1907.
NEW ZEALAND.

NEW ZEALAND GEOLOGICAL SURVEY DEPARTMENT

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

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

SIR,— Geological Survey Office, Wellington, 1st January, 1907.

I have the honour to present to you the first annual report (new series) of the Geological Survey Department. This report deals particularly with the operations of the Geological Survey during the year 1906; but, as it is the first report of the Department, since its reorganization in 1905, designed for general circulation, it has seemed advisable to give some account of the survey previous to that date, together with a brief description of the work accomplished during 1905.

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

The Hon. James McGowan, Minister of Mines.

HISTORICAL.

Previous to F. von Hochstetter's arrival in 1858, little was known about the geological features of New Zealand, though a number of naturalists, including Charles Darwin, J. D. Dana, and E. Dieffenbach, had visited our shores, and given to the world various notes concerning New Zealand geology.

Hochstetter was commissioned by the New Zealand Government to report on the geology of these Islands as far as the nine months at his disposal would allow. The results of his work, as embodied in "New Zealand" and his other publications, were of the highest value, in a great part forming the foundation of subsequent more detailed operations.

Hochstetter's visit to New Zealand was followed by an outburst of activity on the part of several of the Provincial Governments. Geological surveys, initiated in Otago, Canterbury, and Wellington, under the conduct of such men as Hector, Hutton, and von Haast, resulted in some useful work being done.

The first geological survey of all New Zealand was started in 1867, when the New Zealand Government passed an Act "to establish an Institute for the Advancement of Science and Art in New Zealand, and to make Provision for the Carrying-out of the Geological Survey of the Colony."

Sir James Hector—then Dr. Hector, in charge of the Otago Provincial Survey—was chosen as Director of the Geological Survey of New Zealand. This position, together with many others, he ably filled until his retirement in 1903. Among those associated with Sir James Hector were Mr. S. Herbert Cox (now Professor of Mining in the South Kensington Technical Institute), the late Captain F. W. Hutton, F.R.S., Mr. A. McKay, F.G.S., and Professor James Park, F.G.S. The hearty appreciation of all geological workers in New Zealand is due to the Director and staff of the early Survey. When Sir James Hector first took charge of the work the difficulties of travel were very great. The country contained few roads and practically no railways, communication being mainly by rough tracks or by small vessels along a generally dangerous coast. It is marvellous what was accomplished by so small a staff under such conditions. Now most of the country is well opened up by roads, railways, or tracks, and, in addition to these travelling facilities, we have the successful results of the labours of the former Survey on which to base our geological operations. Our work is to a great extent a detailed study of the features broadly mapped by the former Survey, and to a less degree consists of reconnaissance surveys of areas which, in a geological sense, are still *terræ incognitæ*.

For purposes of reference there is here inserted a list of publications of the Survey previous to its reorganization in 1905.

Reports.

Survey Reports Nos. 1 to 22 (1866–94).
Report on the Fossil Remains of New Zealand. J. W. Davis. (From Trans. Royal Dublin Society, Vol. iv, Ser. 11, 1885.)
Bulletin No. 1, 1888: Amuri Earthquake. A. McKay. October, 1888.
Bulletin No. 2, 1888: On the Ophir District, Otago. James Park. November, 1888.
Index to Geological Reports, 1866 to 1885. 1889.
Bulletin No. 1, 1892: West Coast Goldfields. A. McKay. 1892.
Annual Reports on the Colonial Museum and Laboratory, Nos. 1 to 27 (1866–93).

Maps.

Geological Map of Both Islands of New Zealand, 1869.
Geological Map of Both Islands of New Zealand, 1873.
Geological Map of Both Islands of New Zealand, 1880; and on a reduced scale in handbook (Melbourne Exhibition).
Geological Map of Both Islands, 1883, in "Handbook of New Zealand, 1883," and in Geological Report No. 16, 1884.
Geological Map of Both Islands, 1885. Same as above, but dated 1885 in Catalogue of New Zealand Court, Indian and Colonial Exhibition, 1886.
Sketch-map of Mineral Localities, 1886. In Geological Report No. 16, 1887.

Published by Mines Department of New Zealand Government (1894–1904).

Reports of the Government Geologist and others, as parliamentary papers. (*Vide* papers and reports relating to minerals and mining.)
Annual Reports of the Colonial Analyst from 1893. No. 28 to date have been issued by the Mines Department.

Separate Publications.

Catalogue of Geological Models and Casts.
Palæontology of New Zealand: Part IV—Fossil Corals and Bryozoa. Tenison-Woods.
Report on the Tarawera Volcanic District. F. W. Hutton. 1887.
Handbook of New Zealand Mines. 1887.
Report on the Eruption of Tarawera and Rotomahana. Professor Thomas. 1888.
Report on the Auriferous Drifts of Central Otago. A. McKay. 1894.
Report on the Recent Seismic Disturbances within Cheviot County in Northern Canterbury and the Amuri District of Nelson. A. McKay. 1902.
Rocks of Cape Colville Peninsula. Determined by Professor Sollas. Introduction and Descriptive Notes by A. McKay. Vol. i, 1905; Vol. ii, 1906.

NOTE.—The list of publications of the Geological Survey is taken almost *in toto* from Colonial Museum Bulletin No. 1, by A. Hamilton, Esq., Director.

A list of papers on New Zealand geology, arranged under authors' names, is given in Vol. xxxv, page 489, of the Transactions of the New Zealand Institute, and this, of course, gives the whole of the papers written by officers of the Geological Survey of New Zealand prior to 1902.

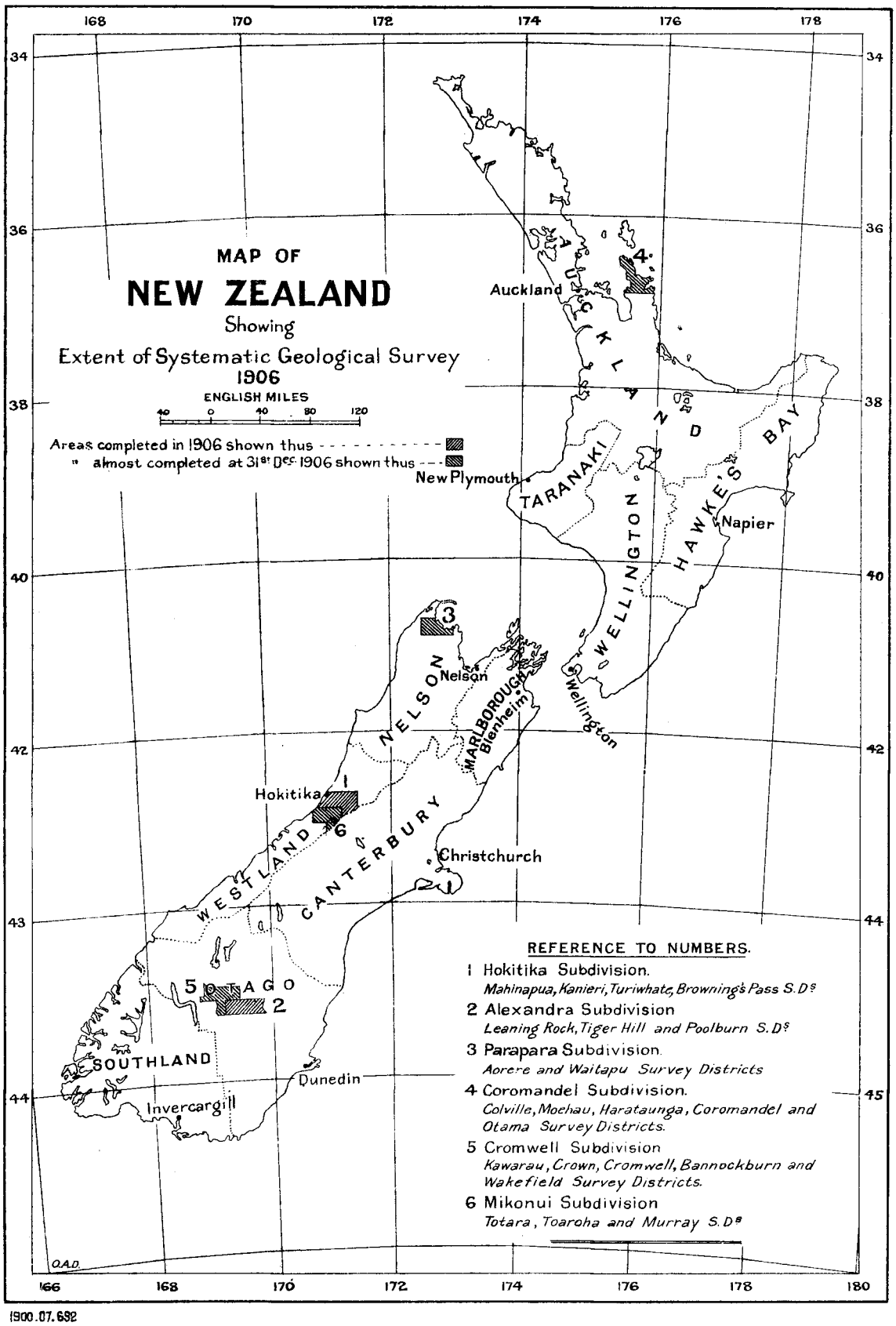
REORGANIZATION OF THE SURVEY.

Towards the end of 1904 I was appointed as Director of the Geological Survey in succession to Sir James Hector. On my arrival in New Zealand in February, 1905, the Survey was reorganized, provision being made for the appointment of a permanent field and office staff. Besides these permanent officers, allowance was made for the appointment of temporary assistants on the various field staffs, and for the obtaining of skilled assistance, if required, for extra work during the summer months.

The reorganized Geological Survey Department has outlined a scheme for the preparation of a detailed topographical and geological map of New Zealand. For this purpose the country has been cut up into divisions, each one of which is supposed to present a problem of especial interest, or several such problems, which can be conveniently grouped together. For example, the Hauraki division is of note chiefly on account of its containing the richest quartz-mining fields of the colony; the Karamea division contains the immense iron-ore deposits occurring near Parapara; the North Westland division is of marked interest because of its richly auriferous gravels, and of the veins and rock-masses from which they were derived; the Rotorua division contains the chief manifestations of the remarkable thermal phenomena for which New Zealand is justly famed; and so on.

Each division contains a number of survey districts corresponding in boundary with those of the Lands and Survey Department. Several survey districts which can be conveniently grouped together to give a continuous section of country comprise a subdivision. It is intended to prepare full reports, accompanied by geological and topographical maps, on each subdivision as soon as the necessary field-work in each case is completed, and to issue these to the public without delay at an almost nominal price.

In carrying out the geological field-work a good topographical map is the first requisite; and on it, as a basis, the geological work is placed. The whole area which is being investigated is most carefully examined, the various creeks are ascended, and the spurs and ridges followed in mountainous country. Every phase of geological science is given attention—the palæontologic, petrographic, structural, physiographic, and economic. However, especial stress is laid upon the economic side of geology, which relates to the occurrence of minerals of commercial value, and has a direct bearing upon the mining industry, the development of which is so important in any new country.


MAP OF
NEW ZEALAND
Showing
Extent of Systematic Geological Survey
1906
ENGLISH MILES
40 0 40 80 120
Areas completed in 1906 shown thus
" almost completed at 31st Dec. 1906 shown thus
Auckland
New Plymouth
Napier
Nelson
Wellington
Hokitika
Christchurch
Dunedin
Invercargill
AUCKLAND
TARANAKI
HAWKE'S BAY
WELLINGTON
NELSON
MARLBOROUGH
Blenheim
WESTLAND
CANTERBURY
OTAGO
SOUTHLAND
REFERENCE TO NUMBERS.
1 Hokitika Subdivision.
Mahinapua, Kanieri, Turiwhate, Browning's Pass S.Ds
2 Alexandra Subdivision
Leaning Rock, Tiger Hill and Poolburn S.Ds
3 Parapara Subdivision.
Aorere and Waitapu Survey Districts
4 Coromandel Subdivision.
Colville, Mochau, Harataunga, Coromandel and Otama Survey Districts.
5 Cromwell Subdivision
Kawarau, Crown, Cromwell, Bannockburn and Wakefield Survey Districts.
6 Mikonui Subdivision
Totara, Toaroha and Murray S.Ds
168 170 172 174 176 178
34 36 38 40 42 43 44 45
166 168 170 172 174 176 178 180

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As the result of our labours, carefully prepared geological maps of the areas examined, especially arranged with a view to aid prospectors, will be obtainable. On these maps we do not pretend to locate every feature of economic interest, though many of these may be discovered in the course of our examinations; but we do hope to delineate the horizon within which prospecting for deposits of commercial value may be conducted with a reasonable hope of success.

The nature of the country and the detailed examination undertaken prevent more than a very limited area being examined in a single year with the staff at present available, but the work that is completed from time to time may be regarded as practically final. Of course, the classification of the rocks according to age cannot be finally worked out until considerable areas have been examined, and hence the grouping adopted in the earlier bulletins is subject to alteration. Similarly other general features may require revision.

