1896.

NEW ZEALAND.

GEOLOGY: GENERAL REPORT AND REPORTS OF SPECIAL EXAMINATIONS MADE DURING THE YEAR 1895-96.

BY ALEXANDER McKAY, F.G.S., MINING GEOLOGIST.

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

Mr. A. McKay to the Under-Secretary of Mines.

Sir,—

I have the honour to report the results of the geological branch of the department as follows, and to append the various reports on special districts, which are now completed.

The first work of the season was the examination of certain outcrops of coal at the Gordon Downs, between the upper waters of the Wai-iti River and the gorge of the Motueka River, in the Nelson District.

The coal-seams and associated strata at that place were determined as belonging to the Cretaceo-tertiary formation to which belong the great bulk of the coal-measures of New Zealand. The outcrops show the strata to be highly disturbed, and so arranged that they appear to pass under the older rocks of Carboniferous date that form the mountain-ranges to the eastward. In this direction they continue but for a short distance till they are cut off by a line of fault, which, along the lower slopes of the Dun Mountain Range, has been traced from the gorge of the Motueka River to the neighbourhood of the Town of Nelson.

Owing to erosion and subsequent deposition over the western part of this coalfield, it appears doubtful whether coal-seams could be reached by sinking through the Older Pliocene gravels that occupy the surface in that direction.

Towards the south-west there is a considerable development of the coal-bearing formation, extending in that direction so as to occupy a considerable area within the limits of the Big Bush. In the opposite direction, the coal-bearing strata are traceable as far as the gorge of the Wai-iti, beyond which they are not again met with until the foot of the range between Hope and Richmond is reached, from which point they may be considered practically continuous to the valley of the Maitai River, near Nelson.

Coal outcrops are known along this part of the line, at the back of Stoke, at Jenkins's Hill, Enner Glynn, and more to the north-east, within Brook Street Valley, near the reservoir of the Nelson Water-works. Jenkins's Hill Mine, work at which was suspended as far back as the date of Dr. Von Hochstetter's examination, indicates the position of the coal to be such as described at the Gordon Downs—*i.e.*, as strata inverted or standing at high angles, and seemingly dipping under the older strata of the mountain-range to the eastward. This position of the coal rendered it difficult to work with profit, and as a consequence the works at Jenkins's Hill have long since come to a standstill.

More recently, outcrops of one or more seams have been prospected within the watershed of Brook Street Valley, and with such results that an association or company was formed in Nelson for the purpose of exploring and working the same. Local experts have pronounced favourably as regards the probable success of this undertaking, and prospecting works by shaft-sinking, and short drives therefrom on the lines of coal, have been carried to a depth of 250ft. from the surface. This work shows the coal to be standing nearly vertical, and to vary considerably in the thickness of the seam at different parts, but still traceable from the surface to the depth reached. At one place, near the bottom of the shaft, as much as 10ft. of coal was met with, and hopes are entertained that this amount or thickness will continue along the strike at that level and pay for extraction. I am not very sanguine of this, and would limit the extent of the seam in a south-west direction as scarcely exceeding a quarter of a mile from where the mine-mouth and present prospecting works are situated.

To the north-east the continuity of this seam is at an end within a lesser distance. From analysis, the coal may be regarded as a superior class of brown coal, but in no sense can it be considered as bituminous, or at all comparable with the coals mined in the Grey Valley, or on the Westport field. The Enner Glynn Mine and works were examined during the current year by Mr. Inspector Cochrane, who reports on the nature of the coal, the character and condition of the works, and, with respect to the latter, their satisfactory conditions.—(See report by Inspector Cochrane, C.-3B., p. 3.)

In the same district, in response to an application made by Tayton and Jackson, of Nelson, an examination of an outcrop of chrome-ore, situated on the western slopes of Mount Starveall, at a height approaching 3,000ft. above the level of the sea, was effected. The amount of ore observable, and the position of the outcrop, as described in the report which follows, are such that there seems little prospect of the ore being worked for some time to come. Considerable expense would have to be incurred in constructing a road or other means for bringing the ore to the low grounds in Aniseed Valley opposite the junction of the Serpentine River, whence it would have to be carted to Hope Railway-station.

