a mile to the north-west of Mount Radiant reef, a well-defined vein appears at an altitude of 3,635 ft.* It strikes south-east with steep north-easterly dip, and has a maximum width of about 30 ft. The vein-material is quartz, generally barren, with the exception of a 4 in. to 6 in. shoot of ore near the foot-wall. Chalcopyrite is present, with a little molybdenite and molybdite. A sample from the ore-shoot assayed—

	Per Cent.
Copper ...	0·51
Molybdenum	0·33

On the open country near the head of Piano Creek, and 16 chains north-west from the last outcrop, at an elevation of 3,500 ft.,* is a small exposure of mineralised quartz, carrying chalcopyrite in bunches, with minor quantities of molybdenite. A sample from this assayed as follows:

	Per Cent.
Copper ...	0·53
Molybdenum	0·09

At the head of Silver Creek, and 20 chains east of the Mount Radiant Trigonometrical Station, at an altitude of 3,500 ft.,* another vein is exposed. This has a width of about 15 ft., with a steep northerly dip, and is traceable along its west-north-westerly strike for 120 ft. The vein-material is quartz, generally of a bluish colour, and usually barren, mineralisation being mainly restricted to a band about 1 ft. wide near the foot-wall. This carries pyrite and chalcopyrite, with a little chalcocite, melaconite, and molybdenite. A general sample gave on assay the following results:—

	Per Cent.
Copper	0·34
Molybdenum	0·006

while a sample from the mineralised band gave—

Gold.	Silver.	Copper.	Molybdenum.
1 gr.	8 dwt. 4 gr.	0·78 per cent.	0·03 per cent.

In the right-hand branch of Copper Creek, at an elevation of 2,000 ft.,* a vein is exposed for 500 ft. in horizontal and 280 ft. in vertical extension. It has a north-easterly strike, with steep westerly dip, and has a maximum width of 2 ft. near the bottom, thinning out at the top to mere stringers. Several parallel stringers were noted in places, bringing the total width of the formation up to 20 ft. Occasional bunches of sulphides occur, mostly pyrite and chalcopyrite, with a little bornite, cuprite, and melaconite, but the vein-material is generally barren.

On the ridge, less than a quarter of a mile to the north of this outcrop, a large vein occurs at an elevation of 2,175 ft.* Its strike appears to be about north and south, its width indefinite, but probably exceeding 25 ft. It has somewhat the appearance of a pegmatite dyke, showing a series of parallel quartz stringers with feldspar associated. It is of a barren nature, with the exception of two veinlets, 6 in. and 2 in. in width respectively, which are highly impregnated with chalcopyrite and melaconite. Fragments of mineralised quartz appear on the ridge-top 5 chains to the west of this vein, while in the creek on the other side of the ridge two veins, 2 ft. and 6 in. in width respectively, carry more or less copper mineral.

Indications of copper, in a small stringer carrying a little chalcopyrite, bornite, and malachite, appear in the bed of the Little Wanganui River near the bridge, at an altitude of 890 ft.* above sea-level. Thirty chains to the north-east a 2 ft. vein appears in the bed of Sluice Creek, at an altitude of 1,650 ft.* This is exposed along its strike for 25 ft., but iron-sulphides appear to be the only metallic minerals present. On the eastern slopes of Mount Scarlett, at an elevation of 3,700 ft.* above sea-level, and distant a mile and a half from the river, there is exposed a vein-formation carrying both copper and iron pyrites, with oxidation-products, as well as some molybdenite. Practically no work has been done on this vein, the formation being merely exposed in four places in a distance of 3 chains along its strike. These exposures show it to be a stockwork, with a width of probably about 30 ft., though in no place is this entirely exposed.

* Barometric heights.

Samples selected from the various exposures gave the following results on assay:—

Locality.	Gold. Gr.	Silver. Dwt. gr.	Copper, Per Cent.	Molybdenum. Per Cent.
1. Northerly outcrop, Mount Scarlett ...	1	5 1	0·27	0·06
2. Middle outcrop, Mount Scarlett ...	0·5	1 21	...	0·02
3. Southerly outcrop, Mount Scarlett ...	...	0 15	0·03	0·015

On the ridge between Sluice and Tangent creeks, at an elevation of 2,930 ft.,* a 2 ft. vein-formation is exposed, highly mineralised in places with pyrite and marcasite. A little zinc-blende is also present.

On the spur on the north side of the gorge above Specimen Creek, and again near the mouth of a small creek higher up the river, are exposures which are probably referable to one and the same vein-formation. In the former outcrop the vein has much the appearance of a pegmatite dyke. It is from 3 in. to 18 in. in width, and apparently carries no mineral. The creek exposure is somewhat similar in character. It is about 6 ft. wide, with large lenses of quartz, in places somewhat pyritised.

General Observations.—All the veins as yet examined on the northern side of the Little Wanganui River have a uniformly north-easterly strike, with generally a steep south-easterly dip. It is possible that the copper indications observed in the river-bed mark the southern extremity of a vein-formation, of which the Sluice Creek and Mount Scarlett outcrops are widely separated exposures. The latter outcrop is, however, the only one so far met with on the northern side of the river which offers economic possibilities.

On the southern side of the river the most promising outcrops are, as already stated, the Mount Radiant and New Anaconda reefs. It is probable that the outcrops in Piano Creek, and on the spurs to the north and south of the Mount Radiant reef, are referable to this formation. It is possible that the New Anaconda reef may be a further continuance at a lower level of the same formation, which would in this case have a strike-extension of over two miles. Connecting outcrops between the New Anaconda and Piano Creek outcrops have not so far been noted, but may yet be found.

Floaters of highly mineralised ore found in the bed of Copper Creek lead to the opinion that further examination of the slopes to the west of the waterfalls is warranted.

Practically nothing has been done in the way of opening up known outcrops, or in endeavouring to prove their continuity along the line of strike. So steep and densely wooded is the country that such work is extremely arduous, and could only be undertaken with the expenditure of considerable capital.

From a consideration of the results of assays of the various samples selected from the two main outcrops it will be seen that the ore in general is very low-grade, the copper-contents averaging less than 1 per cent. This percentage could, however, be readily brought up to a commercial standard by judicious hand-sorting. It must be pointed out also that these results must only be considered as tentative, since the process of sampling was rendered extremely difficult and the results somewhat unsatisfactory, owing to the undeveloped state of the properties. It is proposed later on to undertake a more exhaustive sampling on a larger scale, the results of which may prove more encouraging, and will be published in the final bulletin.

The New Anaconda is undoubtedly much the more promising of the two veins, owing to the comparative regularity of its values in the vein-material and to its continuity along the line of strike. In many ways it bears a striking resemblance to the veins of the great copperfield of Butte, Montana. Two of the samples, Nos. 2 and 4, from this vein have a copper-content exceeding 2·3 per cent., while the values in molybdenum, gold, and silver are not negligible. Owing to the specific gravities of chalcopyrite and molybdenite, the two principal minerals, differing but little, the separation of the two would appear to be difficult. Their markedly different physical characters, however, combined with the fact that they are not generally closely associated in the ore, lead to the opinion that a mechanical separation should not prove insurmountable. Analyses of samples Nos. 2 and 4 from the New Anaconda vein are as follows:—

	No. 2.	No. 4.
Silica (SiO_2) ...	87·56	86·03
Alumina (Al_2O_3) ...	1·10	0·84
Ferric oxide (Fe_2O_3) ...	5·04	6·27
Lime (CaO) ...	0·10	0·10
Magnesia (MgO) ...	0·20	0·15
Alkalis (K_2O, Na_2O) ...	0·20	0·30
Cuprous sulphide (Cu_2S) ...	2·97	2·91
Molybdenite (MoS_2) ...	0·08	0·25
Ferric sulphide (Fe_2S_3) ...	2·75	3·15
	100·00	100·00
Copper ...	2·37	2·32
Molybdenum ...	0·05	0·15
Total sulphur ...	1·90	2·14

(2.) *Gold.*—So far no auriferous veins have been encountered by the Survey, but placer deposits of considerable richness, though of but limited extent, have been worked within the bounds of the subdivision. Such deposits were found in branches of Granite Creek in association with

* Barometric height.

the Miocene beds of wash, from which they were doubtless a concentration-product, and it is possible that similar deposits may yet be encountered in other parts of the subdivision.