Much of the mountainous country of New Zealand is unsuitable for agriculture or pasturage, and its chief value would seem to be in its mining and water-power potentialities. As yet we have no comprehensive idea as to what our mineral resources actually comprise, since much of the country, especially the mountainous part, is still not thoroughly explored. To gain the required knowledge a careful and detailed geological survey is certainly necessary, and it is highly desirable that the class of work now in progress should be pushed on as much as possible, so that results of economic value may be available without delay.

SUMMARY OF OPERATIONS DURING THE YEAR 1905.

During the year 1905 detailed field-work was begun in the North Westland division, in the Hauraki division, and in the Central Otago division. The first work undertaken was in the Hokitika subdivision of the North Westland area, which was started in April, 1905, with Mr. Colin Fraser, M.Sc., as Assistant Geologist, Mr. C. E. Adams, B.Sc., as Topographer, and myself in charge of the survey. At the end of May, leaving the Westland work in Mr. Fraser's hands, I departed on a general tour throughout the North Island and parts of the South Island, in order to familiarise myself with the various mining localities of the colony. Various departmental matters had also to be attended to, but by the beginning of August I was back at work in the Hokitika subdivision with Mr. Fraser, who had before my arrival been joined by Mr. P. G. Morgan, General Geologist. The topographical work was now undertaken by Mr. R. P. Greville, who succeeded to the position of Topographer, some weeks after Mr. Adams had retired in July. At the end of October I left for Coromandel, in order to initiate detailed work in the Hauraki division. Here, in a few weeks, I was joined by Mr. Fraser, while Mr. Morgan commenced operations in the southern portion of the North Westland division—the Mikonui subdivision. Mr. Greville remained in North Westland in order to carry out the topographical mapping of the hitherto unsurveyed parts of the Hokitika and Mikonui subdivisions.

Professor James Park, of Otago University, was engaged under special agreement for the summer season of 1905–6, and in November, 1905, started field operations in the Alexandra subdivision of Central Otago.

By the end of the year 1905 the work of the newly organized Geological Survey was well started. I come now to a detailed account of our operations during the year 1906.

DETAILED REPORT FOR THE YEAR 1906.

Office Work.

Reports.—During the year 1906, in addition to my report to you for the year 1905, published in Parliamentary paper C.–3, 1906, two separate bulletins were brought out by the Geological Survey. No. 1, written by myself with the assistance of Mr. Colin Fraser, bears the title "The Geology of the Hokitika Sheet, North Westland Quadrangle, with which has been included a small portion of the Upper Wilberforce Valley in the Waimakariri Quadrangle." Although the actual field-work was not completed until the end of May, the bulletin was ready for presentation to Parliament on the 30th August.

Bulletin No. 2, written by Professor James Park, and based on the results of his geological examinations during the summer months of 1905–6, is entitled "The Geology of the Area covered by the Alexandra Sheet, Central Otago Division." Both bulletins contain maps which exhibit the geology and topography of the areas which each report covers.

During the year 1,425 bulletins were issued, largely in exchange for the publications of other surveys, scientific societies, &c.

Correspondence.—One of the most gratifying features of the work throughout the year has been the great interest apparently taken by the public of New Zealand, and even of the outside world, in the operations of the Geological Survey. We are constantly receiving inquiries from various parts of the colony, from Great Britain, and elsewhere, as to the occurrence, or the contrary, of various mineral deposits and their location if occurring. Requests are also frequently coming to hand for the identification of mineral and rock specimens, and for information on various technical subjects relating to the mining industry of the country. Moreover, applications for geological inspections to be conducted in a detailed manner have been received from quite a number of places.

The correspondence received and answered may be tabulated under the following headings:—

	Received.	Answered.	Total.
Letters requesting the identification of minerals ...	41	58	99
Applications for employment	40	45	85
Letters requesting the services of Geological Survey officers in the field	29	15	44
Letters on technical subjects relating to mining ...	116	123	239
Departmental letters and memorandums	293	340	633
Letters on general subjects	301	348	649
	820	929	1,749

No less than 115 specimens of rocks and minerals have been identified and reported on this year by officers of the Department at headquarters.

Library.—During the year we have been able to make a great improvement in the condition of the departmental library. This betterment is due partly to the purchase of text-books, but more especially to the generosity of various scientific and mining departments and institutions throughout the world, who have supplied us with their recent publications in exchange for our bulletins, and have even in many instances given us, gratis, past publications, now of considerable value. The library now contains 1,609 volumes.

The superintendence of the library, as well as the general clerical work, has been conducted by Mr. John Thompson.

Staff.

During the year the technical staff of the Department has been increased by the appointment of Messrs. Ernest John Herbert Webb, Edward de Courcy Clarke, and James Henry Adams, Assistant Geologists; Kenneth Montrose Graham, Assistant Topographer; and Owen Ambrose Darby, Cadet Draughtsman, transferred from the Department of Lands and Survey; while Mr. John Thompson and Mr. Peter Clarke have been appointed to the clerical staff.

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

Director of the Geological Survey ...	James Mackintosh Bell, M.A., Ph.D.
General Geologist	Percy Gates Morgan, M.A.
Mining Geologist	Colin Fraser, M.Sc.
Assistant Geologist	Edward de Courcy Clarke, M.A.
Assistant Mining Geologist	Ernest John Herbert Webb, B.E.
Assistant Mining Geologist	James Henry Adams, B.Sc.
Topographer	Reginald Palmer Greville.
Assistant Topographer	Kenneth Montrose Graham, A.O.S.M.
Draughtsman	Robert James Crawford.
Cadet Draughtsman	Owen Ambrose Darby.
Correspondence Clerk	John Thompson.
Cadet Clerk	Peter Clarke.

Acknowledgment.

It gives me pleasure here to express my appreciation of the many favours received from the Department of Lands and Survey. I particularly wish to thank them for giving us the services of Mr. George Edward Harris, draughtsman, since the 26th September, and also for allowing another draughtsman to prepare several maps of Bulletin No. 2.

New Zealand Geological Survey Exhibit at the New Zealand International Exhibition.

We were instructed during the year to prepare a Geological Survey exhibit for the International Exhibition at Christchurch. Owing to the very short time at our disposal, it was absolutely impossible to prepare, with the limited material at hand, an exhibit in the least degree representative of the widely varied and extensive mineral wealth of New Zealand, so we thought it best to limit ourselves to obtaining a good display of minerals and rocks of economic value, discovered or examined in the Hokitika subdivision of North Westland during its geological survey. In this much delay was occasioned owing to the difficulty of obtaining specimens from the high country of Westland at a season when it is covered with snow, but, nevertheless, a collection fairly representative of the mineral wealth of the Hokitika area was obtained.

It seems apparent that every effort should now be made to get together as soon as possible at least two representative collections of specimens of New Zealand rocks and minerals of economic value. One of these should be for permanent display in Wellington, and the other might be used for exemplifying the colony's mineral wealth at the various exhibitions throughout the world to which exhibits are sent from this country. These displays might be arranged in such order as to exemplify the various uses to which the rocks and minerals could be placed. In this way, by adopting the system in vogue in the Canadian Geological Survey, the following classes might be separated:—

Metals and their ores, such as ores of gold, silver, zinc, copper, &c.
Materials used for heat and light, such as petroleum and coal.
Minerals for chemical manufactures, such as pyrite and phosphate.
Mineral pigments, such as iron, ochres, and cobalt ores.
Refractory materials, and minerals applicable to the manufacture of pottery, &c., such as asbestos, soapstone, feldspar, and fireclay.
Materials for grinding and polishing, such as grindstone and pulpstone.
Materials for fine arts and jewellery, such as greenstone (nephrite).
Materials applicable to construction, such as granite and serpentine.

There is no doubt that a collection such as this would greatly increase general interest in the rocks and minerals of the colony, and would give a decided stimulus to the mining and quarrying industries. This would, I think, amply compensate for the expense in arranging the displays.

Parties in the Field.

This season we have four parties in the field—one in the Coromandel subdivision of the Hauraki division of Auckland, one in the Parapara subdivision of the Karamea division of Nelson, one in the Cromwell subdivision of Western Otago, and one in the Mikonui subdivision of North Westland. The Coromandel work is in charge of Mr. Colin Fraser, and he is assisted by Mr. J. H. Adams. The Parapara party is under my own direction, and I am assisted on the

geological side by Mr. E. J. H. Webb and Mr. E. de C. Clarke, and on the topographical by Mr. K. M. Graham. It was considered advisable for me to have the assistance of both Mr. Webb and Mr. Clarke, in order that they might become familiarised with the methods of geological survey work. The geological work in North Westland is being directed by Mr. P. G. Morgan, while the topographical survey in the same area is under Mr. Greville's direction. Professor James Park has been again given temporary employment by the Geological Survey, and is now prosecuting work, with several temporary assistants, in the Western Otago division.

Routine of the Year.

Throughout the year I have been engaged practically continuously in field-work, with the exception of the period from the 13th April to the 8th September. During this period I was engaged at headquarters in the preparation of my report for the year 1905 and of Bulletin No. 1 on the Hokitika Sheet of North Westland, and in various other matters arising out of the supervision of the departmental work throughout the colony.

As previously mentioned, at the close of 1905 I was engaged with Mr. Colin Fraser in the geological survey of the Coromandel subdivision of the Hauraki Peninsula. Early in January, feeling that the work was well started, I left this part of the survey-work in Mr. Fraser's hands, and departed for Auckland. While in Auckland I was enabled to pay a brief visit to the Drury Mine, near the city, and attend to other minor departmental matters. On the 22nd January I left Auckland, and proceeded south *via* the Wanganui River. At Wellington and Christchurch a few days were necessarily spent in attending to various departmental matters, but by the beginning of February I was able to join Professor Park in Central Otago, where he was engaged in prosecuting the geological survey of the Alexandra subdivision. A few days were passed with Professor Park, in order to familiarise myself with the interesting work which he had in hand, and a departure was then made for the Hermitage, Mount Cook. The route followed was by the road from Cromwell, up the Clutha Valley to Queensberry, and thence across the Clutha River to Tarras Station, on to Omarama and Lake Pukaki, and thence to the Hermitage. Some ten days were spent in and around the Hermitage, and a very good general idea was obtained of this centre of glaciation in New Zealand. As a stranger to the country, I was greatly impressed with the magnificence of the ice features, and their really wonderful proportions, considering the relatively low altitude of the country and its comparative proximity to the Equator.

Reconnaissance of Copland River.—On the 26th February I left the Hermitage in company with Guide Clarke and Dr. Marshall, and, having crossed the lofty mountain col in the Moorehouse Range known as Fitzgerald Pass, we descended into the valley of the Copland. This river was followed to its junction with the Karangarua, down which we continued to the Main South Road.

The Copland rises in the Marchant Glacier, under the name of the Douglas. About five miles below the frontal face of the glacier it is joined by the Strauchon, a river which flows from a glacier of the same name. The Copland is a typical example of a stream formed by glacial erosion of a pre-existing river-channel, as shown by the broad U-shaped valley, smooth steep mural precipices bordering it, and by the truncation of spurs jutting from the ridge on either side of the valley. Scenically the river-valley is of great beauty, with its gorgeous vegetation, magnificent cliffs, and the snow-clad peaks ever visible in the background. Lithologically the river-valley is not of great interest, and there is a pronounced similarity in the rocks exposed along its banks. Near the headwaters schistose argillites and phyllites prevail, while more to the westward these are underlain by highly metamorphic mica-schists and quartz-schists. Vein quartz is generally conspicuous by its absence. Alluvial gold has been found, I believe, at Welcome Flat, situated some five miles below the mouth of the Strauchon, but never in any appreciable quantity. Scientific interest in the lower part of the river centres around some remarkable thermal springs on the northern bank of the stream, just below Welcome Flat. These springs rise in a small flat-topped area of brownish sinter exhibiting miniature terraces. The sinter area is surrounded by a luxuriant growth of New Zealand flax and other coarse vegetation, while close at hand, beneath an immense erratic, apparently but slightly removed from its original position, is a cave at the base of which a spring heavily charged with hydrogen-sulphide occurs. The springs issuing through numerous orifices within the sinter area are at a high temperature, but below boiling-point.

Assays were made of the sinter by Dr. Maclaurin, Colonial Analyst, and gave negative results for gold, silver, and platinum. An analysis of hot water issuing from the springs gave the following results, which are expressed in grains per gallon: Potassium-chloride, 2·3; sodium-chloride, 17·0; sodium-bicarbonate, 76·6; calcium-bicarbonate, 27·0; magnesium-bicarbonate, 2·5; ferrous bicarbonate, 2·0; sodium-silicate, 14·9: total solids, 142·3 grains. This shows a mineral water resembling the Puriri waters, containing, however, a very much smaller amount of salts than the latter. The Copland water may perhaps be of value as a mild alkaline water.

Early in March, after proceeding to Christchurch *via* the Otira Gorge and Arthur's Pass, I joined Mr. Colin Fraser at the head of the Wilberforce River, travelling from Christchurch by way of Lake Coleridge. Mr. Fraser, who had left his work in the Hauraki division to assist me in Westland, in order that a bulletin on the Hokitika subdivision could be published during the session, was at the time engaged on a detailed survey of the area included within the Westland Reefs Mining District, which lies between the area drained by the headwaters of the Wilberforce River, a tributary of the Rakaia flowing eastward through Canterbury, and the headwaters of the Arahura River, flowing westward through Westland. This district, and the contiguous mountainous country to the westward within the limits of the Hokitika subdivision of North Westland, occupied the united attention of Mr. Fraser and myself for the rest of the season.