In the Collingwood District, Nelson, there was made an examination of the Aorere goldfield, with a view of determining its future value as a field for the development of hydraulic sluicing by ordinary methods, or by means of elevating machinery where the natural fall for the disposal of tailings would prove deficient. This work naturally led to a re-examination of several localities which have become historic in the discovery, progress, and decadence of this the first of the goldfields of the Middle Island of New Zealand. These localities included the Lower Parapara and the several areas held and being worked by the Parapara Hydraulic Sluicing and Gold-mining Company, which includes Glengyle Gully; the upper part of Appo's Creek and Appo's Flat; the northern part of Appo's Flat held by West, Adams, Fell, and Co.; the upper part of Lightband's Gully, the Golden Gully area, Blue Creek Plateau, and the Quartz Ranges.

The general geology of the southern side of the Aorere Valley was worked out, and at all the localities mentioned the gold found in the more superficial drifts and gravels of the present creek-channels was regarded as having been derived from an older gravel- or drift-deposit, laid down at a time when the present physical features of the Aorere watershed had no existence. Former geological workers in this field have speculated variously as to the source of this older drift, and usually it has been credited to the action of the Aorere River within the bounds of the present watershed. Sir James Hector seems to be the only dissentient from this view, for he says, in the preface to the Geological reports for 1890–91, at page xii., "I have never felt altogether satisfied with the explanation that attributes the origin of the gold to the ordinary drift-gravels." But Sir James does not indicate clearly what the true origin of the gravels may have been. With less caution, perhaps warranted by a further array of facts and a greater depth and breadth of generalisation, there need be now no possible hesitation in pronouncing these beds as having resulted through the action of the sea, the gravels formed upon a sinking shore-line being successively submerged as the sea encroached upon the land. The date of the submergence was prior to the deposit of the marly and calcareous divisions of the Cretaceo-tertiary series of formations. The nature of the gravels is at places almost wholly quartz.

It has been stated, in a previous report (on the older auriferous drifts of Central Otago, C.–4., page 38), that "there is no river in New Zealand at the present time that does or apparently can produce pure quartz-gravel by current action along its beds." And least of all might this be expected as a result of the action of the Aorere River now or in the past; the great number of tributary streams that throughout its course make junction with it, mingling with its more reduced gravels much angular and subangular material derived from a great variety of rocks in the neighbouring ranges. In schistose areas the action of the sea beating on the shore-line, by the pounding and carrying out to sea of the soft material, tends to the production of a residuum of pure quartz-gravel, the result being scarcely affected by small streams draining to the coast-line and bringing gravels from a region of schist or metamorphic rock. Away from the mouths of lesser and torrential rivers the cutting-back of a plane of denudation results in the production of a gravel the material of which is local, and thus distinguishable from those of a stream that has cut through a variety of rocks.

Towards the north-east, in the Lower Parapara, Glenmutckin, and Glengyle, and to the Saddle at the source of Appo's Creek, the gravels of the older period referred to are somewhat of a mixed character; but this mingling of different material may have largely arisen subsequent to the laying-down of the original deposit, since it appears that both the older gravels and a more modern deposit due to the action of the Aorere River have been engulphed along a line of fracture that skirts the northern base of the mountains on the southern side of the Aorere watershed. But everywhere throughout this mingled deposit there are disjointed, or more or less continuous, patches of pure quartz-gravel, which are mainly the auriferous parts.

In Lightband's Creek and Golden Gully quartz-drifts predominate, while at Blue Creek Plateau the quartz-drifts are mixed and alternate with coarser material which is locally derived.

In the Quartz Ranges, the quartz residue of the harder gravel material of the original rocks forms deposits which occupy largely the north-eastern end of the auriferous area, and are to be followed along either the northern or southern border of the gravel-deposit to its south-western extremity; while the higher part generally, and at places the whole of the deposit, is composed of ordinary gravels locally derived. The local character of the coarser gravels on the Quartz Ranges have been noticed by other writers on the geology of the district, notably by Mr. J. Park, but he also failed to see in this an argument in favour of the marine or lacustrine origin of the deposit.

As auriferous deposits of considerable extent, the various areas of these older gravels could be worked to profit, provided an ample or sufficient water-supply with the required hydraulic head, can be brought on to the ground at a reasonable cost. In the Lower Parapara area, as far as the supply from the Parapara River opposite the head of Lightband's Gully is sufficient, this has been done; the Parapara Hydraulic Sluicing and Gold-mining Company having a weir or dam in the river-channel, which lifts the water so as to pass the Saddle at the Old Richmond Hill Claim by a tunnel, and thence is conveyed across the Hit-or-Miss Saddle, at the head of Glengyle Gully, whence a pipe-line conveys the water across the Parapara and the intervening hills to the various points where it is required. These works have been in operation during the past twelve months; but, so far as can be gathered, only a moderate degree of success has resulted.