Leads of payable gold occur in the sands along the sea-coast, and beach-combing is still carried on with more or less success.

(3.) *Coal.*—Small seams of lignite occur within the subdivision in association with the Oamaru beds near the sea-coast. The coal is said to be fairly satisfactory for household purposes, though somewhat sulphurous. None has as yet been encountered within the subdivision by the Geological Survey.

(4.) *Limestone.*—The bed of limestone constituting one of the lower members of the Oamaru Series outcrops frequently along the edge of the mountains. It appears, as far as present observations are concerned, never to exceed 80 ft. in thickness. In this thickness it shows every gradation from conglomerate with calcareous matrix to high-grade limestone. Beds of the latter may yet be found of sufficient extent to warrant the manufacture of lime and cement, or for use as a basic flux in metallurgical operations.

(5.) *Building-stone.*—Much of the granite of the interior mountainous region is eminently suitable for use in building and for ornamental work, though its general inaccessibility would militate against its successful exploitation on a large scale.

Mr. James Henry Adams, Assistant Geologist.

Mr. J. H. Adams, who joined Mr. Colin Fraser's party as a temporary field assistant on the 8th October, 1906, was permanently appointed to the staff as an Assistant Geologist on the 1st April, 1907. He assisted Mr. Fraser both in field and office work until the 9th January, 1908, when he left Wellington for Gisborne to commence field operations in the Whatatutu Subdivision of the Raukumara Division. Mr. Adams presents the following brief summary of the work accomplished:—

Work in the Whatatutu Subdivision.

The area which is to constitute the Whatatutu Subdivision of Raukumara, Hawke's Bay, comprises the Mangatu and Waingaromia survey districts, and is a rectangle of 25 miles by 12½ miles, thus having an area of 312½ square miles.

The portion of this subdivision to which work has been confined during the past five months represents about one-third of the total area. The Waingaromia River, north-eastward from its confluence with the Waipaoa, together with all its main tributaries, excepting the headwater portions of the Parariki and Makahakaha streams, has been geologically surveyed to and beyond the northern limits of the subdivision. The Waipaoa River has, together with its main tributaries, been surveyed geologically for a distance of about seven miles above its confluence with the Mangatu. Some work has also been carried out in the north-eastern portion of the subdivision, and under your personal supervision a detailed survey was made of an area including Waitangi Hill, where good surface indications of petroleum occur.

Physical Geography.

The area included within the Whatatutu Subdivision consists, physiographically, of a series of rolling ridges of moderate height, separated by deeply cut river valleys. Its general slope is in a south-easterly direction from the Raukumara Range to the sea-coast. The area has been dissected by drainage-channels converging from the east, the north, and the west to a point of junction about two miles below the median point of the southern boundary of the subdivision. The highest peaks included in the area are situated in the western portion of the Mangatu Survey District. Of these, Maungahamia (3,983 ft.), on the Raukumara Range, is the most prominent. Other well-known peaks are Wheturan (1,730 ft.), Pyramid A (2,200 ft.), Arakihi (2,302 ft.), Ahititi (1,911 ft.), and Paraheka (1,867 ft.).

Almost the whole of the area is included in the watershed of the Waipaoa or Big River, which debouches into the western corner of Poverty Bay. The main Waipaoa River enters the subdivision close to the eastern boundary of the Mangatu Survey District, and flows in a general southerly direction through the main central portion of the area. In the vicinity of Whatatutu the Waipaoa is joined by the Mangatu River, which drains the country to the west and north-west, and by two left-hand branches, the Mangataikapua Stream and the Waingaromia River, which together drain the central and north-eastern portions of the area. The Wheao, the Waikohu, and the Waihora, all tributaries of the Waipaoa, but junctioning with it outside of the subdivision, have portions or the whole of their watersheds within the subdivision. A small portion of the area under description is drained by branches of the Pakarae River, which flows south-east to the coast-line at the township of the same name.

All these rivers and larger streams flow at grade. They are in places bordered by somewhat extensive high-level and low-level terraces, the most conspicuous of these being the flat-topped upland extending from Whatatutu for several miles along the right or western bank of the Waipaoa River.

Nature of the Work carried out.

Maps compiled on a scale of 20 chains to 1 in., from information obtained from the Lands and Survey Department, have been prepared and supplied by the draughting staff of the Department for use as a basis for the plotting of field-work.

Since the watercourses afford by far the best sections of the rocks in which their valleys have been eroded, and at the same time contain specimens of rocks and mineral-deposits, which have gravitated from the ridges or have been transported by water, the greater part of the work consists in the examination and survey of the stream-beds. An examination of the ridges and spurs is also undertaken, but these do not as a rule show good rock-outcrops.

The disposition and lithological character of all exposures of strata have been noted and mapped with a view to indicating the anticlines of the area, so important in connection with a petroliferous area.

General Geology.

The following classification of the formations occurring within the area already examined, is tentatively submitted pending further palæontological and petrographical work on the numerous specimens collected :—

Formation.	Age.
(*a*.) Whatatutu Series ...	... Probably Miocene (lower beds possibly older).
(*b*.) Waipaoa Beds ...	... Pliocene.
(*c*.) River and terrace gravels	... Pleistocene and Recent.

Mr. Alexander McKay, who has traversed a much larger area than that now being described, gives a more detailed classification in a report "On the Petroleum-bearing Rocks of the Poverty Bay and East Cape Districts."*

The following table, indicating the various formations mapped by Mr. McKay as occurring within the Whatatutu Subdivision, together with their lithological character and typical localities of occurrence, has been compiled from the above report :—

Age.	Petrological Character.	Typical Localities of Occurrence.
Middle Cretaceous	Sandstones, dark shales, and calcareous concretions. Bands of limestone of yellow tint	Upper Waitangi Stream.
Upper Cretaceous ...	Green sandstones, siliceous shales. Indurated chalky limestones alternating with greensands. Marly-limestones or calcareous sandstone	Waitangi River to oil-springs. Along Oilspring Creek to near its junction with the Waipaoa. From Oilspring Creek to Mangatu River.
Lower Tertiary ...	Coarse conglomerate or breccia. Sandy marly clays, with beds of brown sandstone, including foraminiferal limestone	Waipaoa River Valley. Oilspring Creek, Waipaoa River. Eastern basin of Upper Waingaromia River.
Pliocene	Sandy clay. Pumiceous sands, limestones	Terraces east side of Waipaoa River above Te Karaka.
Recent	Beach-deposits; blown sands; alluvial (river) deposits.	

(*a*.). *Whatatutu Series.*—Almost the whole of the formations occurring in the area examined up to the present time have been classed under this head, for the reason that stratigraphical unconformities are by no means apparent, and such palæontological evidence as is at present available does not appear to warrant their being referred to more than one series. Mr. Alexander McKay, however, considers the lower beds to be unconformably older, and of probable Cretaceous age.

Certain beds, from their general mode of occurrence, appear to be associated, and thus the series admits of subdivision in ascending order as follows:—

(1.) Chalky limestones; glauconitic sandstones.
(2.) Coralline limestone.
(3.) Claystones, with calcareous concretions; argillaceous limestone.
(4.) Argillaceous sandstones, coarse conglomerates, sandstones, and claystones; concretionary bands; fine shelly conglomerates; sandstone.

(1.) *Chalky Limestones and Glauconitic Sandstones.*—The chalky limestones occur in broken outcrops along a line extending in a north-east direction from a point in the Waipaoa River about a mile above the confluence with the Mangatu, across the Mangataikapua to the heads of the Waitangi and Makara streams. The chalky limestone formation is for the most part of whitish appearance, but is often tinged pale green or brown, probably by ferruginous minerals. The rock frequently breaks into small fragments, but where numerous veinlets of calcite occur is more compact. In places it is highly friable and even slickensided.