As already remarked, I returned in April to Wellington and gave my attention to office-work there until the 8th September, when I departed for the southern part of the Hot Lakes District.

Work in the Southern Part of the Hot Lakes District.

In my report for 1905 attention was drawn to the remarkable discovery of gold and silver occurring in appreciable quantities in the siliceous sinters at Whakarewarewa, in the Hot Lakes District. In that same statement the hope was expressed that a detailed survey would soon be undertaken of the diverse and ever-varying phenomena of that wonderful thermal region. This survey seems all the more necessary as our information concerning the area increases. During the reconnaissance of this season, investigations were limited to the southern part of the Taupo volcanic zone — namely, to the thermal centres of Wairakei, Taupo, Orakeikorako, and Tokaanu. A hurried trip was made to the volcanic cones of Ruapehu and Ngauruhoe, but the heavy snow which covered their summits and the plain between the two mountains prevented an adequate examination. The beautiful wooded valley of Wairakei, with its numerous geysers, boiling cauldrons, and hot mud-pools, forms one of the most fascinating resorts for the tourist in New Zealand. It is no less interesting for the student of vulcanology and of economic geology. Analyses were made of sinters from geysers at Wairakei, which are all depositing abundant silica. The sinter from the Red Coral Geyser and from the Heron's Nest Geyser contained no metals except iron in the state of ferric oxide; but the sinter from the Black Geyser, in addition to ferric oxide, contained, as shown by the following analysis, manganese-dioxide, antimony, and silver.

Ferric oxide	0·32 per cent.
Manganese-dioxide (MnO_2)	15·05 ,,
Antimony	0·48 ,,
Silver	6 gr. per ton.

Even more remarkable were the results derived from analyses of sinters from Taupo, where interest centres around the Spa and the Terraces. The Spa, situated on the edge of the Waikato River, has some fine geysers (the principal being the Crow's Nest Geyser). At the Terraces, not far from the shores of Lake Taupo, the most conspicuous feature is the long, low, black terrace, which gives the place its name. The colouring is apparently due in the main to vegetable matter, and possibly in part to manganous oxide. From the sinters at the Spa, ferrous oxide, ferric oxide, manganous oxide, and both gold and silver were obtained, as shown by the following analyses:—

Crow's Nest Geyser—	
Ferric oxide	0·39 per cent.
Silver	12 gr. per ton.
Other metals	Nil.
Horror Pool—	
Ferric oxide	0·32 per cent.
Silver	6 gr. per ton.
Gold	1 gr. ,,
Paddle-wheel Ben—	
Ferric oxide	1·36 per cent.
Manganous oxide (MnO)	0·20 ,,
Silver	6 gr. per ton.

Analyses, which resulted as follows, were made from the upper, middle, and lower parts of the Black Terrace:—

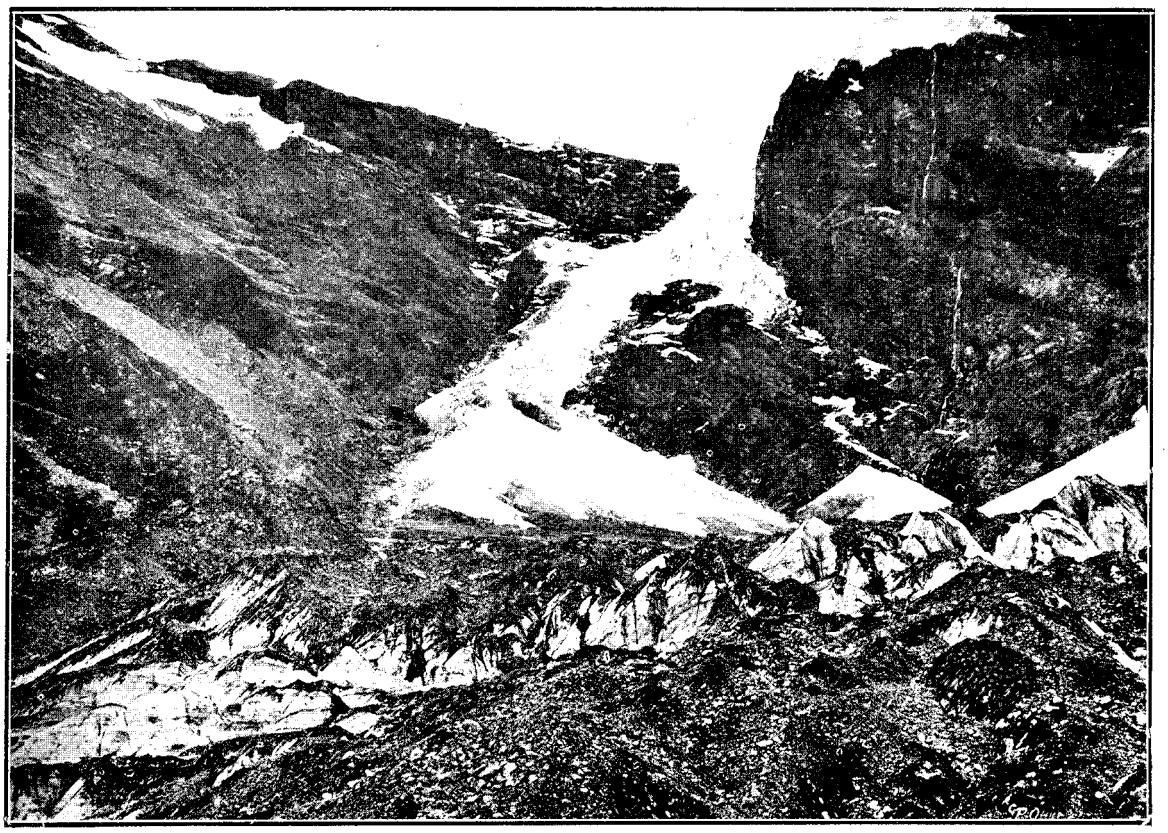
Upper—	
Ferric oxide	2·08 per cent.
Other metals	Nil.
Middle—	
Ferric oxide	0·56 per cent.
Manganous oxide	0·05 ,,
Other metals	Nil.
Lower—	
Ferric oxide	0·64 per cent.
Manganous oxide	0·06 ,,
Silver	9 gr. per ton.
Gold	2 gr. ,,

The thermal centre of Orakeikorako, situated on either side of the Waikato River some sixteen miles below the outlet from Lake Taupo, exhibits some hot pools of exquisite colours, some beautiful terraces, a variety of steam-jets, and an alum cave. Analyses of sinters from this locality showed no metal other than iron, which was, however, present in both the ferrous and ferric states.

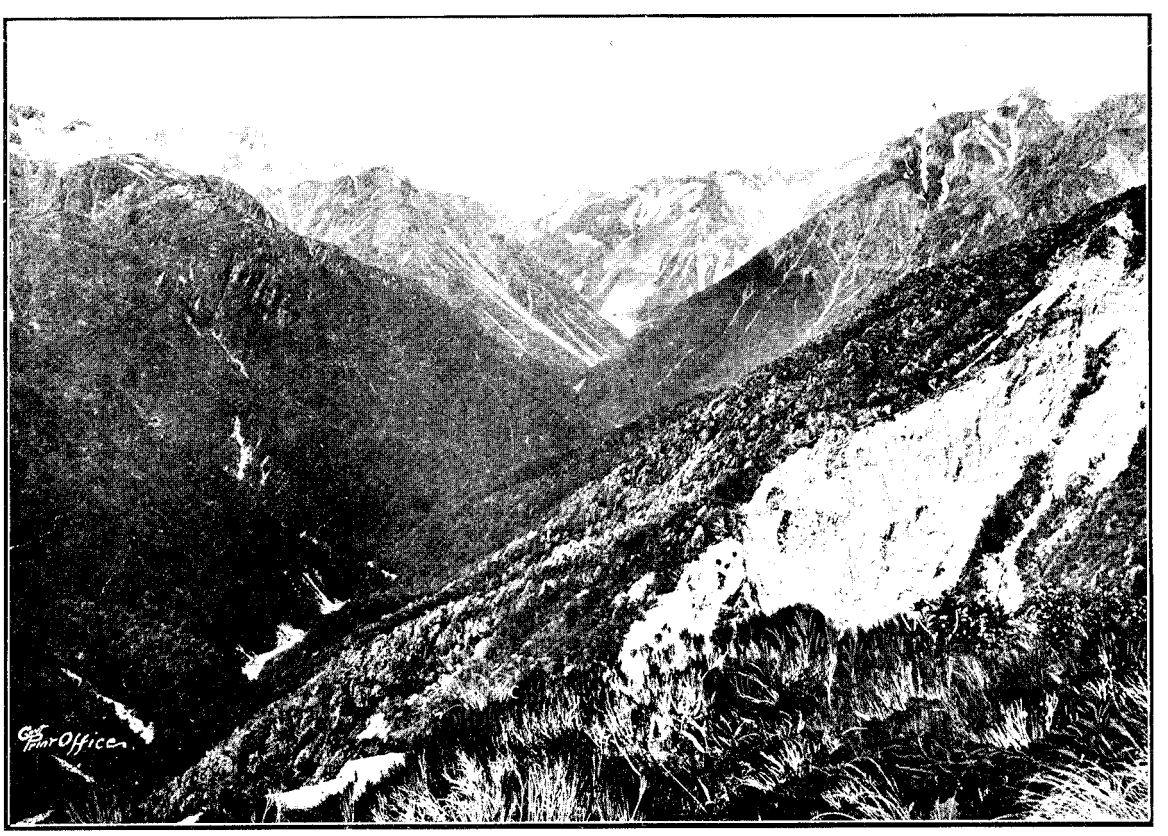
The interesting Maori village of Tokaanu, to the south of Lake Taupo, has long been famous for its hot springs and steam-jets. Sinter from this centre was found on analysis to contain ferric oxide, but no other metal. These various results, obtained from several relatively widely separated centres, are of great interest to the science of economic geology, owing to the illuminating evidence thus afforded as to the origin of metals in quartz veins. A detailed study of all the springs in the Taupo volcanic zone should be of great advantage as bearing on auro-genesis in New Zealand, as well as in other parts of the world.

Visit to Petroleum-field in Poverty Bay.

On my return from Taupo a very short visit was paid to the petroleum-bearing country near Gisborne, and a preliminary investigation made of the valleys of the Waihuka and Waipaoa Rivers, in both of which signs of petroleum have been known to exist for some time. Boring operations have been carried out in the past along the Waipaoa and its tributary, the Waingaromia, but with little



The Wilkinson Glacier, near the Head of Whitcombe River, Westland.



Headwaters of the Mungo River, a Tributary of the Hokitika.

success. Apparently, much the best indications are to be observed on Waitangi Hill, which forms a prominent point on the ridge between these two streams. Here a number of springs, forming pools, which are heavily coated with crude petroleum, ooze out along the banks of a small stream.

Parapara Work started.

About the middle of October I left Wellington to undertake the detailed survey of the Parapara subdivision of Karamea, Nelson. A few days were spent in the Town of Nelson obtaining some data necessary for the conduct of the work from the Lands and Survey Office. Parapara was reached on the 20th October, and a central camp pitched on the Parapara Inlet.

Operations are still proceeding in the Parapara subdivision at the close of the year. As it is hoped to publish a bulletin in considerable detail on the geology of the Parapara subdivision during next session, a full report is not required here, especially as our investigations are at present not well advanced.

Physiography.

The Parapara subdivision contains the Survey Districts of Aorere and Waitapu, which together represent an area of about 230 square miles. The only considerable settlement within the subdivision is the Township of Takaka, in the valley of the same name. By far the greatest area consists of densely forested country, quite without settlement. Much of the subdivision is hilly, and some of it may be dignified as mountainous. The most prominent elevations are Parapara Peak, 4,098 ft.; Mount Hardy, 4,926 ft.; and Lead Hill, 5,281 ft.

Low-lying flats are limited to the flood plains of the various rivers, more especially of the Aorere and of the Takaka, and to the incipient coastal plains formed along the sea-shore, usually where the streams debouch into the ocean. The most conspicuous feature of the subdivision is the broad ancient valley of the Aorere, incised deeply by the modern stream. Fluviatile erosion of the ancient valley has given the many decided terraces which flank the present course of the river, and the flood plains which form the fertile grazing-lands near the Rockville Settlement.

General Geology.

The oldest rocks in the district are a series of highly metamorphosed schists, epidote rocks, quartzites, phyllites, and complex carbonates, and of less metamorphosed grauwackes and argillites. Some of the latter are highly carbonaceous, and contain graptolites which fix their age as Ordovician. At the present stage of our investigations it is uncertain whether the highly metamorphic schists, quartzites, phyllites, and complex carbonates are coeval with the less metamorphic grauwackes and argillites, but later on it is hoped to investigate these points and many others. Above these ancient strata lies a later series of beds of conglomerate breccias, argillites (generally highly ferruginous), epidotic or serpentinous agglomerates, and sills of serpentine rocks, generally much altered. This series has been classified by the earlier geologists as Devonian.