It is proposed to bring a water-race from the Upper Slate River to work the leases being acquired by West, Adams, and Fell at Golden Gully, Lightband's Gully, and Appo's Flat. This water, the volume of which is fifty Government heads, would have to be brought by way of the ridge between Blue Creek branch of the Slate River and the Upper Parapara. The pipe-line securing a sufficient hydraulic head would be of moderate length to reach the working faces on the south-west parts of the Golden Gully area; but the further extension of the race so as to reach the head of Lightband's Gully and Appo's Flat would require an extended pipe-line to carry the water across the Golden Gully area and again over Appo's Gully to reach the north-easternmost of the leases held by West, Adams, and Fell.

The source of the water that of sufficient volume might most easily and at the least cost be brought on to the Quartz Ranges has not yet been determined. The supply from the Clark River would be doubtfully sufficient, except during the melting of the snow in spring and during periods of more than normal rainfall at other seasons of the year. The water would have to be lifted from above the rapids in the part of the gorge cut through granite, and it may be that greater difficulties than are anticipated would be encountered in bringing this water on to the ground intended to be worked by it. The water, if brought over the shoulder of Pine Ridge, would command all parts of the auriferous area.

On return from the Collingwood district, owing to the requirements of the Court sitting in connection with the Midland Railway arbitration case, no field-work could be done till after the New Year; but during the first week of 1896 a start was made for the Wilson River and Preservation Inlet goldfield, occupying the south-west corner of the Provincial District of Otago.

In the district of Preservation Inlet, and on the northern shores of Foveaux Strait, gold has been known to occur since 1863, but not till about the middle of 1889 was ground of a payable character discovered on Coal Island. This discovery was shortly followed by the rush to Wilson River, the following-up of the alluvial working on which led to the discovery of the Golden Site reef. The stone in this at the outcrop and near the surface was phenomenally rich in gold, and the discovery caused considerable excitement in gold-mining circles, and proved likewise an attraction to others not usually engaged in mining matters. The rich prize was even with some a bone of contention at law, while others, apparently convinced of the truth of the proverb, "There is as good fish in the sea as ever came out of it," set themselves the task of prospecting and exploring the country for other reefs of like character. The result was the discovery of the Morning Star line of reef and that of Sealers' No. 1. A battery and gold-saving appliances were erected on the Golden Site Claim, and the vigorous extraction of the auriferous stone was commenced; but, pushed to the south, the reef shortly and suddenly came to an end, while on the north side of the river it broke up into a number of small veins, which also became much poorer in gold than the main body of the stone under the river.

The comparatively limited workings that have been carried on in the Golden Site Mine have exhausted the richer stone, except in the vertical line immediately beneath the river-bed, while injudicious mining has allowed water from the river to flood this part of the mine, so that, from the circumstances here stated, the present prospects of the mine do not bear out the high anticipations that at one time seemed warranted.

Adits have been driven at two different levels on the hill-slopes on the north side of the gorge, and stone has been found in each, but the prospects so far have not been of such a character as to encourage the proprietary, and, as a consequence, all work is for the present at a standstill.

The amount of work done, and the information that may be gathered from the workings, and the disposition of the lode at the surface or from the surrounding strata, are not sufficient to warrant a judgment being given as to what the future of the mine may be. That the extraordinarily rich patch found at the outcrop in the bed and southern bank of the river is or was the only rich patch contained in the lode is unlikely, but the loss of the reef in the south extension of its line is an untoward circumstance, which may involve the expenditure of considerable sums before it can again be picked up. To the northward the following of the several thin leaders, into which the main body of stone broke up, should be continued, in the hope that these will again unite so as to form one reef and prove payably auriferous.

At Longbeach, the Morning Star line of reef displayed a character of continuity that, as far as the easy tracing of the stone is concerned, is sufficiently satisfactory. The gold found in the southern extension of the three levels of the mine has not been equal in amount per ton to what it was and is in the remaining ground of the northern part. Unfortunately, in this direction the length of reef and the amount of "backs" are not equal to what might be explored in a south direction. To the south it appears the stone got poorer till it would not pay for treatment at the mill; but in the mid-level the last stone taken gave a return of 6dwt. to the ton, and the directors have determined to push on this level in the hope of a permanent improvement taking place. Meanwhile, the stone from the northern stopes supply the mill, and up to the present time the yield therefrom has been satisfactory.*

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* The following extract from a letter, received since this report was written, may be of interest in connection with this claim:—

Morning Star Claim.