The glauconitic sandstone is a fairly well-compacted rock, green in colour, appearing dun-coloured on weathered surfaces. It occurs in the vicinity of the main oil-spring, in branches of the Te Hau-o-te-Atua and Mangataikapua streams and elsewhere

* Mines Report, 1901, C.-10, pp. 21–25.

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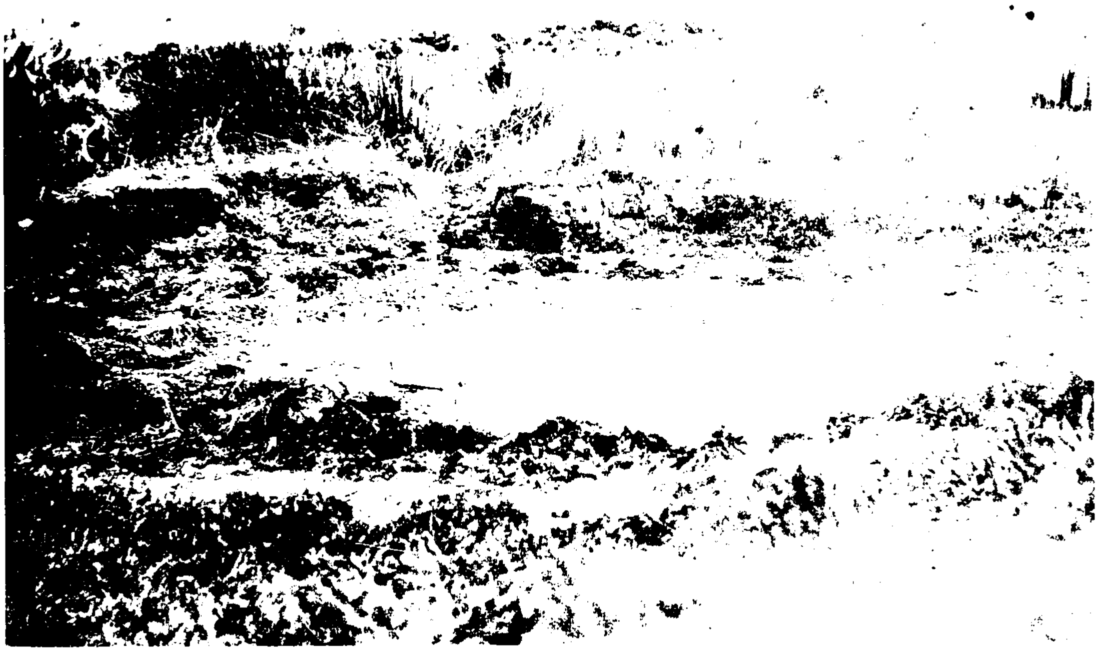

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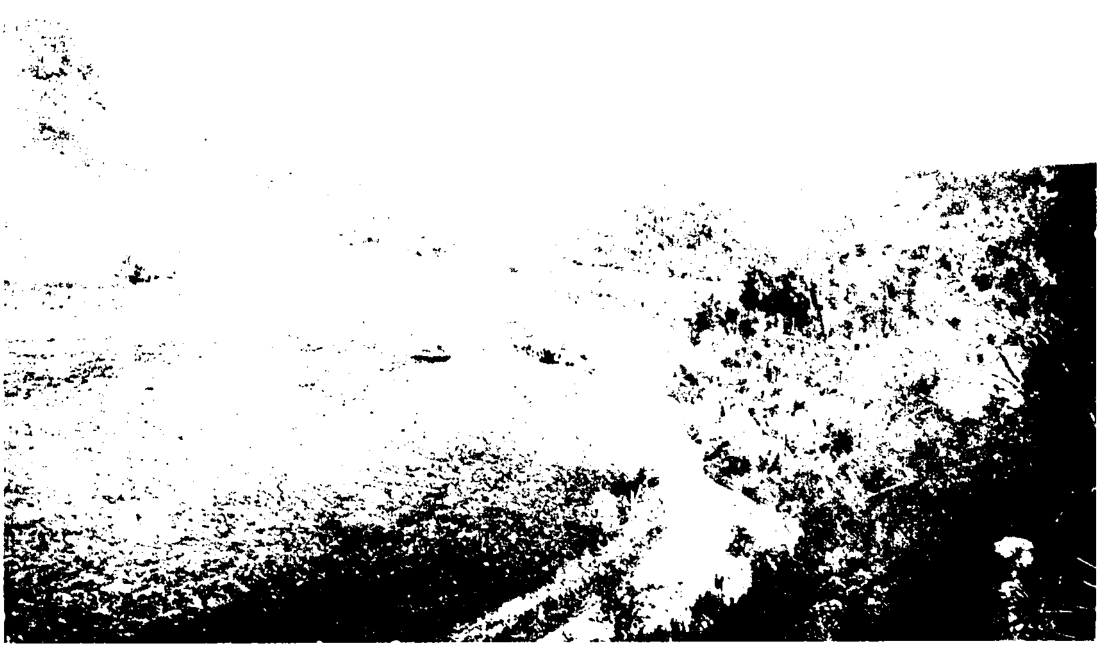

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At present it is somewhat doubtful whether the glauconitic sandstones alternate with the chalky limestones or not.

(2.) *Coralline Limestone.* — Coralline limestone containing Foraminifera occurs near the junction of the Mangataikapua Stream with the Waipaoa River. According to Mr. McKay the coralline limestone has a considerable development near Maungapohatu, where it is underlain by calcareous greensands.

(3.) *Claystones with Calcareous Concretions, and Argillaceous Limestones.*—Claystones with calcareous concretions occur mainly in the valleys of the Waingaromia River and its branches. The claystones themselves are gray in colour, finely textured, and fairly impervious. The calcareous concretions consist of hard, finely textured material, pinkish-white in colour, probably containing a large percentage of lime. The concretions occur sometimes as cylindrical masses up to 6 in. in diameter and 4 ft. in length, again as concretionary boulders of various shapes, often five or six feet in diameter.

The argillaceous limestone shows two varieties—one a dark well-compacted limestone with few fossils, the other a highly fossiliferous rock with shells cemented by an argillaceous matrix.

(4.) *Claystones and Fine Sandstones with Rare Concretionary Bands, Coarse Conglomerates, Fine Shelly Conglomerates, and Coarse Sandstones.*—Claystones passing through argillaceous sandstones into fine sandstones cover a considerable portion of the area examined. The sandstones are of greenish-brown tint, generally finely textured, and loosely compacted. The argillaceous sandstones and claystones are dark-gray to black in colour, and in general show small shell-fragments scattered throughout, and occasionally contain bands consisting almost entirely of shells. Associated with these rocks occur harder concretionary bands with or without shells, and fine conglomerate bands consisting mainly of shells, shell-fragments, and pebbles of sandstone up to half an inch in diameter.

The coarse conglomerates consist of an arenaceous or argillaceous matrix and pebbles of igneous rocks, which are generally basic, but are in places possibly somewhat acidic. The exact petrological character of these rocks has not yet been made out, but they apparently consist of diorites, gabbros, amygdaloids, and possibly basic syenites. The conglomerate is well exposed in the valley of the Waipaoa just opposite Waipaoa Station, and appears as a layer conformably interbedded with claystones. The occurrence of fragments of igneous rocks in Mangataikapua Stream suggests that the conglomerates occur in that locality also.

So far as the present examination has gone, no igneous rocks of any kind have been observed *in situ* within the subdivision.

The closing member of the Whatatutu Series is apparently a band of brownish sandstone of coarse texture, which occurs for the most part on the higher elevations—that is, on the spurs separating the heads of the various streams.

Structure of Series.—The mapping of the strikes and dips, which throughout the area have been observed with the greatest care, indicates a structure of considerable complexity. The rocks have been folded into a series of very irregular folds—in places wide and open, again much compressed. Faulting on an extensive scale has apparently greatly increased the complication. From the vicinity of Waitangi Hill north-westward to the Waipaoa River, the prevailing strike is north-west to south-east; a short distance beyond this river, however, the prevailing strikes are in directions nearly transverse to that mentioned—a feature which may imply a great fault-line approximately parallel to the general course of the river.