Lying unconformably on these so-called Devonian rocks, and occurring at many widely separated parts of the subdivision, is a series of shales, sandstones, conglomerates, limestones, and marly clays, in the lower members of which coal-seams occur. From fossils obtained at various horizons in this series, it is apparently of Middle Tertiary age. Overlying these Tertiary rocks are terraced river gravels, sands, and clays of Pleistocene and later age.

The sills of serpentine rock mentioned as occurring in the so-called Devonian strata represent a phase of eruptive somewhat widely distributed in the oldest rocks as well. These originally were probably all either dunite or some form of peridotite, but are now almost all greatly serpentinised or talcosed.

Acid eruptives, consisting of granite, syenite, feldspar, porphyry, &c., are of widely distributed exposure in the subdivision, but occur chiefly in the southern part, where they form the *massif* of Lead Hill, and in the adjoining area to the southwestward beyond the limits of the Parapara subdivision.

Economic Geology.

Iron-ore.—Economic and popular interest in the Parapara subdivision centres around the enormous deposit of iron-ore which appears on the surface near Parapara Inlet, and brokenly extends southward for seven miles and a half, with a maximum width of about 26 chains. The main exposures of the ore appear between Washbourn's paint-mill and the saddle between Washbourn Creek and the Tukurua River, an area known as the Washbourn Block; between the Tukurua and the Onakaka River, known as the Tukurua Block; and southward from the Onakaka towards the Pariwhakaoho River, known as the Onakaka Block. The exact nature of this huge ore-body is too large a problem to enter into here, as it will be discussed in great detail in the forthcoming bulletin on the Parapara subdivision. In general, however, it may be said that the ore of highest quality is in the Washbourn Block, and that it depreciates passing southward. In the Washbourn Block the ore consists chiefly of a high-grade limonite. In places it contains unimportant impurities, such as fragments of quartz, which were in the original rock, by the replacement of which the ore has been formed. Along the watercourses, and in rare places also on the surface, the disintegrated ore, after comminution, has become so mixed with pebbles and cobbles of extraneous material as to form a ferruginous conglomerate of little value. The ore is inclined to be micaceous and siliceous in both the Tukurua and Onakaka Blocks.

Quartz Veins.—Quartz veins occur, widely separated, throughout the Palæozoic strata (Ordovician and so-called Devonian). Most of these are apparently valueless, but at the time of writing by far the greatest number have not been fully tested. The Golden Blocks Mine and the Golden Ridge Mine, both occurring within the boundaries of the subdivision, are being worked on auriferous quartz veins situated in undoubted Ordovician strata. Gold-bearing veins have been reported from the head of Snows River, near the southern edge of the subdivision, where they are

said to occur with auriferous conglomerates of so-called Devonian age. Auriferous veins of small value were examined on the Pariwhakaoho.

Alluvial Gold.—Gold-bearing gravels of various ages (early Tertiary to Recent) have been worked for many years in the Parapara subdivision. By far the richest leads occurred mainly on the tributaries of the Aorere River, entering on the south-east side, especially on the Slate River. These have long ago been worked out, and now a much smaller return than that obtained in former years is derived mainly by hydraulic sluicing.

Coal-seams.—The coal-seams of the subdivision, which occur near the mouth of the Takaka at Rangihaieta Head, and Motupipi on the eastern side of the subdivision, and in the valley of the Paturau and Slate Rivers on the western side, are apparently not of great extent, but have not yet been fully investigated.

Building-stone, &c.—The subdivision contains much granite of high quality and of great beauty, though it is generally situated at places difficult to obtain with the present means of transport. Serpentine rocks of value as ornamental building-stones outcrop at several places in the district. Marble (complex carbonate) of exquisite colours, varying from pure white to pink-grey and almost black, occurs at a number of points in the subdivision.

Clays which are said to be capable of use in the manufacture of fine pottery appear at Motupipi, while more ordinary clays suitable for rough pottery and for brickmaking are widely scattered throughout the subdivision.

Impure talcs and sandstones, which may be put to commercial uses, occur on the Waikoromumu and on the Parapara River.

It will be seen from this brief *résumé* that the economic mineral resources of the area represent a great variety. Each phase of the mineral wealth will be elaborated in full detail in the forthcoming bulletin on the Parapara subdivision.

REPORTS OF SENIOR FIELD OFFICERS AND DRAUGHTSMAN.

Mr. P. G. Morgan, General Geologist.

Mr. Percy G. Morgan, General Geologist, has been engaged almost continuously throughout the year at work at Westland, being absent therefrom for only a few months during the middle of winter, when he was occupied in the Head Office at preliminary work in connection with his maps. It is hoped that a bulletin will soon be issued giving the results of the work in the Mikonui subdivision of North Westland, in which he has been engaged. Meanwhile Mr. Morgan gives the following brief summary of results for the year 1906:—

Introduction.

During the greater part of 1906 I was engaged in working out the general and economic geology of the Mikonui subdivision, North Westland. In addition, some field-work was undertaken in connection with the Hokitika sheet, on which Bulletin No. 1 has already been published, and for about two months I was occupied in office-work at headquarters. During September and October I was employed almost entirely in supervising the collection of mineral and rock specimens from North Westland for the Geological Survey Exhibit at the New Zealand International Exhibition.

Assistance.

Until the end of February I was assisted in the field-work by Mr. A. M. Finlayson, M.Sc., of Otago University, and towards the close of November I was joined by Mr. J. Ritchie, M.A., of the same college.

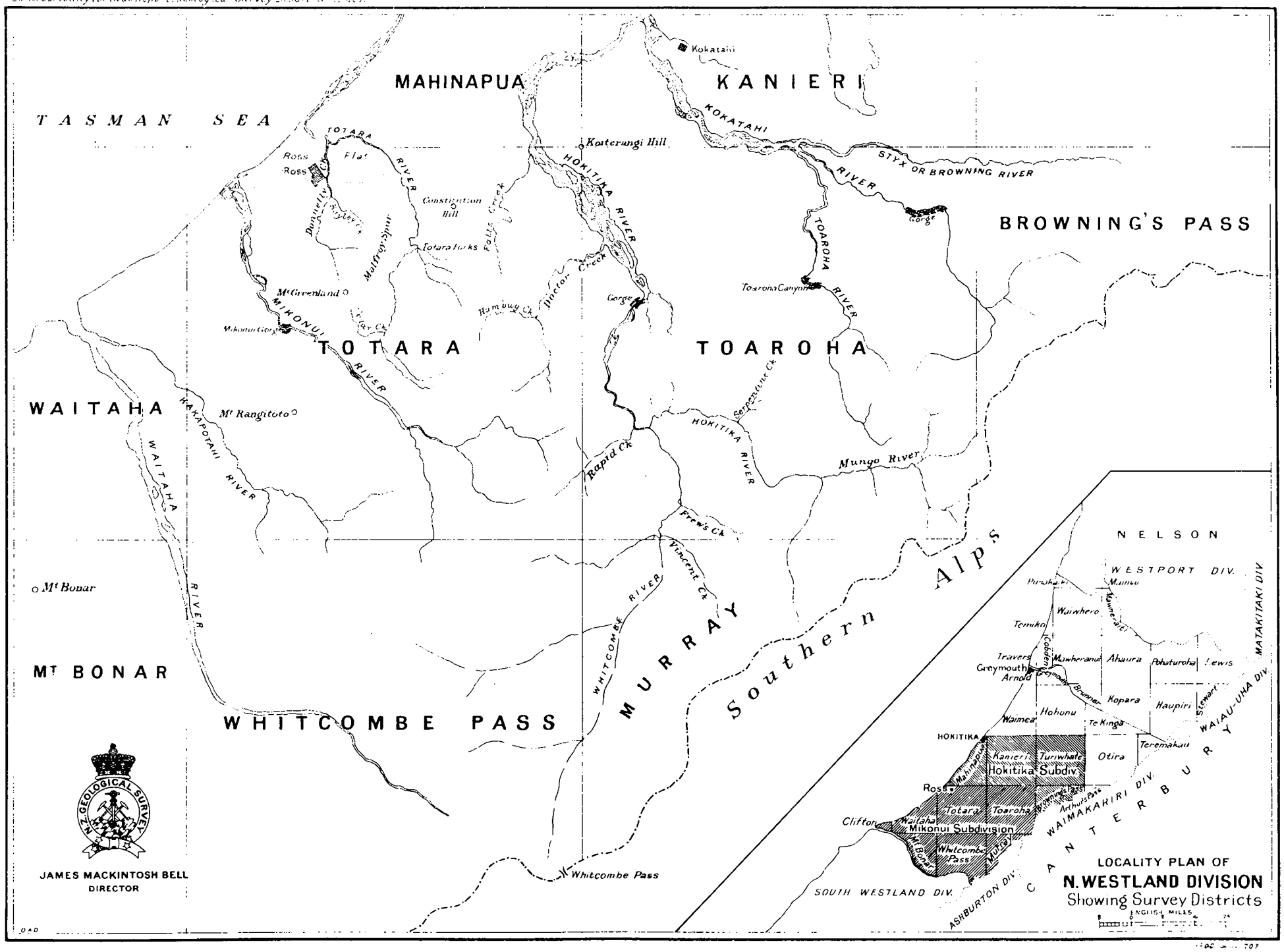
Location of Work.

Work was begun on the Mikonui sheet in November, 1905, and it will be convenient to include in this report some mention of our labours from that date to the end of 1905.

My first camp was pitched in the lower Totara Valley, about three miles from Ross. From this point we investigated the geology of the Totara River basin, Donnelly Creek basin, Mount Greenland, Ross Flat, &c. On the 2nd December I met with an accident, which necessitated hospital treatment for some time, but field-work was carried on by Mr. Finlayson, assisted by Mr. H. Hamilton, a student of the Otago School of Mines. Towards the end of the year camp was shifted to the Upper Mikonui Valley, sixteen miles from Ross by the track, but little more than half that distance as the crow flies. From this base the geology of the greater part of the Mikonui Basin was determined, but some further work will be done in this district before the publication of a final report.

At the end of January, 1906, we shifted camp to near the junction of the Toaroha and Kokatahi Rivers, about fourteen miles south-east of Hokitika. From this station we explored, by means of temporary camps, the valleys of these streams and their tributaries, traversing in our operations some very rough and difficult country. We surveyed also that part of the Browning or Styx River which flows through the Toaroha Survey District.

In the month of May the main camp was moved to the first gorge of the Hokitika River. Surveys were carried up and down the Hokitika, and the minor streams of the district traversed. The short winter days and stormy weather interfered greatly with the progress of our work, and at the beginning of July camp was broken up. Geological exploration in this neighbourhood was resumed in November, and continued until the end of the year.



Map to illustrate report by Mr P. G. Morgan on the

GEOLOGICAL SURVEY OPERATIONS IN WESTLAND DURING 1906

SCALE OF ENGLISH MILES

Area of Country examined.

The area of country completely surveyed during the year was small, for reasons the chief of which it may be advisable to enumerate: (1.) The work was done as thoroughly as possible, and hence slowly. (2.) Heavy rainfall, especially in the mountain districts; the greater part of the year was unusually wet, even for Westland. (3.) Rugged and mountainous nature of much of the district. (4.) Absence of roads and tracks in back country. (5.) Dense bush covering lowlands and mountain-slopes up to altitudes of 3,500 ft. to 4,000 ft.

The accompanying map shows the districts in which work was carried on, together with the chief geographical features.

Maps of the Area.

Before a detailed geological survey of any district can be made it is necessary to obtain a good map, showing topography, roads, tracks, trigonometrical stations, &c. Few people outside the ranks of professional surveyors are aware of the immense amount of labour involved in the production of an accurate topographical map. The Lands and Survey Department of New Zealand since its foundation has done an enormous amount of work, yet much still remains to be done. It is to be regretted that in recent years the Survey Department has been compelled to confine itself chiefly to "settlement" work, so that little topographical or trigonometrical surveying has been undertaken, and much valuable information in its possession lost for the time being, owing to lack of means for publication. The Department, however, has published an excellent lithograph of the Totara Survey District, on the inch-to-the-mile scale, and Mr. G. J. Roberts, Commissioner of Crown Lands and Chief Surveyor for Westland, furnished me with a tracing of the Upper Hokitika and Whitcombe Rivers, as well as with much valuable information regarding the district generally. I obtained also through the Hokitika Survey Office a tracing of the Toaroha Survey District, which was of great assistance. Nevertheless, much additional information was required in the Mikonui subdivision, and during the greater part of the year Mr. R. P. Greville, Topographer, was occupied in surveying and mapping the Toaroha District. Mr. Greville has from time to time supplied me with tracings of his work.

General Geology and Physiography.

The general geology and physiography of the Mikonui subdivision are similar to those of the Hokitika subdivision, fully described in Bulletin No. 1. For this reason, and because the survey of the district has not yet been completed, I think it advisable to pass over these features for the present. It may be mentioned, however, that much information concerning the district may be obtained from Mr. Alexander McKay's "Report on the Geology of North Westland," published in Geological Report No. 22, 1894, and also, with some alterations and additions, in the Mines Report for 1893.

Economic Geology.

It will be fitting to give a fairly full account of the economic branch of my work during 1906 under the headings of "Alluvial Gold," "Auriferous Quartz Reefs," "Copper and Minor Metals," "Asbestos," "Coal," "Building and Ornamental Stones," "Pounamu Formation," "Water-power," "River-gauging," &c.