DEAR SIR,— Invercargill, August, 1896.

I thought you would like to know the result of your advice in driving into the hill in No. 1 level. We had not gone many feet before we came on gold-stone; we drove right on and found the gold-shoot 86ft. wide, with 150ft. overhead. We are now working it, and from three weeks' work got 233oz. of gold, worth at the Mint, Melbourne, £960, from 240 tons of stone. We are taking an uprise and driving on still south, with good indications of approaching another shoot of gold.

In No. 2 level we have found another gold-shoot driving north, but have not yet gone through it. Your advice was valuable. . . .

Yours faithfully,

A. McKay, Esq., Wellington. J.H.

The reef in Sealers' Creek, which lies somewhat to the westward of the south extension of the Morning Star line, has not been prospected, except at the surface, at which patches of rich stone can be seen, or the stone may be proved to be rich by crushing and washing.

On Steep-to Island and at Cuttle Cove prospecting for or upon reefs is at present at a standstill. On Steep-to Island no distinct line of reef has been found, while at Cuttle Cove the reefs reported as yielding payable gold are thin, and the samples brought to Wellington did not yield more than a trace of gold.

All these reefs are contained within a development of Lower Silurian rocks that lie between the granite mountains and the coast-line, and which, from the shore of Foveaux Strait, extends north-west from the mouth of Kiwi Burn across Preservation and Chalky Inlets to the northern shore of the latter at North Port. In the northern part, the lower portion of the series has been altered to metamorphic rocks that contain much carbon, while towards the east, where the original rocks were of a more arenaceous type, the change is in the direction of micaceous quartzites, with lesser developments of mica-schist, into which numerous veins of granite have been intruded. The higher rocks of the series are less altered, and at places contain abundant fossil remains, indicating the age and period to which the rocks have been referred.

Within the granite region, lodes carrying ores of the metals are rare. Bradshaw's reef, on the western shore of Isthmus Sound, occurs in granite, and appears as a well-defined and continuous lode, carrying gold, silver, copper, lead, zinc, and iron, and forming a mineral vein 2ft. to 3ft. wide. The ores of the various metals named are generally mixed throughout the lode, but usually the copper-ore replaces the galena. The galena of the lode is, next to the iron, the more abundant ore, and, when pure, contains 120oz. of silver to the ton.

To the north-east and east of the north-west extension of the granite, there is a large area of country over which highly-metamorphic schists are present. These rocks begin near the head of Edwardson Sound, and the line of junction between them and the granites passes diagonally across Cunaris Sound to Last Cove in Long Sound, which latter, the boundary-line between the two rocks, also crosses diagonally, reaching the eastern shore of the Sound at a point some two miles higher up the Sound. Schistose quartz is abundant in this formation; such quartz having often imbedded plates of mica, usually of a black or brown colour (probably biotite). This schistose area has been in places more or less prospected for gold, which, however, does not seem to occur in paying quantities either as alluvial gold or in the reef matrices. However, of this part of the district it may be said that it has received as yet very little prospecting, the extent of the country considered.

To the westward of the auriferous belt of Silurian rocks, an area of coal-bearing rocks stretches along the coast-line, the greatest breadth of which is along the line of section between the foot of the gorge of the Wilson River and the sea at Windsor Point. The greater part of Coal Island shows the presence of these rocks underlying glacier detritus and more modern auriferous gravels derived from the latter.

The auriferous drifts of the district are not varied, being glacier morainic drifts, and concentrated results from the same by the action of the sea, and the ordinary gravels of streams, such as Wilson River, and finally the sands of the sea-beach.

Alluvial mining at the present time is, over the whole field, in a languishing condition. On Coal Island there are more men engaged in this form of mining than at any other locality, and could a plentiful supply of water be stored in the higher part of the island and utilised at lower levels, where the auriferous gravels lie, there might here be a revival of mining.

On Te Whara Beach, and at Gulches Head, the value of the gold-bearing areas have yet to be demonstrated.

During the latter part of the season Woodville, the Upper Tiraumea, and Mauriceville were visited, in connection with reported discoveries of jet or coal at these places or in their vicinity. Details of these visits will be found in the special reports which follow.