(*b.*) *Waipaoa Beds.*—The Waipaoa Beds are sandy pumiceous deposits, the material of which is probably derived from an area far outside the subdivision. They occur overlying the sandstone, which, as already remarked, seems to represent the highest formation of the Whatatutu Series, on the ridge to the north of Tawa Creek. Boulders of a similar character also occur on the left bank of the Waingaromia River, about three miles above Waitangi Homestead.

(*c.*) *Pleistocene and Recent.*—The valleys of the larger streams show high- and low-level terraces of some considerable extent, the surfaces of which are covered to a depth of 10 ft. or more by loosely consolidated débris, consisting of water-worn material derived from the more resistant strata occurring in the area. In the Waipaoa River this detritus also contains pebbles of igneous rocks derived from the conglomerates previously noted as occurring in the Whatatutu Series.

Economic Geology.

Petroleum.—The mineral of chief interest occurring within the area examined is petroleum, surface indications of which are well shown in the vicinity of Waitangi Hill, at the head of Te Hau-o-te-Atua Stream (see accompanying plan). A very small branch of this stream, named Petroleum Creek, exhibits oil indications on the surface of the water contained in natural springs, seepage-holes and test-pits occurring at intervals for a total distance of about 16 chains.

The natural springs are pools containing water, through which gas rises in bubbles and leaves a thin coating of oil on its surface. The seepage-holes are shallow surface depressions, with numerous minor holes which contain water showing a thin coating of oil: the soil in and around these seepage-holes is saturated with oil. The test-pits sunk by the various oil companies which from time to time have operated in this locality have depths ranging to 20 ft. At present they contain water, and, as in the case of the natural springs, sometimes show a bubbling of gas through the water with a thin coating of oil on its surface. In all, counting test-pits, springs, and seepage-holes, fifteen points showing petroleum were noted in the 16 chains.

Two samples of oil collected from the main oil-springs were submitted for analysis. No. 1 sample was collected at the end of January after some weeks of dry weather, when the pool contained much charred manuka scrub, and appeared to have been burnt off a short time before.

No. 2 sample was collected from oil which formed after the pool had been cleaned out, and heavy rains had caused an overflow which carried off any oil that had been subjected to burning. The different conditions existing when the two samples were taken probably accounts for a difference of viscosity in the two samples, and for the percentage of light oils being lower in No. 1 sample than in No. 2 sample.

The analyses are submitted below, and with them for comparison are given the analyses of a sample of oil from New Plymouth taken in 1906, and a sample from Kotuku, Greymouth, taken in 1906:—

——	From Main Oil-springs at Head of Te Hau-o-te-Atua Stream.				New Plymouth Oil.		Kotuku Oil.	
	No. 1.		No. 2.					
	Per Cent.	Specific Gravity.	Per Cent.	Specific Gravity.	Per Cent.	Specific Gravity.	Per Cent.	Specific Gravity.
Water...	Nil	...	Nil	...	Nil	...	Nil	...
Petroleum-spirit (benzene), distilling below 150°	Nil	...	Nil	...	20·2	0·7601	4·1	0·7954
Kerosene or burning-oil, distilling between 150° and 300°	25·2	0·842	47·2	0·836	42·8	0·8351	42·4	0·8443
Lubricating-oil, distilling above 300°	71·8	...	51·7	...	22·1	...	47·8	0·9024
Paraffin	3·0	...	1·1	...	10·3	...	Nil	...
Pitch ...	Nil	...	Nil	...	4·6	...	5·2	...
Loss ...	Nil	...	Nil	...	Nil	...	0·5	...
	100·0	...	100·0	...	100·0	...	100·0	...
Specific gravity of crude oil ...	...	0·900	...	0·877	...	...	...	...

Since the conditions under which sample No. 2 was taken were the more favourable, it probably is a more representative sample. When compared with the oils of New Plymouth and of Kotuku it will be noticed from the analyses that it does not contain benzene as they do, but a higher percentage of kerosene and much higher percentage of lubricating-oil. The paraffin percentage is, however, much lower than that of the New Plymouth oil.

Utility of Clays for Brickmaking.—As the work progresses in the subdivision attention is being given to the possibility of using some of the clays which occur in the area for the purpose of brickmaking. Our investigations have not proceeded sufficiently far to state anything definite on the subject. Good plastic clays, however, do occur, and at the same time contain but a small percentage of lime, so that there is every possibility that a valuable economic deposit exists.

Cement.—On account of the large extent of the deposit of siliceous chalky limestone, which has been referred to under general geology, an analysis of it was made with a view of ascertaining its value for cement-making. The following is the result of the analysis:—

	Per Cent.
Silica (SiO_2)	11·55
Alumina (Al_2O_3)	2·81
Ferric oxide (Fe_2O_3)	1·28
Lime (CaO)	45·56
Magnesia (MgO)	0·50
Carbonic oxide (CO_2)	35·80
Water (H_2O)	1·60
Undetermined	0·90
	100·00

From this analysis it will be seen that the limestone contains 81·36 per cent. of carbonate of lime, and, though the percentage of silica is high, the rock may prove useful for cement-making. One great drawback, however, to its economic value is the fact that coal for burning has not yet been discovered in the area, and the cost of burning the limestone is necessarily greatly increased.

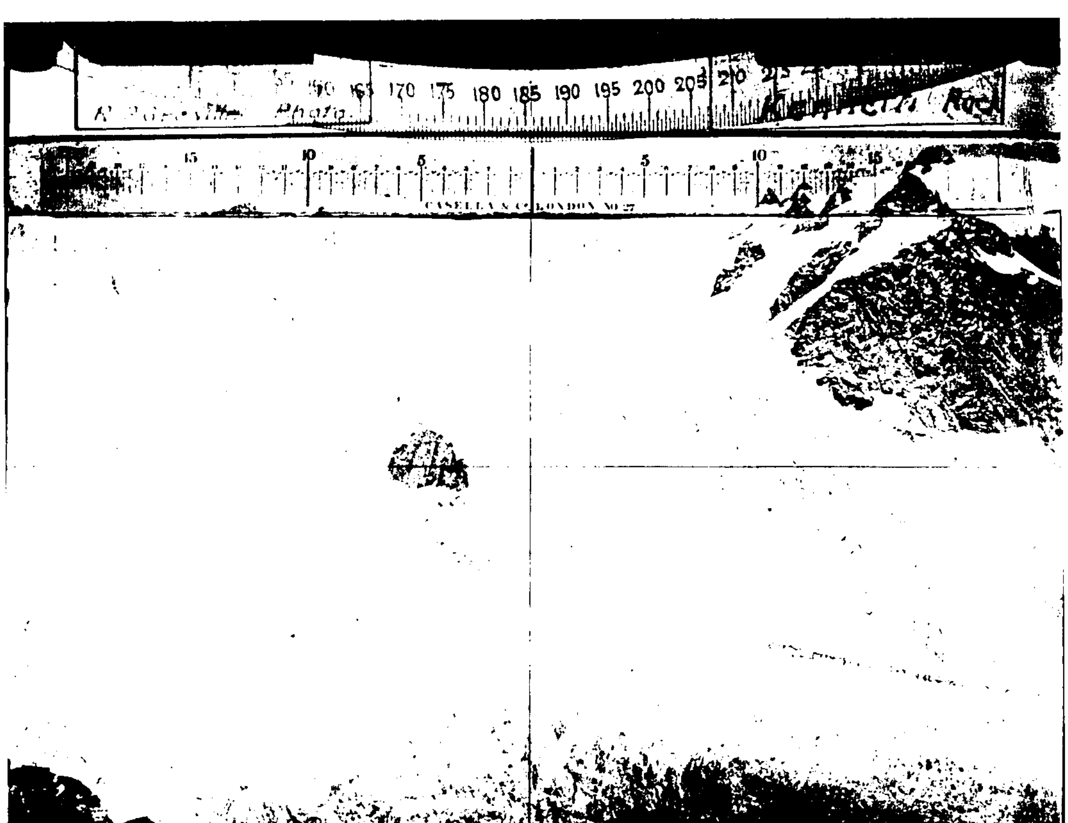
Concluding Remarks.