(1.) *Alluvial Gold.*—The most important area to be considered under this head is Ross Flat. This is a gently sloping, triangular piece of land lying at the foot of Mount Greenland, in the valley of Donnelly Creek. It is partly enclosed by ancient gravel terraces, and westward merges into a narrow coastal plain. The apex of the triangle is about 100 ft. above sea-level, and in the early days of Ross yielded gold to the value of about £300,000. The history of the flat need not be retold here, for full information may be obtained from various Mines Reports and from the Mining Handbook lately published by the New Zealand Government.

Geologically considered, Ross Flat consists of a number of layers of modern gravel, derived mainly from ancient auriferous river-gravels (pre-glacial)—"the old-man bottom" of Mr. McKay. There is also a certain amount of material brought down from the slopes of Mount Greenland. The gravels lie unconformably on soft brown sandstone of Miocene age. Undoubtedly a high degree of concentration has been effected through the agency of water, and there is good reason for believing that the unworked portion of the flat will prove to be payably auriferous, provided that a pumping plant adequate to deal with the water is installed.

Close to Ross is the Mont d'Or Claim, where for many years hydraulic sluicing has been successfully carried on in coarse gravels, apparently of fluvio-glacial origin. On the south side of the Mikonui River the McLeod's Terrace Sluicing Company is operating in similar material, but so far has failed to yield an adequate return to the owners.

A few alluvial miners are still at work in Donnelly Creek, and in the various streams flowing into the Totara River from the eastern side of Malfroy Spur; but the rich ground was long ago exhausted, and, with the exception of one small party, it is doubtful if any of the men now working make more than a bare living.

There are various other localities not far from Ross where more or less alluvial gold has been obtained, as, for example, from Constitution Hill, Totara Forks, the Alpine Claim near the top of Mount Greenland, and the eastern slopes of Mount Rangitoto. The last-mentioned locality appears to be decidedly promising. Here members of my party obtained good prospects of coarse gold in a heavy granite wash.

During the dredging boom of a few years back six or seven dredges were built near Ross, but only one of these is now carrying on operations. The others failed to pay even a moiety of the working-expenses, and have been dismantled.

The only other localities that need be mentioned as likely to produce alluvial gold are the beaches and terraces of the Hokitika River, and its branches from Hokitika Gorge upwards. At various times good wages have been made by small parties working on the river-beaches, especially

near Rapid Creek (a little below the Hokitika–Whitcombe junction), and on the Whitcombe near Vincent Creek, and opposite Frew Creek. The last locality is said to have been fairly rich. At Hokitika Gorge, gold, but hardly in payable amount, has been obtained from the sands piled high up on flood-swept points. On the western side of the river below the gorge is a gravel terrace, which we found gave promising prospects, and is well worth trying. An old prospector—Mr. Frank Ellis—has informed me that the terrace below Rapid Creek is gold-bearing. Should the prospects here warrant it, an ample supply of high-pressure water could easily be obtained from Rapid Creek, which is a large snow-fed stream with a steep grade. Along the course of the Whitcombe River colours of gold can usually be obtained from the gravel, whilst from the moss which grows on the stones about flood-level a good prospect of fine gold can almost invariably be washed. The various gravel terraces along the course of the Whitcombe River are all to some extent gold-bearing, but in no case can a payable character be asserted as likely to be present. It is of interest to recall that Whitcombe,* in his expedition of 1863 over the pass and down the river named after the ill-starred explorer, discovered gold in the river-gravels.

The Upper Hokitika and its main tributary, the Mungo, are also gold-bearing to some extent. Several miners who had found their way across Mathias Pass from Canterbury were at work on the Upper Hokitika during the summer of 1905–6, and are said to have made wages.

(2.) *Auriferous Quartz Reefs.*—In January, 1906, I examined as far as possible the old workings on the quartz reefs near the head of Cedar Creek, on the southern slope of Mount Greenland. Twenty years or more ago a small patch of fairly rich quartz was discovered, and in consequence many thousands of pounds were spent, or rather thrown away. The reefs are somewhat irregular bodies of quartz, 1 ft. to 2 ft. thick, usually following the dip and strike of the enclosing argillite or grauwacke. They appear to have no great linear extension, and are either faulted or die out in depth. Iron oxide and pyrite are associated with the quartz, which also shows an occasional but rare speck of visible gold. The history of Cedar Creek and my own examination have failed to impress me favourably either with the reefs themselves or with the methods adopted in their attempted development.

A number of small veins carrying visible gold occur in the valley of Donnelly Creek and its tributaries. One of these near Bayley Creek was exploited to some extent years ago. A five-stamp battery was erected, and worked for some time, but I have not been able to learn what the returns were. At the present time another vein, which is 4 in. to 6 in. in thickness, and shows gold freely, is being prospected by a local syndicate. It may be regarded as a rather promising prospecting proposition, but its small size, and the likelihood of the vein being cut off in one direction by a fault and in the other by the valley of Bayley Creek, are decided drawbacks.

Near the Toaroha Saddle, at the head of the Toaroha River, we found a quartz lode about 10 in. thick, which yielded occasional colours of gold, visible to the eye. On the other hand, a small sample taken for analysis and picked free from visible gold failed to yield any gold when assayed.

On the track to Whitcombe Pass, about a mile above the Hokitika-Whitcombe junction, two quartz lodes, each about 1 ft. in thickness, were noted. An assay of a sample from one of these resulted as follows: Gold, 2 dwt. 12 gr. per ton; silver, 1 dwt. 16 gr. per ton; copper, 0·57 per cent. These lodes carry a moderate percentage of iron oxide and pyrite, and may be worth prospecting, especially as they strike across the bedding of the enclosing schist. Quartz reefs were noted in many other localities, but none gave any evidence of carrying values.

(3.) *Copper and other Metals.*—Copper-ore has often been reported as occurring in the Westland mountains, but unfortunately no payable deposit has ever been located. Boulders showing stains of copper-carbonate or carrying cupriferous pyrite are not uncommon, but I have as yet never come across any fragments of decidedly rich ore. One occurrence of copper-ore *in situ* was investigated—namely, at the first gorge of the Kokatahi River, near an outcrop of the Pounamu formation. Here small veins and pockets of copper-bearing pyrite occur in a wide band of silvery-green talc-schist. Samples taken for assay yielded from 0·5 to 7·8 per cent. of copper. One sample carried a trace of gold and another 2 per cent of lead, probably in the form of galena. The neighbourhood of the Pounamu formation is a hopeful feature, which perhaps warrants further search, but it must be confessed that the visible prospects are not very encouraging.

Galena carrying a few ounces of silver to the ton occurs at Mount Rangitoto, near Ross, but the outcrops have not yet been investigated. The same mineral appears in a quartz vein near Smith's Claim, Donnelly Creek, Ross.

(4.) *Asbestos.*—A small vein or pocket of this mineral was discovered in talc-schist adjoining a serpentine outcrop (Pounamu formation) near Jumble Top, at an elevation of about 4,200 ft. The asbestos is of splendid quality, but the quantity is apparently very limited. Asbestos of fair quality has also been noted in Serpentine Creek, a tributary of the Upper Hokitika, and on the higher slopes of Mount Inframeta. In no case did we find the mineral in quantity, but the prospects are sufficiently encouraging to warrant careful search wherever the Pounamu formation is known to outcrop.

(5.) *Coal.*—Further investigation was made of the coal-outcrops on Koiterangi Hill (Camelback), but with unsatisfactory results. The seams are of poor quality, and the enclosing strata considerably faulted, so that development-work cannot be recommended.

The Koiterangi coal-measures were discovered outcropping near the head of Humbug Creek, a tributary of Doctor Creek, and small pieces of coal of good quality were found, but careful search failed to disclose any seam. This locality is so remote, the area of coal-bearing strata so small, and so much crushed and disturbed, that the occurrence, though geologically interesting, may be considered economically unimportant.

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* After two weeks of incessant toil and hardship Whitcombe succeeded in reaching the coast, but was drowned while attempting to cross the Teremakau River in a small canoe. For particulars concerning his journey, see *Canterbury Provincial Gazette*, 6th August, 1863, and "Handbook of New Zealand Mines," 1887, pp. 101–108.

(6.) *Building and Ornamental Stones.*—The limestone of Koiterangi Hill, though of somewhat poor quality for use in the manufacture of lime, would make a good building-stone, and is suitable for monumental purposes. Its accessible position adds to its value. At Falls Creek, on the west side of the Hokitika River, nearly opposite Koiterangi Hill, there is an abundant supply of grey granite of first-class quality. The locality is fairly accessible, though to reach it the Hokitika River has to be forded. Other possible building-stones that may be mentioned are the basalt of Koiterangi Hill and the grauwacke of Donnelly Creek, near Ross. Serpentine suitable for ornamental use outcrops near Jumble Top, on the slopes of Mount Inframeta, and on the west side of the Whitcombe River, but all these localities are difficult of access.

(7.) *Pounamu Formation.*—This is well developed in the northern and middle parts of the Mikonui subdivision. At the first gorge of the Kokatahi River it is seen as a band of impure steatite (soapstone) about 35 ft. thick. The presence of serpentine on the neighbouring hillsides is indicated by huge boulders of that rock in the vicinity. Serpentine is again seen on the upper slopes of Mount Jumble Top. Here it is associated with a small mass of steatite and asbestos, as previously mentioned. A short distance to the east is a band of impure steatite, which continues to the south-west for nearly a mile, apparently without interruption. Along the course of the Upper Hokitika, on Mount Inframeta, and on the west side of the Whitcombe, serpentine is seen outcropping along three distinct lines, some of the outcrops being of great width and length. The most prominent of all, however—namely, those on the west of the Whitcombe—have yet to be examined. The occurrence of asbestos and copper-ore in connection with the Pounamu formation has been mentioned under previous headings. No nephrite has been seen in the solid, but pieces of very fair quality have been found by members of the Survey in the beds of the Toaroha and Hokitika Rivers.

(8.) *Water-power.*—The numerous falls along the courses of the minor streams would furnish an enormous amount of energy if it could be economically used. In the case of the larger streams, attention has been called by Mr. Greville to the Toaroha Cañon, where there is 750 ft. of fall in about three-quarters of a mile. Here in ordinary dry weather water to the extent of at least 200 cubic feet per second is available. It has been proposed to obtain power for electrical purposes from the gorge of the Mikonui near Ross. At this spot, however, though the volume of water is large, the fall is comparatively small, and it would be necessary to construct a high dam before any great power could be obtained.

(9.) *River-gauging.*—During 1906 several of the principal streams were repeatedly gauged when fairly low. Some—for example, the Whitcombe and the Upper Hokitika—could not be gauged on account of their size and because of the absence of good fords giving a fair cross-section. In these cases rough estimates have been made. The results are of interest, as indicating a very heavy rain and snow fall for the mountain districts. The average precipitation from the foothills to the main divide in all probability reaches or even exceeds 200 in. per annum, whereas on the coast, at Hokitika, the average yearly rainfall is only 117 in.

Conclusion.

It is expected that the material for a bulletin on the Mikonui subdivision will be obtained early next season. In this bulletin some matters of considerable scientific interest will be dealt with, and it is hoped that the result will be an addition to our knowledge of Westland geology. Due attention will be paid to the economic phase, and information that will be of value to the miner, prospector, or settler given to as great an extent as possible.

Mr. Colin Fraser, Mining Geologist.

Mr. Colin Fraser was engaged during the early part of the year in detailed work in the Coromandel section of the Hauraki division, where operations had been commenced under my personal supervision in November, 1905. This work he was obliged to relinquish in February, in order to proceed to an area situated at the headwaters of the Arahura and Wilberforce Rivers, in the North Westland and Waimakariri divisions, for the purpose of finishing some work on which he had been occupied during the winter and spring of 1905. From May till August Mr. Fraser was busy aiding in the compilation of the report on the Hokitika section of the North Westland division. At the end of August he returned to his work in the Hauraki division, which has kept him constantly engaged till the close of the year. As the results of Mr. Fraser's labours in the North Westland and Waimakariri divisions are already published in Bulletin No. 1, the area is hardly mentioned in Mr. Fraser's present annual report. During the coming year he expects to publish a bulletin on the Coromandel work, so that the results of his investigations are merely summarised here. Mr. Fraser presents the following report:—

Introduction.

During the year 1906 geological field-work in the Coromandel subdivision of the Hauraki division and in the Hokitika subdivision of the North Westland division has occupied the greater portion of my time. In addition to this, certain work at the Head Office assisting in the preparation of Bulletin No. 1 on the Hokitika subdivision claimed my attention.

From the date of your departure (3rd January, 1906) from the Coromandel area the charge of the field-work in this section of the Hauraki division was intrusted to me, and with me was associated Mr. E. J. Webb, B.E., now Assistant Geologist. On the 14th February, however, under instructions from you, I proceeded from Coromandel to Westland to assist in the completion of the field-work and the preparation of the report on the Hokitika section, which together occupied my

time until the end of August, when I returned to the Coromandel work. During my absence Mr. Webb continued the work in the northern section. From the 8th October Mr. J. H. Adams, B.Sc., was attached to my staff as temporary assistant in place of Mr. Webb, who proceeded to Wellington on his way to Parapara to assist you in that area. Mr. D. V. Allen, B.Sc., Director of the Coromandel School of Mines, who was engaged for a period of six weeks during his summer vacation of 1905–6, carried out a geological examination of the Cabbage Bay portion of the Coromandel subdivision. A similar arrangement has been made with Mr. Allen for the present season, in accordance with which he assumed his duties on the 14th December. A detailed examination of the Whangapoua Valley has been assigned to him.