I have, &c.,

The Under-Secretary of Mines, Wellington. ALEX. McKAY, Mining Geologist.

THE GEOLOGY OF THE AORERE VALLEY, COLLINGWOOD COUNTY, NELSON.

REPORT by ALEXANDER McKAY, F.G.S., Mining Geologist.

SIR,— 12th June, 1896.

Between the 1st and 20th November last I made, as directed, various examinations in e district of the Aorere Valley, Collingwood County, Nelson; on the geology of which part of the country I have the honour to supply the following report.

The Under-Secretary of Mines, Wellington. ALEX. McKAY.

REPORT.

INTRODUCTION.

THAT part of the north-west district of Nelson, which includes the Aorere Valley and the district around Collingwood, is of great interest geologically. It is rich also in useful minerals, and has yielded many varieties, rare or not elsewhere found in New Zealand, and it has the undoubted claim to be regarded as the first goldfield discovered on the Middle (or South) Island. Dr. Von Hochstetter visited the Aorere goldfield in August, 1859, two years after the first discovery of gold at Lightband's Gully, and subsequently he gave the results of his observations in his great work on New Zealand, from the English edition of which, as the work is now rare, I have thought fit in this place to make the following extract:—

"The principal event" [for Nelson] "of the year 1857 was the discovery of gold in the Aorere district on Massacre Bay. In the beginning of the year Mr. W. Hough, a Nelson storekeeper, having some land at the Aorere, went over there in company with Mr. W. Lightband, a young man who had some experience as a gold-digger in Australia. They commenced prospecting in some of the gullies. Mr. Hough shortly returned to Nelson, leaving Lightband to prosecute his labours with the assistance of some Maoris. They continued steadily at work until they had obtained about 3oz. of gold, which was forwarded to Nelson. This was the beginning of the development of the rich mineral resources of the provincial district, and the greatest amount of credit is due to William Lightband, whose steady perseverance at the diggings induced others to go over and try for themselves. The first reports received from Lightband were to the effect that his average earnings were about 10s. per day. Although this could not be called a splendid profit, it allured a good many others to follow his example. Fresh gullies and creeks were discovered, yielding better returns, and when the encouraging fact became known that three men, working on the Slate River, a tributary of the Aorere, had obtained 100oz. of gold in seven weeks, the diggings might be said to promise hopefully. The number of diggers increased from day to day, and it was estimated that on the 1st of May, 1857, there were no less than a thousand men at work upon the Aorere diggings. On the mouth of the river arose the fast-thriving little town of Collingwood. As the winter approached, the expense of transporting provisions from the port of Collingwood, owing to the want of roads, became greater; and as the floods in the rivers at this period destroyed the dams and other works of the diggers, many of these became disheartened and left the place; although many remained throughout the winter, earning good wages, and others returned in the spring, the diggings have never regained their former population.

"When I visited the goldfields in August, 1859, there were, in all, only about two hundred and fifty diggers at work. Although the work is frequently interrupted by the overflowing of the rivers, and although much time is lost in the difficult transportation of provisions, the average gain of a digger at that time was, nevertheless, computed at 12s. per day. But such pay, although sure and permanent, seems, after all, too small to allure a large number of men to engage in the laborious work of gold-digging. What caused the headlong rush of thousands of persons to other goldfields was less the certainty of a reward for their labour to all than the enormous lottery-like gains of some lucky individuals. Such prominent cases of good luck, however, never occurred on the Nelson goldfields; they consequently continued to be only scantily worked, and yielded a comparatively small although permanent produce, which they will continue to yield for a long series of years to come. The largest piece of gold (which was found in the Rocky River) weighed not quite 10oz.; a second, 8oz. And by August, 1859, the total amount of the produce was estimated at about £150,000.

"The mode of occurrence of gold in the Province of Nelson is quite different from that in Australia—in the Colony of Victoria. The Australian gold is originally derived from quartz reefs passing through fossiliferous strata of Silurian age, which are but very little metamorphosed, and the gold is obtained partly as alluvial gold from deposits of gold-drift (wash-dirt of the miner); partly from the quartz veins themselves, by crushing the quartz, and by subsequent washing and amalgamating processes. As the gold-alluvias are already nearly all washed over, an extensive system of quartz-mining has been begun within the last few years, and the vital question still awaiting its final and decisive settlement is: Whether the quartz veins—which, close to the surface, were sometimes found to be unusually rich (the auriferous quality of them has, however, hitherto been tested only to a depth of 300ft. to 400ft.)—will continue at a still greater depth to be so rich in gold as to pay for mining."