With regard to the location of a suitable site for a borehole in this area, one very important factor must be taken into consideration—that is, whether the petroleum-bearing formation belongs to, or is conformable with, the formations which are exposed at the surface, and the anticlines which it is possible to locate.

If the petroleum is derived from a formation not exposed and unconformable with the surface formations, and has reached the surface by rising up fault-planes or breaks, it is doubtful whether the flexures of the upper beds will correspond with those of the lower beds, and therefore

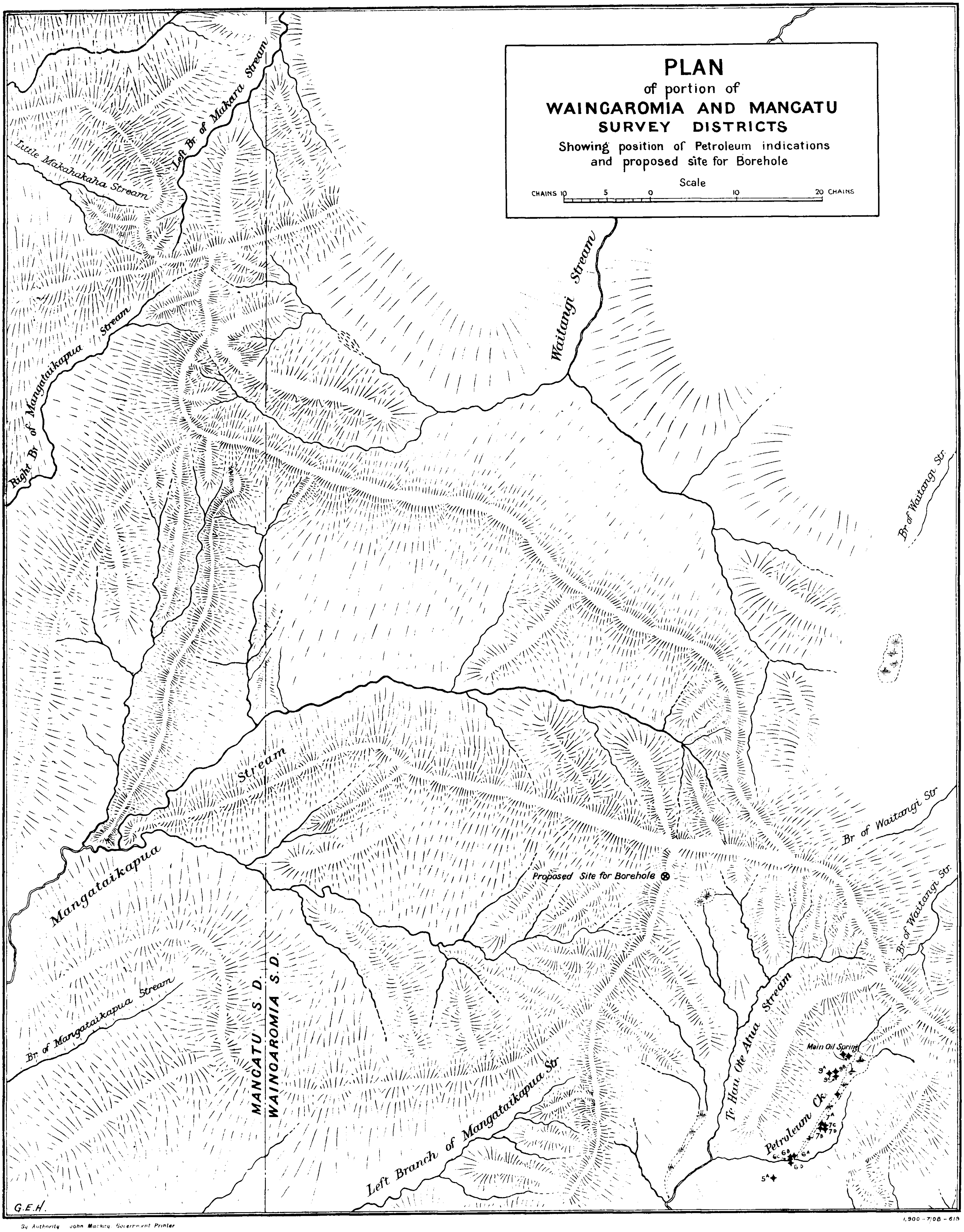
PLATE VII.

Part of Franz Josef and Blumenthal Glaciers.



Blumenthal Glacier, showing "The Blot."

To face p. 50



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the location of a dome or anticline in the upper formations will not necessarily be of any value for the location of a borehole-site. On the other hand, it is possible that the impervious beds of the Whatatutu Series have arrested petroleum derived from underlying formations, and in that case there will be every reason for believing that satisfactory borehole-sites can be located.

Investigations in the area are not sufficiently advanced to state from what formation the petroleum is derived, and this point may possibly only be settled by deep boring.

A plan on a scale of 10 chains to the inch accompanies this report, and on it will be found marked the main oil-spring; Petroleum Creek; the positions of the petroleum-indications; and a suggested site for deep boring. (See plan facing this page.)

Work remaining to be done in the Area.

As regards the work to be done in this subdivision, about two-thirds of the area has still to be examined, including the valleys of the Mangatu River, the Wheao Stream, and the Waihora River.

I anticipate completing the field-work of the subdivision by the end of May, 1909, when the preparation of the bulletin on the area will be undertaken.

Mr. R. P. Greville, Topographer.

In January, 1907, Mr. Greville was engaged in a detailed topographical survey of the valleys of the Upper Hokitika and its tributaries. Early in May the survey of this rugged area was completed, and Mr. Greville then returned to Wellington, where office-work occupied his attention until the middle of September. He then proceeded to the Karamea Division, North-west Nelson, and until the end of the year was employed in the topographical survey of an area lying between the middle part of the Aorere Valley and the Karamea Bight.

Early in January, 1908, Mr. Greville proceeded to South Westland in order to begin a topographical survey of the Franz Josef Glacier and of the surrounding country. In this work he was occupied until the middle of March, when, owing to an accident, he was obliged to return to Wellington. From that time until the end of May he has been engaged in office-work. During the past season Mr. Greville has employed a photo-theodolite for much of his work, with very satisfactory results. On his field and office work Mr. Greville has reported as follows:—

My last report extended up to the 31st December, 1906. Since that date topographical surveys have been continued in various parts of the Dominion, notably in the interior of North Westland, in the Karamea Division of Nelson, and in South Westland. The work in North Westland embraced the survey of a large area of country at the headwaters of the Hokitika and Whitcombe rivers, the geological examination of which was being carried on at the same time by Mr. P. G. Morgan.

In the Karamea Division the work included the survey of a large area of unmapped country extending from the middle portion of the Aorere Valley to the Karamea Bight on the West Coast; while the work in South Westland was confined to the making of a topographical survey of the Franz Josef Glacier and of the surrounding country.

Surveys in Westland.

Early in January, 1907, work was resumed in Westland, and the surveys of the upper portion of the Hokitika River basin and of the Whitcombe River, commenced during the previous season, were successfully completed.

The traverse of the Hokitika River was started at the last point of the settlement survey of the Lands and Survey Department, about twenty-four miles from the Town of Hokitika, and was continued to the head of the river.