Work in Hokitika Section of North Westland Division and Wilberforce Area.

My work in this area, under your direct supervision, was confined to that part of the country which could be examined only during the summer season—namely, that constituting the main alpine divide and the high subsidiary flanking ridges lying at the sources of certain branches of the Hokitika, Arahura, Taipo, and Wilberforce Rivers. The results of this examination need not be referred to here, as they are fully detailed in Bulletin No. 1 of the Geological Survey publications.

Work in the Hauraki Division.

The area which is to constitute the Coromandel subdivision of the Hauraki division comprises the Survey Districts of Colville, Moehau, Harataunga, Coromandel, and Otama. The subdivision forms that portion of the Hauraki Peninsula which has as its northern extremity Cape Colville, and is bounded to the south by a line extending due east from a point in the vicinity of Kirita Bay, crossing the main divide, and passing through Whitianga Harbour to the eastern coast-line.

The Survey Districts of Colville, Moehau, and Harataunga together constitute the narrower portion of the Hauraki division, the distance from coast to coast averaging about six miles. To the south of these survey districts the country included in the Coromandel and Otama Survey Districts immediately attains a width of twenty miles, due to the prolongation to the eastward of the Kuaotunu Peninsula, which is cut off by the Mercury Bay Inlet from the southerly extension of the main Hauraki Peninsular mass. This width of about twenty miles is preserved to and beyond the limits of the Coromandel subdivision.

Of this stretch of country the portion already examined includes all that lying to the westward of the main mountain divide from Cape Colville to Kirita Bay, and on the eastern side extends from Cape Colville as far southward as the northern headland of the Whangapoua Harbour.

Physiographic Notes.

The chief physiographic feature of the area is the main divide—the Cape Colville Range. This longitudinally bisects the narrower and northern portion of the district described, and from here trends in a general southerly direction in such a position as to determine a wider drainage area to the eastward than to the westward. This axial divide is comparatively rugged and broken; the dominating peak, Te Moehau, forms the northern prolongation, and ranks in height (2,935 ft.) as the second mountain of the whole Hauraki area. On the southerly trend of the range other conspicuous peaks, although of somewhat lesser order of magnitude, are Tokatea Hill (1,532 ft.), Kaipawa or Success Hill (1,935 ft.), the castellated crag, Castle Rock (1,724 ft.), Motutere (1,763 ft.), and the conical peak at the head of the Manaia Valley (2,263 ft.).

The flanks of the main divide are incised by numerous streams, which, owing to the rugged configuration of the country and the restricted watersheds, are of relatively steep gradient and small volume. Numerous spurs, more or less transverse to the main divide, mark off the valleys of the numerous streams, while subsidiary flanking ridges and groups of hills, presenting little definite arrangement are in places not uncommon. Plains of any extent are absent from this portion of the peninsula, and in the area examined during the year the flat country is confined to the lower portions of the valleys of the main streams and to very narrow belts, which here and there fringe the coast-line.

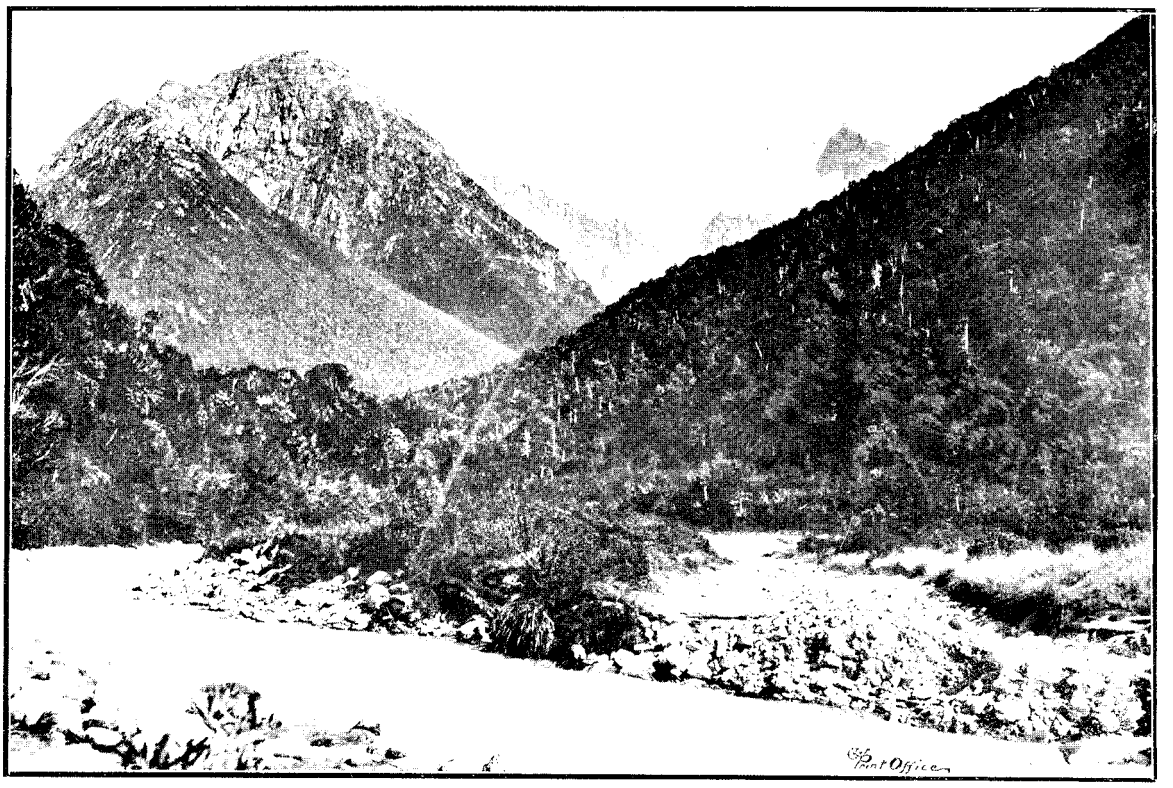
Compared with its small area, this portion of the peninsula is girdled by a great length of coast-line, bays and deep indentations being numerous. On the western and more sheltered side, Coromandel and Cabbage Bay are the principal harbours, while Kennedy's Bay affords the safest anchorage on the somewhat exposed eastern coast-line.

Nature of the Work carried out.

An enlargement to a scale of 20 chains to an inch of the ordinary county map issued by the Lands and Survey Department is used as a basis for the plotting of the field-work.

A traverse of the whole length of coast-line over the area examined has been carried out. By this means a much more accurate mapping of the minor topographical features has been possible. Of more importance, however, than this amplification of topographical data is the exact determination of the position and extent of the areas covered by the various rocks involved in the structure of the peninsular mass.

All the streams of any importance have been carefully examined, chained traverses of the lower and middle courses and paced traverses of the headwaters and tributaries being the general rule. Barometric elevations of the principal stream-junctions and of the saddles at the sources of the larger branches have been recorded. As the beds of the watercourses afford fair sections of the rocks through which their valleys have been eroded, and may also be regarded as the natural sluice channels for the passage seaward of the débris from the various rock-masses and from any mineral-deposits contained therein, the greater part of our field-work has been confined to these physical features. As great importance is attached to the economic side of the work, a surface prospecting,



Near the Head of Whitcombe River, Westland.

Looking down Whitcombe River from Frew's Creek, Westland.

as exhaustive as time would permit, has been carried out for gold and other minerals over the whole area, and, of course, the examination of the stream débris is one of the leading indications in such operations. To this end two capable gold-prospectors have been attached to the field party, and it is hoped that the results obtained will, when recorded, afford a good working-basis for the guidance of future operations by private individuals. The initial prospecting of the back country is a more costly undertaking than the ordinary prospector can afford, so that the determination of the areas or belts over which the precious metals may be looked for with a reasonable hope of success, as well as the areas giving indications of the existence of other minerals, is of prime importance.

In addition to the stream-valleys, the main ridges and mountains have been explored; but over the greater portion of the area good rock-outcrops are rare on the higher country, owing to the heavy mantle of surface débris and the dense vegetation. This feature renders all prospecting operations difficult and expensive. Where a road or graded track traverses such country, the deeper excavations frequently afford the best sections obtainable.

An examination of the underground workings of the various mines, either abandoned or at present in operation, has been undertaken, and a connected plan of the various reefs of the gold-field will be compiled. It is unfortunate that none of the mines of the Hauraki or Kapanga groups are at present working below the level of the ground-water, as this has precluded all examination of the conditions obtaining in the lower levels.

General Geology.

General Classification.—The following classification of the rocks involved in the structure of the area of country under review is tentatively submitted pending a further petrographical examination, which may be expected to throw more light on certain rather obscure points:—

(1.) Palæozoic and Mesozoic strata.
(2.) Late Cretaceous or early Tertiary strata.
(3.) Tertiary volcanic rocks of the first period of vulcanism.
(4.) Tertiary volcanic rocks of the second period of vulcanism.
(5.) Intrusive rocks of various periods.
(6.) Pleistocene and Recent-Alluvial deposits.

(1.) *Palæozoic and Early Mesozoic Strata.*—Stratified rocks, both arenaceous and argillaceous, constitute the greater bulk of the fundamental or basement series of the Hauraki Peninsula. In the special area considered they have their greatest development in its northern prolongation, forming the main mass of Te Moehau mountain (2,935 ft.), and have here lateral extension continuously from the eastern to the western coast-line. South of Te Moehau district these rocks only reach the crest of the main divide at Tokatea Hill, but are, however, exposed in many stream-valleys, and occasionally on the actual coast-line on both sides of the divide. On the westward side they have been traced to and beyond the southern limits of the subdivision, but on the eastward side they do not occur further south, in the area at present examined, than Kennedy's Bay.

Subdivision of the older groups is by no means easy, as stratigraphical unconformity is not apparent. A consideration of their lithological character and the meagre palæontological evidence available may suggest a possible subdivision into three groups:—

(*a*.) Certain characteristic and extensive areas afford evidence that the period during which the accumulation of the sediments took place was marked by widespread manifestations of volcanic action. This has resulted in the interstratification with the ordinary clastic material of thick bands of rhyolitic lavas and tuffs. These rocks, wherever developed, are largely intruded by dykes, principally of porphyrite.

(*b*.) Another group of rocks occurs in proximity to the strata already mentioned. These consist of thin-bedded grauwackes and argillites, showing no evidence whatever of volcanic action occurring contemporaneously with the period of their deposition. They are intruded, however, in certain localities by diorite and porphyrite.

(*c*.) The youngest group of these sedimentaries is characterized by the presence of conglomerates, grits, and reddish-coloured shales. These conglomerates contain well-rounded boulders of grauwackes and argillites, and in addition igneous rocks, both rhyolites and porphyrites. All of these boulders would be derived from the erosion of a land-mass consisting of the rocks described, (*a*) and (*b*). The conglomerates of two widely separated areas are fossiliferous, and as some very fair specimens have been selected, their identification should place beyond doubt the age of these rocks.

All of the rocks, here grouped as Palæozoic and Mesozoic, have undergone considerable folding, and are disposed at high angles. Their maximum elevation, approximately 2,800 ft., is attained in Te Moehau Mountain, where they are capped by the younger volcanic rocks.

(2.) *Late Cretaceous or Early Tertiary Strata.*—These rocks—the New Zealand coal-bearing series—play a very subordinate part in the structure of the peninsular mass, but are of great interest as bearing on the age of the volcanic rocks of the auriferous series. They occur as isolated patches on both sides of the peninsula, in every case directly overlying in marked unconformity the argillites and grauwackes of the older groups. They are themselves overlain at certain localities by rhyolitic tuffs of the older volcanic group, and at others by the breccia-agglomerates of the younger volcanic (Beeson's Island) group, both of which are hereafter described.

The most complete sequence of these beds is to be found at Torehine, on the western coast-line, where they consist, in ascending order, of sandy marls, conglomerates, sandy clays, calcareous sandstone, and limestone. The beds are fossiliferous, and in places thin coal-seams are associated with the clays and marls. A collection of fossil forms has been made for identification from the various outcrops of these beds, but more especially from those on the eastern side of the peninsula, as the existence of the beds on this side was first discovered during the course of the present survey.

(3.) *Tertiary Volcanic Rocks of the First Period of Vulcanism.*—These rocks, which are of great economic importance in that they constitute the principal auriferous series, consist of lavas, tuffs, and breccias in various stages of alteration and decomposition. By far the greater part of the series is andesitic in character, but rhyolitic rocks are also represented.

As regards distribution, it will here be sufficient to remark that over great stretches of the country forming the main divide, and lying both to the east and west of this physical feature, andesites either flank or overlie to unascertained depths the rocks of the basement series. The rhyolitic tuffs and breccias of this series have but a limited development within the area examined. On the western side of the divide they give rise to the steep country lying at the headwaters of the Umungawha Stream, while on the eastward side of the divide they occur in the valley of the Omoho Creek. In each locality these rocks directly overlie the strata of the coal-bearing series. The sections, where both andesites and rhyolites are present, appear to indicate that of the two the rhyolites are the older.

(4.) *Tertiary Volcanic Rocks of the Second Period of Vulcanism.*—These rocks, which are all andesitic in character, consist of lavas, tuffs, breccias, and agglomerates, and have heretofore been assigned to the Miocene period by the New Zealand Geological Survey. The term "Beeson's Island" group as applied to these rocks is well established, as they are typically represented on the island of this name, which forms the north-western shores of the Coromandel Harbour.

These rocks, as previously indicated, form the coastal belts, and are more or less continuous over the greater portion of the peninsula already examined southward of a line from Cabbage Bay to Port Charles. In turn they have been found resting, necessarily unconformably, on members of each of the rock-groups already described.

The tuffs, breccias, and heavy agglomerates form the great bulk of this series, and these and the associated lava-streams frequently show a rude stratification. From a consideration of the disposition of the beds in certain localities the positions of old centres of eruption are suggested.

Hyalopilitic andesite, in which hornblende and hypersthene are the dominant ferro-magnesian minerals, is the type of rock having the widest range in this series.

(5.) *Intrusive Rocks of Various Periods.*—Dyke rocks have a considerable development in the area under review, and are found intruding all the rock-groups already described.

Both acid and intermediate rocks are represented among the intrusives, but those of the latter class are by far the more abundant and more widely distributed. Various varieties of diorites, porphyrites, and andesites contribute to the intermediate, while rhyolites are the sole representatives of the acidic class.

No separation of these intrusives according to age will here be attempted, but it may, however, be stated that the available evidence suggests that the intrusive rocks of the intermediate class range in age from Palæozoic to Miocene(?).

(6.) *Pleistocene and Recent-Alluvial Deposits.*—No volcanic rocks younger than those of the Beeson's Island group have been detected in that portion of the Coromandel subdivision already examined, and the accumulations referable to this period consist entirely of alluvial deposits.

Owing to the configuration of this portion of the peninsula, its general elevated character, and limited lateral extension, plains of any considerable extent are absent.

Small alluvial flats lie within the lower reaches of the principal stream-valleys, with here and there higher level terraces skirting the lower slopes of the neighbouring hills.

Narrow flats fringing the coast-line in certain localities owe their origin partly to the fan deposits from the numerous high-grade streams, and partly to elevation of the shore-line.

Metalliferous and other Mineral Deposits of Economic Value.

Gold-silver Quartz Veins.—The metalliferous deposits of the area are mainly restricted to gold-silver quartz veins, and these occur both in the stratified rocks of the basement series and in the older group of volcanic rocks. In this connection the rocks of Beeson's Island group, although carrying in certain parts of the peninsula quartz reefs of some importance, are in the area dealt with altogether negligible.

The rocks enclosing the quartz veins are all more or less altered from their original conditions. The alteration of the andesites results in a rock which is designated by the miners "kindly sandstone," and is best described as propylite, the term being used in the restricted sense proposed by Professor Rosenbusch. This is the country rock of the Kapanga, Hauraki, Waikoromiko, and several other groups of mines. The principal rocks of the Palæozoic group enclosing gold-silver quartz veins are those of the Tiki-Tokatea type, which are well represented in the lower levels of the Royal Oak and Hauraki Associated mines of the Tokatea Hill and Saddle. These have been altered by the same agencies which have resulted in the propylitisation of the andesites, and in general assume a lighter colour than the original rocks, and are highly pyritised.

Mapping of the various reefs in this portion of the peninsula reveals a general uniformity of strike, the great majority pursuing courses not far removed from the meridional line. Furthermore, a similar uniformity is apparent in the trend of certain belts of country, which include the centres where payable reefs have been located. In view of the special report to be issued shortly on this area, it is not here necessary to describe in any detail either the quartz veins or the mineral belts.

The veins vary in dimensions from mere thread-like partings to strong, well-defined reefs exceeding 60 ft. in width; but the mining experience of the past has shown that, as far as operations have been extended, the larger veins are not payably auriferous.

Coromandel has been noted for its ore-shoots of the bonanza type, the rich vein-material, locally termed "specimen stone," and valued at "ounce to the pound," having contributed more to the total gold-output than the ore yielding "ounces to the ton." As is the general rule in all veins of

this type, faults, cross-courses, cross-veins, and mineralised bands, as well as the character of the wall rock, have all exerted a powerful influence on the position and value of the ore-shoots.

The most common associate of the gold and silver in the quartz veins is pyrite, and, of course, the decomposition products of this mineral in the case of the ores near or at the surface. Other minerals which are not uncommon, although rather sparsely distributed, in the veins of certain localities are galena, sphalerite, stibnite, chalcopyrite, arsenopyrite, and native arsenic.

In reference to the main Tokatea reef, the largest and most persistent within the Coromandel area, it has often been suggested in mining circles that in view of the rapid and continued progress in all branches of mining and metallurgy, and the prospective cheapening of motive power, this reef will in the near future pay to work. An endeavour to collect reliable information bearing on this question elicited the fact that the accurate value of the veinstone exposed at the various outcrops and in the underground workings, which afforded cross-sections, had never been ascertained. A careful sampling of the reef at various points that appeared to offer the greatest facilities for examination has been undertaken by the writer, and the result of the assays is awaited with interest.

An endeavour has also been made to ascertain whether certain dykes and interstratified bands of igneous rocks which occur within the Tiki-Tokatea area of the Palæozoic group, present any possibilities as low-grade ore-bodies. These rocks have been highly silicified, and contain a fair percentage of pyrite and its decomposition products. The results of the assays of the samples taken are not yet to hand.

As the question of exploiting the deeper levels of the Coromandel Goldfield must eventually demand attention, all reliable information which has a bearing on the subject is being obtained, and the opinions expressed on this particular point by previous writers dealing with the geology and mining industry of the area will be brought together for comparison in the bulletin shortly to be issued.

Other Veins.—Apart from the gold-silver quartz veins, mention should be made of certain quartz reefs occurring near the line of contact of the older sedimentary rocks and the volcanic series within the belt of country drained by the main left-hand branch of Cadman Creek and the right-hand branch of the Tiki Creek. These reefs contain bunches of fairly high-grade metallic sulphides —viz., galena, chalcopyrite, and sphalerite—together with a little silver. They have been prospected to some extent, but so far without success, owing to the small dimensions and erratic nature of the ore-shoots. Vein-stone containing chalcopyrite was selected from a narrow band in one of these occurrences, and was found to contain 13·75 per cent. of copper. Considering that a block of ore of large dimensions, containing a high percentage of galena and some chalcopyrite, together with silver to the extent of 30 oz. to the ton, has been found in the débris of the Tiki Creek, further prospecting along this belt might lead to the discovery of larger veins than those already located.

I anticipate completing the field-work on the Coromandel subdivision by the end of March, 1907, when the preparation of the bulletin on this area will be undertaken.

Mr. R. P. Greville, Topographer.

Mr. R. P. Greville, Topographer, was engaged during the early part of the season in executing surveys in the rugged interior of North Westland, and at the headwaters of the Waimakariri River, in Canterbury. During the winter he was occupied in compiling his maps at the Head Office. In the beginning of the spring he established survey parties under the newly appointed assistant topographer, Mr. K. M. Graham, and his chainman, Mr. Alfred Whitehorn, in the Parapara subdivision of Karamea, Nelson. Early in October he took charge of the Geological Survey exhibit at the New Zealand International Exhibition. Towards the end of the year Mr. Greville resumed the work in Westland, which he had relinquished in the autumn. He reports as follows on the operations conducted under his charge during 1906:—

Field-work in Westland.—Early in January the surveys of the Kokatahi and Toaroha Rivers, which were well advanced last year, were completed.

The Kokatahi River, it may be explained, is the largest eastern branch of the Hokitika River. Rising near Mount Fitzgerald and Commodore Range, on the main divide, it flows in a course slightly to the east of north for about four miles, when it is joined by the Crawford, a stream of equal volume, which rises near Mount Beals and the Twin Peaks. From the junction of the Crawford the river follows a northerly course to the Whakariri Gorge, which is nearly three miles long, and after issuing from the gorge flows in a direction slightly to the north of west to its junction with the Hokitika.

Three miles below the Whakariri Gorge the Toaroha River, coming from the southward, joins the Kokatahi, and about two miles further down is the junction of the Styx River. The Styx rises at the Styx Saddle, close to the Arahura River, and has a general westerly course throughout. The area drained by the Kokatahi and its tributaries is, with the exception of the settled lands on the plain towards the Hokitika River, clad with dense forest to an altitude of about 3,500 ft., and is of a very rugged and generally inaccessible character.

The survey of the Kokatahi River was commenced by my chainman, Mr. Alfred Whitehorn, at the most southerly fixed point of the settlement surveys of the Lands and Survey Department, about two miles above the junction of the Styx River. Progress was fairly easy until the Whakarira Gorge was reached, about three miles from the starting-point. It was there found impracticable to follow the course of the river, and a long *détour* had to be made, necessitating a steep climb of 1,500 ft., and a descent of 1,400 ft. to the river again at a point about a mile above the head of the gorge. The traverse then followed the western edge of the river to the Forks, at the junction of Crawford

Creek. The travelling was difficult and tiresome throughout, and the swagging of food and baggage was a most arduous task. The traverse of the Kokatahi and its northern branch, the Crawford, was finished about the middle of January, and Mr. Whitehorn and party shifted to the main camp at the Upper Kokatahi settlement.

Simultaneously with the survey of the Kokatahi, a party under my chainman, Mr. Allan Wilson, was making a traverse of the Toaroha. This river flows through dense forest country almost for its entire length. The valley, though not of so rough a character as that of the Kokatahi, was difficult to traverse. It was practically an unexplored region, and it was found necessary to cut a good walking-track up the valley. The track starts from a point about two miles above the Styx River, and follows a well-selected route along the eastern side of the Toaroha.

Attention was drawn last year to the possibilities of the Toaroha as a water-power at the cañon situated from four and a quarter to five miles above the mouth of the river, and also to a fine hot spring discovered about a mile above the cañon. It may be noted in this connection that the people of Hokitika are evincing keen interest in the possible development of the water-power and of putting the hot spring to practical use.

The volume of water in the Toaroha was carefully measured in January, 1906, and an accurate section made of the river. The discharge was computed to be 440 cubic feet per second. The stream was again measured in May of the same year by Mr. Percy Morgan, of the Geological Survey staff, who obtained a result of 435 cubic feet a second. A calculation made on the assumption that there was a discharge of only 200 cubic feet a second, instead of the actual measured discharge of 435 ft., gave 17,000 actual horse-power.* The measurements of the river last year were each made after a long spell of dry weather, and it is believed give a good average discharge. The Toaroha is a snow-fed river, and large tributaries flow from the slopes of Mount Chamberlain and Mount Bannatyne on the east and Mount Ross and Mount O'Connor on the west. These mountains are apparently always snow-clad. The discharge of the river is, it is estimated, about equal in summer and winter, owing to the melting of the snow in the summer and the heavy rainfall in the winter.

The survey of the Toaroha was started at a point where it had previously been carried by the Lands and Survey Department, and continued to its source on the Toaroha Saddle. Several of its tributaries, including the Macmillan, Barton, Wren, Jumble, and Bannatyne, were also traversed for part of their courses.

Work in the Toaroha Valley was completed about the 20th January, and the whole of my party shifted camp to the Wilberforce River. The baggage and stores were carted by way of Kanieri and Kanieri Lake to Milltown, and thence packed on horses up the Arahura Valley to the Pyramid Rocks, at the foot of Browning's Pass, the members of the party going by way of the Styx Valley, up which at that time there was a good walking-track. The whole of the stores and baggage had to be swagged over Browning's Pass, this work requiring considerable time and exertion. The ascent of the pass on the Arahura side, though steep in places, is generally not a difficult one. The point where the track crosses the main divide, at an altitude of 4,950 ft. above sea-level, is about half a mile to the north of the actual pass and about 150 ft. higher, and is 1,650 ft. above the level of the Pyramid Rocks. The descent of the Wilberforce Valley is very abrupt. For the first 500 ft. the path zigzags down the precipitous rocky faces and then descends a steep talus-slide to the Wilberforce River, the total drop from the top of the range to the river being nearly 1,700 ft.

By the end of January the whole of the baggage and stores had been carried over the pass and a main camp fixed on the western side of the Wilberforce Valley, near the mouth of Cronin Creek. A detailed survey of the country in the vicinity of the Westland Reefs was then undertaken. The Wilberforce River was surveyed from its source at Pope's Pass (which has an altitude of 5,290 ft.) for a distance of twelve miles to about a mile below the junction of the Stewart or Unknown River.