The Hokitika rises about a mile south-west of the Mathias Pass, near the prominent peaks of Mount Frieda (7,013 ft.), Mount Carl (6,553 ft.), and Mount Marion (6,953 ft.), all on the main divide. For the first mile of its course the river flows towards the pass, close to which the river-bed is at an altitude of 4,117 ft., the pass itself lying a quarter of a mile to the eastward at an altitude of 4,610 ft. The river then follows a north-westerly course for a distance of nearly two miles to a point close to Frew Saddle on the Meta Range, lying about a quarter of a mile to the westward. It then flows in a north-easterly direction for about three miles. The altitude of the bed of the stream has here fallen to 3,000 ft. The river then becomes a series of cataracts and descends 1,400 ft. in a distance of one mile. It is here joined by its large tributary, the Mungo, which, taking its rise away to the eastward near a small glacier under Mount Ambrose (6,596 ft.), flows in a westerly direction for a distance of over six miles until it joins the Hokitika.

The Mungo has three large tributaries—the Park, the Brunswick, and the Sir Robert. The Park, which comes in on the north side, flows from the rugged slopes of the Commodore Range, the principal peaks of which are the Rampart (6,169 ft.), Bastion Ridge (5,946 ft.), Mount Chamberlin (5,928 ft.), and Mount Bannatyne (5,954 ft.). The other tributaries flow from the south. The Brunswick rises at the Mungo Pass and drains the precipitous slopes of the Alps from Kai-iwi Peak (6,843 ft.) on the south to Mount Park (6,710 ft.) on the north. The main branch of the Sir

Robert originates in an extensive snow-field under Shafto Peak, and smaller tributaries flow from the steep and furrowed faces of Mount Kensington (7,010 ft.), Mount Ballance (7,008 ft.), and Mount Stout (6,962 ft.), all on the dividing-range.

From the Mungo junction the Hokitika pursues a westerly course for a distance of eight miles and a half and is then joined by its largest tributary, the Whitcombe, entering from the south. The course of the river between the Mungo and Whitcombe junctions lies through a succession of gorges with high and almost perpendicular walls. Some of these gorges are of great grandeur, especially so are those which have been called Kakariki and Omatane.

Along this portion of the Hokitika many creeks join the main stream. By far the greater number join on the north side and flow from the weatherworn slopes of the Diedrich and Knobby ranges. The principal creeks are the Darby (in which there is a striking waterfall, 370 ft. high), the Serpentine, Whitehorn, and Moose.

The source of the Whitcombe River is on the pass of that name at an altitude of 4,025 ft. This river aptly perpetuates the name of one of our earliest surveyors, who in 1865 crossed the Alps from the head of the Rakaia River by way of the pass which bears his name, and after a most adventurous trip reached the sea-coast where the Town of Hokitika now stands, and a few days afterwards was drowned while attempting to cross the Teremakau River. Even now, with a fairly good track along the worst portion of the route and a carriage-road for nearly thirty miles of it, one can well appreciate the hardships poor Whitcombe and his solitary companion, Louper, must have endured in the course of their weary journey for nearly fifty miles through the damp, dismal, and trackless forests of Westland, constantly wading the large streams that they were compelled to cross, without food during most of the time, and uncertain of the difficulties still ahead of them.

The Whitcombe has a fairly straight course throughout, flowing in a direction slightly to the east of north. The length of the main river from the pass to its junction with the Hokitika is approximately eighteen miles. It has many large tributaries, the principal of these on the right bank are Bond, Chairman, Cataract, and Vincent creeks, which flow from the main divide on the east, and Frew Creek rising at Frew Saddle on the Meta Range. The main tributaries on the west are the Wilkinson, the Price, and the Cropp rivers.

The Wilkinson joins the Whitcombe about four miles from the pass. It has its sources in the striking and majestic glacier of the same name, and in the McKenzie Glacier, which lies a short distance further to the westward.

The Price drains a large extent of mountainous country lying to the east of the rugged Lange Range. Near the head of the main stream are the Price Falls of over 400 ft., the summit of which is at an altitude of 3,269 ft. above sea-level. At the confluence of the Price and the Whitcombe is the remarkably picturesque Barron Cañon. Four miles further down the main river is the junction of the Cropp, a large stream draining the country between Mount Bowen (6,516 ft.) on the north and Mount Beaumont (7,035 ft.) on the south. Other tributaries on the west worthy of note are Brow and Rapid creeks: the former joins about four miles above the Hokitika junction, and the latter about one mile below the junction.

The altitude of the area of country covered by the surveys ranges from 270 ft. at the starting-point in the Hokitika River to over 8,500 ft. Up to an average height of 3,500 ft. the whole area is covered with dense forest. The valleys of the Hokitika (above the Whitcombe junction) and of the Mungo were, prior to the present survey, an unexplored region, and, probably owing to the almost continuous series of gorges, no attempt had previously been made to open up a track through them. For the purpose of our survey a good foot-track was essential, and one was constructed. The track is on the northern side of the river, and is continued to the upper bush-line, near the head of the Mungo River. The upper portion of the Hokitika River was also approached by utilising an old track which branches off the Whitcombe Valley and crosses Frew Saddle at an altitude of 4,267 ft.

There is a fairly good track up the Whitcombe Valley, which was constructed over ten years ago under the direction of the Lands and Survey Department. The track extends as far as Chairman Creek, to a point about seven miles from Whitcombe Pass. Shortly after the construction of the track, shelter-huts were erected at various points along it for the convenience of tourists and explorers. One of these huts is at the junction of the Hokitika and Whitcombe rivers, on the north side of the river; a second is at Frew Creek, three miles up the river; a third opposite the Cropp River junction; and the last is at Price's Flat, a most picturesque spot, about nine miles from the Hokitika junction. The worst feature of the track is the very indifferently constructed cage for crossing the Hokitika River—the site of which is about half a mile above the junction of the rivers. The span is about 100 ft., and it is most desirable that a foot suspension bridge should be placed at this dangerous crossing for the convenience of those persons who have to visit this most interesting part of the country.

One of the greatest difficulties to be contended with in connection with the survey of the Whitcombe River and its tributaries was the large volume of water in the main river during the summer months. During the season from December to the end of April it was not possible to ford the river anywhere north of the Wilkinson. Recourse was had to flat-bottomed boats, the timber for which was obtained in Hokitika and packed and carried for considerable distances by the men of the party. Owing to the rapidity of the current there was always an element of danger in crossing the river, but fortunately we got through the season without accident.

Water-power.

Notwithstanding the very large volumes of water carried down by the Whitcombe and Hokitika rivers during a considerable portion of the year, I know of no place in this particular area where

PLATE VIII

THE HEAD OF FRANZ JOSEF GLACIER, SHOWING GRAHAM SADDLE.

FRANZ JOSEF, BLUMENTHAL, AGASSIZ GLACIERS.

there is a water-power of any economic value under present conditions. To utilise the waters of the Whitcombe itself would entail the expenditure of an enormous sum of money quite incommensurate with the value of the power which could be derived from it; while any attempt to utilise the streams of steeper grade such as the Price, Cropp, and Vincent, would probably be defeated by the very low discharge of the rivers in the winter-time and the absence of any storage-capacity in their basins.

Progress of the Surveys.

The traverse of the Hokitika from the Whitcombe to the Mungo junction and of the Mungo itself was carried out by Mr. Allan Wilson under my direction. He displayed considerable energy in connection with the work, which he pushed on as rapidly as was possible. He carried his traverse as far east as Mungo Pass and connected it with the previous year's surveys brought up from the Wilberforce Valley on the Canterbury side of the Alps. I personally made the survey of the Whitcombe River and its tributaries, with the exception of the Cropp, which was done by Mr. Wilson. I also made several ascents of prominent peaks to complete the topography of the high country. The Vincent Stream was traversed to the Kea Pass, which is at an altitude of 4,850 ft.

Field-work in Westland was suspended early in May, and I returned to Wellington.

Office-work.

I was engaged at the office until the middle of September. During this time I was employed completing the mapping of the Westland surveys, and assisting in the preparation of the maps for publication in Bulletin No. 3 dealing with the Parapara Subdivision.

Field-work resumed.

I left Wellington on the 14th September and proceeded to Collingwood to take in hand the survey of a large area of unmapped country extending from the middle portion of the Aorere Valley to the Karamea Bight on the west coast. Work was continued in that locality until the end of the year, and a large area of topographical survey was executed. Included in this was a detailed survey of a considerable scope of country known as the Gouland Downs, which lie at an altitude ranging from 2,000 ft. to 2,500 ft. above sea-level. The area dealt with being beyond the limits of any triangulation, I had, for the purposes of the topographical work, to extend the triangulation as the topographical work proceeded.

Mr. H. Richardson, Assistant Topographer, who joined the staff in October, has also been engaged continuously upon topographical surveys under my direction, in the Karamea Division. He was located on the west coast south of the Wanganui Inlet. Besides a careful survey of the coast-line, Mr. Richardson has made detailed surveys of the main streams flowing from the Whakamarama Range to the sea-coast, the principal of these being the Anatori, the Turimawiwi, the Anaweka, and Big rivers—as well as several of their larger tributaries.

Mr. A. J. Whitehorn, who was seriously ill in the early part of last season, was able to resume work again in January last. He has been engaged in making compass traverses of the Heaphy River and its important tributaries, and has done much useful work in that isolated and inaccessible region.

Work at the Franz Josef Glacier.

Early in January, under special instructions, I proceeded to South Westland to undertake a topographical survey of the Franz Josef Glacier and of the country surrounding it, as well as to determine the various movements of the glacier preparatory to a geological examination of the particular area being subsequently made. Work was continued at the Franz Josef Glacier until the middle of March, and much valuable topographical information was obtained.

A triangulation was extended to near Graham's Saddle and several useful observation-points fixed. The longitudinal movement of the glacier was carefully determined over a period of thirty-six days. A section was also made across the glacier about half a mile above the terminal face, and was extended for several hundred feet on each side of the glacier to the limits of the ice-worn rock. The results in detail of the investigations conducted at the Franz Joseph Glacier will be published later in a special paper.

The Photo-theodolite.

During the past season great use was made of the above valuable adjunct to topographical surveying. The instrument was utilised in the Karamea Division during the latter part of last year, and also in connection with the work at the Franz Josef Glacier. The photo-theodolite, as its name implies, is a theodolite and camera combined. Photographs with a field of view of 42° are taken with the instrument at fixed points at each end of a base line. All points which can be identified on both photographs can by a comparatively easy process be accurately laid down on the map.

The illustrations published with this report will give a good indication of the great utility of the instrument for the class of work for which it is being used.

Work in Office resumed.

Owing to a slight injury to my knee at the Franz Josef Glacier I was compelled to discontinue field-work for the rest of the season. I returned to Wellington on the 18th March, and was engaged until the end of May in working out the results of my Franz Josef work, and in the preparation of maps of surveys executed during the year.

MR. R. J. CRAWFORD, SENIOR DRAUGHTSMAN.

The draughting staff has been fully employed since the 1st January, 1907, as will be seen from the following summary of the work given by Mr. Crawford, Senior Draughtsman:—

Maps have been prepared and published with the several bulletins as follows:—

For Bulletin No. 3 on the Parapara Subdivision of Karamea Division:

Topographical and geological maps of Aorere and Waitapu survey districts, compiled and drawn on the scale of 40 chains to an inch, for reduction by photography to the scale of one mile to an inch.

Geological map of Washbourn Block, drawn on the 5-chain scale for reduction to the 10-chain scale.

Geological map of Golden Ridge area, drawn on the 10-chain scale for reduction to the 20-chain scale.

Topographical and geological map of Boulder Lake and vicinity.

Four geological sections.

Plan of proposed wharf-site at Tukurua.

Plan of Aorangi Gold-mine workings.

Two sheets of lake and river cross-sections.

Two drawings of rock-specimens, one sectional diagram, and one sketch.

For Bulletin No. 4, on the Coromandel Subdivision of Hauraki Division:

Geological maps of Colville, Moehau, and Harataunga survey districts on one sheet; Coromandel and Otama survey districts separately, compiled and drawn on the scale of 40 chains to an inch, for reduction by photography to the scale of one mile to an inch.

Five geological sections, all on the same scale as the above, and the following detail plans: Quartz veins in the Hauraki group of mines; quartz veins in the vicinity of Coromandel: principal veins in the Kapanga Gold-mine; Royal Oak and Hauraki Associated Gold-mines; mining claims in the vicinity of Coromandel: mining claims in the vicinity of Kuaotunu; five diagrams of stream-profiles, and one enlarged drawing of fossil (belemnite).

For Bulletin No. 5, on the Cromwell Subdivision of Western Otago Division:

Western Otago Division Index map.

Geological maps of Wakefield, Cromwell, and Bannockburn survey districts separately; Kawarau and Crown on one sheet, drawn on the scale of 40 chains to an inch, for reduction to the scale of one mile to an inch.

Six geological sections on the same scale as above, and the following detail plans: Geological map of Bannockburn Coalfields and Carrick Goldfield; geological map of Cromwell Township; Cromwell Gold-mining Company's property at Bendigo; topographical map of north end of Remarkables; eight detail geological sections, and forty-seven diagrams.

The following maps are in course of preparation for *Bulletin No. 6, on the Mikonui Subdivision of North Westland Division*, some of them being in the printer's hands:—

Topographical and geological maps of Totara, Toaroha, Whitcombe Pass and adjoining area, Mount Bonar and adjoining area, separately; and Waitaha, Clifton, and Murray survey districts, on one sheet.

Preliminary sheets have been compiled on the scale of 20 chains to an inch, from data collected at the various district survey offices, of the following survey districts for the purpose of forming a basis on which the more detailed maps could be built up as the field-work proceeded:—

For Whangaroa Subdivision of Hokianga Division:
Whangaroa, Kaeo, Omapere, and Mangonui.

For Thames Subdivision of Hauraki Division:
Whitianga, Hastings, and Thames.

For Whatatutu Subdivision of Raukumara Division:
Waingaromia and Mangatu.

For Heaphy Subdivision of Karamea Division:
Paturau and Wakamarama.

For Mount Radiant Subdivision of Westport Division:
Kongahu and Otumahana.

For the purpose of preparing maps of the districts enumerated, and a few others not immediately required, tracings were made from the triangulation plans and 10-chain block-sheets of eighteen survey districts, necessitating in all about 240 tracings. This work kept Mr. Harris away from headquarters for eight weeks and a half, and Mr. Darby for five weeks and a half. The former was also away assisting the field officers in camp for fifteen weeks, and at the Government Printing Office drawing colour stones for Bulletin No. 3, two weeks; while the latter spent some twenty weeks in camp.

Among other miscellaneous work should be mentioned,—

A small map of New Zealand, and another of part of Mikonui Subdivision to illustrate last year's annual report.

Two diagrams for Bulletin No. 6, and three detail plans for Bulletin No. 7, not yet published.

The general routine work has been carried on, such as the revising and colouring of proofs of maps for publication, the recording of plans and field-books, and the making of tracings for various purposes.

An outstanding feature of the year's work is the inauguration of the system of compiling preparatory maps on the working-scale of 20 chains to an inch, referred to above. The adoption of this system has greatly facilitated the work of the Geological Survey parties, and will eventually simplify in great measure the work of the draughtsmen in compiling the final maps.