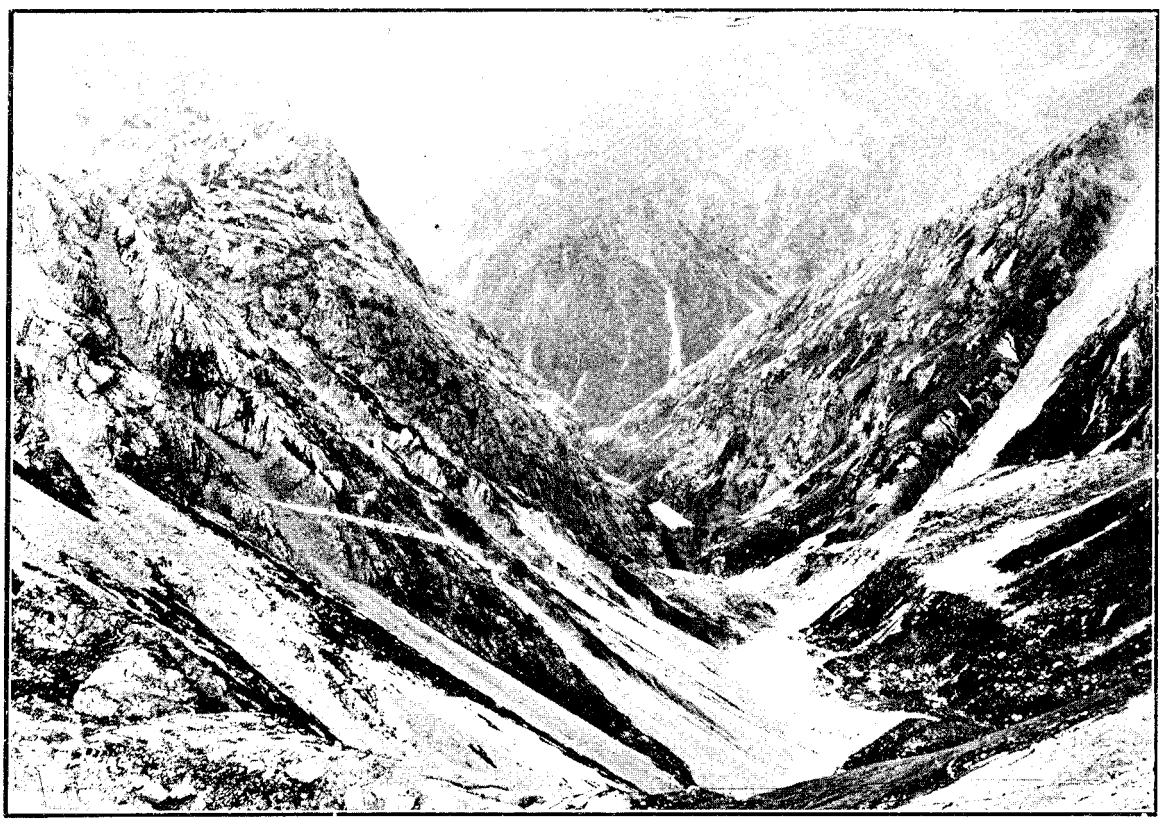
As well as the main Wilberforce River, all its tributaries, including even all the small creeks, were traversed. Chief among the tributaries are Hall Creek, which flows from the Hall Glacier; Grave Creek, flowing from the Grave Glacier: Cronin Creek, rising at Whitehorn Pass near the main divide; Snowy Creek; Sylvia Creek; the Gifford River, a large stream fed by the Gifford Glacier, which extends to the main watershed; and the Stewart River. The last-named was surveyed to its source, together with its large tributaries, the Griffiths and the Gibson. A survey was made of the Griffiths Glacier, at the head of the Griffiths Stream, which forms one of the largest ice-rivers of the northern part of the Alps. With the exception of small belts of alpine scrub, the area surveyed on the Canterbury side of the main range is all open country, which enabled much better progress to be made than is possible in Westland.

The traverse of the Taipo River, a tributary of the Teremakau, which was last year continued to a point about three miles north of Pope's Pass, was this year completed and connected with the Wilberforce Survey.

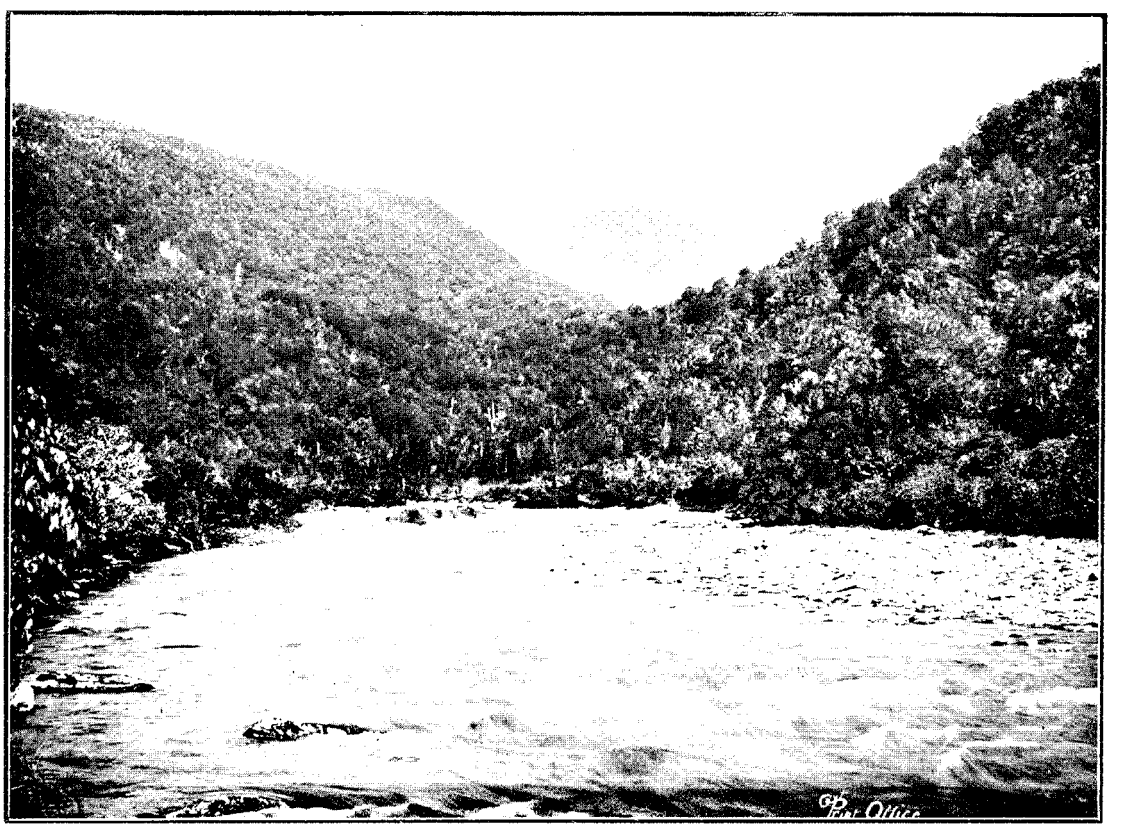
In March an exploration and rough survey was made of the summits of the Turiwhate Range, the Griffin Range, the Tera Tama Range, and the Campbell Range. Fortunately we were favoured by exceedingly fine weather during our investigation of this elevated and rugged part of the country. Thus the topographical information of the area was greatly increased and many valuable data were obtained. From the view obtained from the prominent summit of Mount Turiwhate, one cannot fail to be impressed with the vast undeveloped timber resources of Westland, and it is apparent that there will be a great expansion of the sawmilling industry there in the near future.

The work in connection with the detailed surveys in the Wilberforce and Browning's Pass district was carried on until the end of April. The weather experienced was particularly unfavourable, short spells of fine weather being broken by much rain, accompanied by heavy snowfalls. Early in May I departed for Wellington, leaving my chainman, Mr. Alfred Whitehorn, to finish a few details and to shift camp to the Hokitika River.

* Capable of producing about 13,000 electrical horse-power.



CANON CREEK FROM THE MATHIAS PASS, CANTERBURY



TOAROHA RIVER ABOVE THE TOAROHA CANON, WESTLAND

From the beginning of May till the beginning of September my time was taken up in office duties in Wellington, plotting original maps of field-work, and assisting with the maps to accompany Bulletin No. 1 on the Hokitika sheet of the North Westland division.

Surveys in Parapara Subdivision.—Early in September I proceeded to Collingwood and took in hand the topographical surveys of the area to be geologically examined in the Aorere, Waitapu, and adjoining survey districts. I remained in the Collingwood district until the second week in October. During the short time I was there, being favoured with fine weather, a considerable extent of the country was covered. Surveys were made of the Slate River, Big Boulder River, Little Boulder River, and Salisbury River, and a long traverse carried from the Aorere River near Bainham to Boulder Lake, and to the mountains near the head of the Snow and Slate Rivers. A survey of Boulder Lake was also made, as well as of a considerable area of the hill country surrounding it and contiguous to the traverse. A feature of the Collingwood district is the large area of *pakihi* land lying practically idle. It may be suggested that most of this land would grow *Danthonia semiannularis* and Chewing's fescue grasses, which have been so successfully grown in the poorer lands of the North.

Preparation of the Geological Survey Exhibit at the New Zealand International Exhibition.—On the 16th October, under instructions from you, I proceeded from Collingwood to Christchurch, leaving Mr. Whitehorn in the field to continue the traversing then in hand. From the date mentioned till the 1st December, with the exception of the intervals hereafter referred to, the arrangement of the Geological Survey contribution to the Mines Court of the New Zealand International Exhibition claimed my attention. Unfortunately, the very limited time available for the collecting of rocks and minerals by the field parties rendered the completion of the exhibit by the 31st October impossible. Considerable additions had to be made from time to time during the following month, so that my final departure from Christchurch was delayed until the date indicated.

Field-work resumed.—During November a visit was made from Christchurch to Westland in order to start the traverse of the Hokitika River above its junction with the Whitcombe. The continuation of this work after my return to Christchurch was assigned to Mr. Allan Wilson, chainman, with a party of two men. During this month also, as opportunity offered, the topographical surveys of the Collingwood area, executed in September and the early part of October, were plotted, and the preliminary maps on which to base the geological field-work were prepared.

Leaving Christchurch on the 1st December, I proceeded to Westland and continued the survey of the headwaters of the Hokitika River, which work occupied my time until the end of the year. During the course of this survey an exploration of the head of the Hokitika and Mathias Rivers was made, both Frew's Saddle and Mathias Pass being crossed and examined.

Mr. R. J. Crawford, Senior Draughtsman.

Mr. R. J. Crawford, Senior Draughtsman, gives the following account of the work accomplished by the draughting staff during the year:—

Maps have been compiled from the field-books, drawn, and photo-lithographed for publication in the Geological Survey bulletins as follows:—

For Bulletin No. 1, on the Hokitika sheet of the North Westland division: Topographical and geological maps of Kanieri and Mahinapua Survey Districts, Turiwhate Survey District, Browning Pass and part of Davie and Wilberforce Survey Districts, all on a scale of 40 chains to an inch, for reduction by photography to one mile to an inch.

Large maps of the North and South Islands of New Zealand on a scale of five miles to an inch, showing the distribution of minerals, were prepared and suitably framed for the New Zealand International Exhibition at Christchurch. This occupied a great deal of the time of the staff, and took several months to complete.

Sets of the topographical maps of the area covered by the Hokitika sheet of North Westland division were also mounted and framed for the Exhibition.

The compilation and drawing of the following maps has also been begun, several being ready or almost ready for photo-lithography:—

Hauraki Division.—Geological maps of Colville, Moehau, and Harataunga Districts in one sheet, and Coromandel Survey District and Otama Survey District separately, on a scale of 40 chains to an inch, for reduction by photography to one mile to an inch.

North Westland Division.—Topographical and geological maps of Toaroha Survey District, on a scale of 40 chains to an inch, for reduction to one mile to an inch.

Small index-maps of North Westland, Central Otago, Hauraki, and Karamea divisions; one of New Zealand showing all the divisions; and a later one of New Zealand showing the land districts as well as divisions, have been drawn for the purpose of locating the areas covered by the maps published in the several bulletins. Maps of the North and South Islands of New Zealand, on a scale of sixteen miles to an inch, showing the land districts, divisions, and survey districts, have been prepared for office use.

Besides this work by our staff, the following maps were drawn during the year by draughtsmen from the Lands and Survey Department, temporarily employed by the Geological Survey:—

For Bulletin No. 2, on the Alexandra sheet of Central Otago: Geological maps of Leaning Rock, Tiger Hill, and Poolburn Survey Districts, on a scale of 40 chains to an inch, for reduction

by photography to one mile to an inch. Detail maps of Waikerikeri Goldfield, Ophir Goldfield, and Dairy Creek Coal Area, on various scales.

The general routine work has been carried on, including the making of numerous tracings for field and office use, the recording of plans and field-books, the revising and colouring of proofs of maps for publication, &c.

Staff.—During the year Mr. O. A. Darby, Cadet Draughtsman, was transferred from the Department of Lands and Survey to this office, and since September we have had the services of Mr. G. E. Harris, of the Department of Lands and Survey.

As will be seen from the foregoing, it has been found necessary that our draughtsmen should be proficient both in plotting and compiling from field-notes, &c., and also in drawing the finished plans for photo-lithography.

Approximate Cost of Paper.—Preparation, not given; printing, including map and blocks (1,900 copies), £21 2s. 6d.

By Authority: JOHN MACKAY, Government Printer, Wellington.—1907.

Price 9d.]