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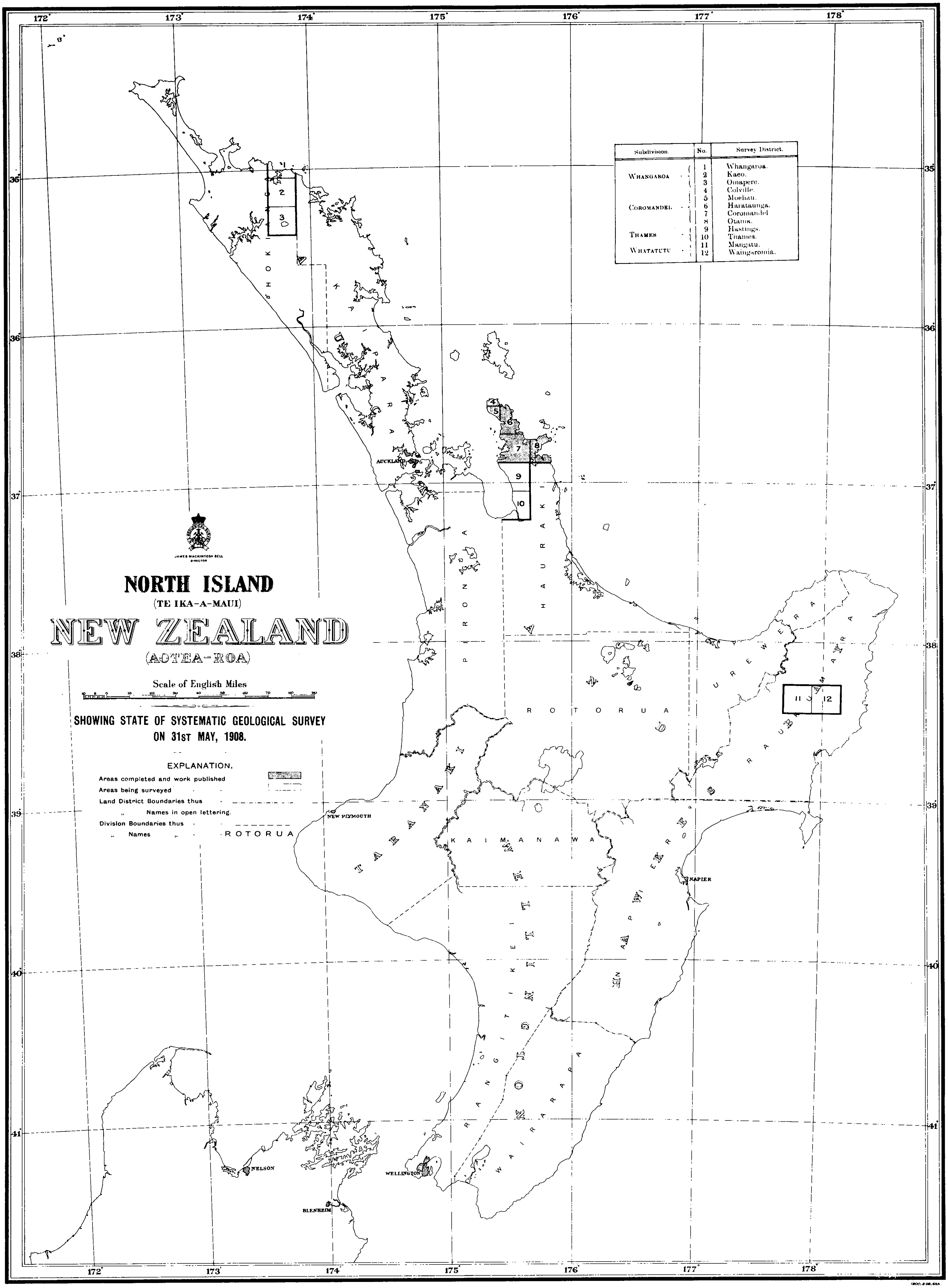
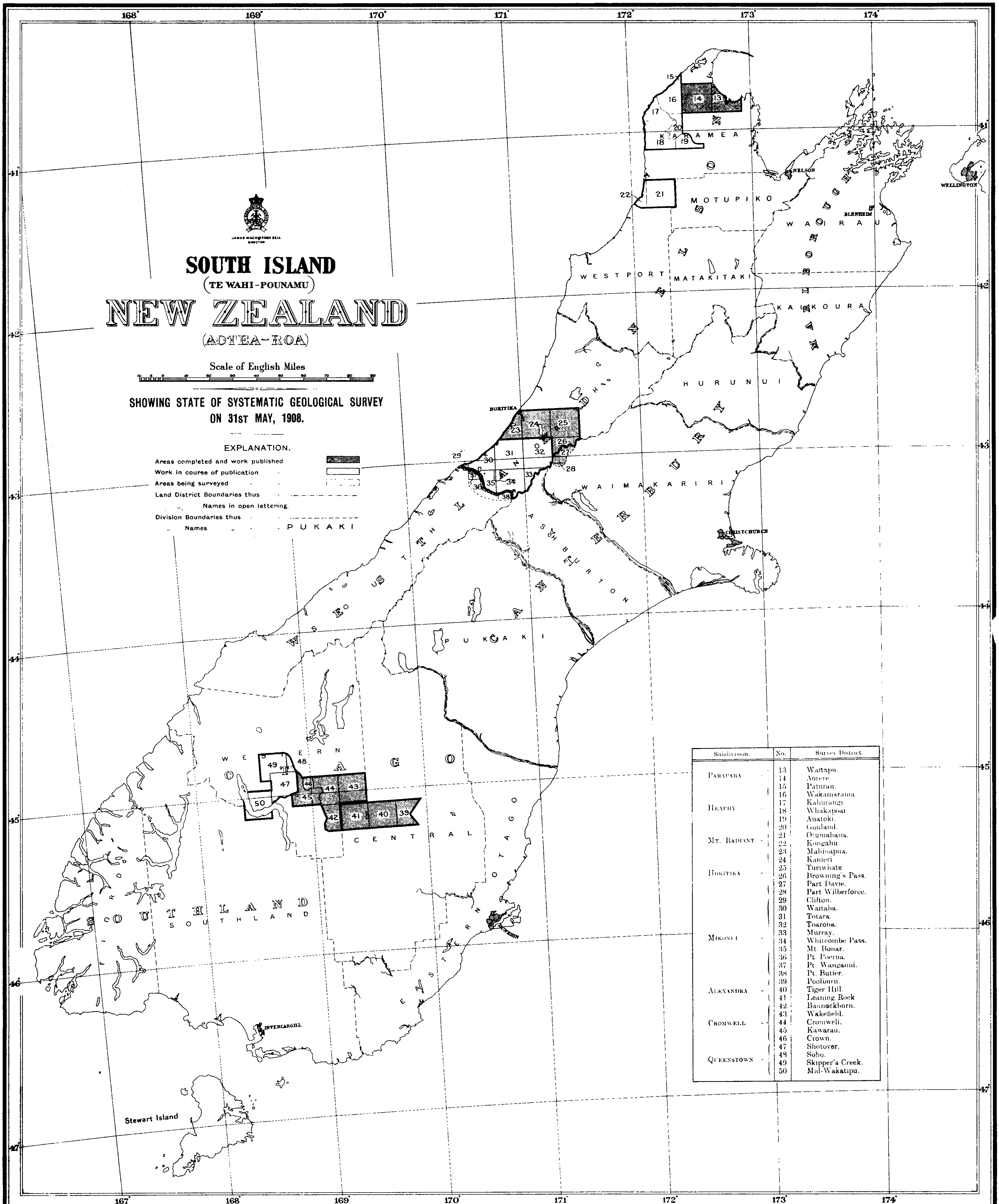

NORTH ISLAND
(TE IKA-A-MAUI)
NEW ZEALAND
(AOTEA-ROA)
JAMES MACKINTOSH BELL
DIRECTOR
Scale of English Miles
SHOWING STATE OF SYSTEMATIC GEOLOGICAL SURVEY
ON 31ST MAY, 1908.
EXPLANATION.
Areas completed and work published
Areas being surveyed
Land District Boundaries thus
Names in open lettering.
Division Boundaries thus
Names ROTORUA
Subdivision. | No. | Survey District.
WHANGAROA | 1 | Whangaroa.
| 2 | Kaeo.
| 3 | Omapere.
COROMANDEL | 4 | Colville.
| 5 | Moehau.
| 6 | Harataunga.
| 7 | Coromandel
| 8 | Otama.
THAMES | 9 | Hastings.
| 10 | Thames.
WHATATUTU | 11 | Mangatu.
| 12 | Waingaromia.
172° 173° 174° 175° 176° 177° 178°
35° 36° 37° 38° 39° 40° 41°
AUCKLAND
NEW PLYMOUTH
NAPIER
WELLINGTON
NELSON
BLENHEIM
ROTORUA
KAIMANAWA
TARANAKI
HAURAKI
UREWERA
WAIRARAPA
RANGITIKEI



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