In a footnote, added evidently after the above was written, the author says, "Experience seems more and more to confirm the views of the Australian geologists (Messrs. A. Selwyn and G. Ulrich) that the reefs of gold-quartz in Victoria are real mineral veins which render a permanent system of mining in a downward direction possible, as on the veins of silver-, lead-, tin-, and copper-ore in Great Britain and Germany, while the prevailing opinion had been that the gold decreased in proportion to the increasing depth of the mine. G. Ulrich has proved upon the quartz reefs of Victoria the most different ores, such as iron pyrites, arsenical pyrites, copper pyrites, galena, grey antimony ore, copper glance, bismuth glance, native copper and native silver. The greatest depth hitherto reached in the gold-mines of Victoria is 460ft., and at this depth quartz has been obtained containing over 5oz. gold per ton." The above refers to the state of mining in Victoria not later than 1866. Very different is it at the present time, when the strata have been pierced to depths exceeding 2,500ft. and 3,000ft. from the surface, and auriferous quartz veins discovered that will pay for mining even from these great depths. Due to the demonstrative nature of the facts ascertained, a change has also come over popular opinion as to the depth to which quartz veins containing payable gold may reach.

Von Hochstetter continues his description of the Nelson goldfields, as at the time known, as follows: "Upon the Nelson goldfields the gold has been originally derived from quartz veins, which occur in non-fossiliferous crystalline (or metamorphic) schists. A section from east to west, through the mountain-ranges between Blind Bay and the west coast of the Provincial District of Nelson, presents us the succession of the crystalline schists. The western shores of Blind Bay, from Separation Point to the mouth of the Motueka River, consists of granite, which, towards the west, is flanked by gneiss. This granite- and gneiss-zone can be traced towards the south along the Motueka Valley to the junction of the Wangapeka River. It is intersected farther south by the Buller River, at its entrance into the gorge of Devil's Grip, and continues on the eastern escarpment of the range as far as Lake Rotoroa (L. Howik). Proceeding from the granite and gneiss towards the west, we find upon the top of the Pikikerunga Range a broad zone of hornblende schist, which alternates frequently and regularly with quartzite and crystalline limestone in vertical strata, with a strike almost due north and south. These ranges continue to the westward as far as beyond the Takaka Valley, where they are intersected, on Stony Creek and the Waikaro, by dioritic

porphyry and serpentine. A characteristic feature of the limestone of this zone is the numerous funnel-shaped pits and caves, reminding us of the caves of the Karst Mountains in Austria. The interesting phenomenon of the Waikoromumu Springs in the Takaka Valley, which send forth a powerful gush of water, is explained by the supposition that the water, after a long subterraneous course, breaks suddenly forth. This zone can also be traced in a southerly direction as far as Lake Rotoroa. It is followed by the mica-schist and clay-slate zone. Garnet-bearing mica-schist, alternating with quartzite, constitutes the highest, sharply-serrated crests of the western ranges in the Anatoki Mountains, with peaks reaching a height of 6,000ft. above the level of the sea, while further to the west the mica-slate passes imperceptibly into clay-slate (phyllite). The Aorere Valley, and the mountains, 4,000ft. to 5,000ft. high, on its east side, such as the Slate River Peak, Lead Hill, Mount Olympus, and the whole of the Haupiri Ranges, belong to the clay-slate zone."

There are several slight errors in the above general description of the rocks of this part of the Nelson District, and these have been passed over as of little importance in the present case; but as, in the following report, Slate River Peak, Lead Hill, and Mount Olympus concern us nearly, it becomes necessary to state here that Lead Hill and Mount Olympus are formed of granite, while Slate River Peak and the neighbouring region consists of breccias sandstones and green slates indurated, but unaltered, which, by Mr. Park, are referred to the Devonian period. The more schistose rocks of Silurian age lie to the north-west within the main valley of the Aorere watershed, and in the upper valley of the Aorere River these are interposed between the granite areas of the Leslie Range and that to the north-east, embracing Mount Olympus and Lead Hill.

"The strata are very much inclined throughout the whole mica-slate and clay-slate zone, and variously bent. On Mount Olympus the strata diverge from below towards the serrated edge of the mountain-top like the folds of a fan. In the, as yet, but little explored Wakamarama coast-range the succession of crystalline slates seems to repeat itself in an inverted order, but with less thickness."

Here also it is important to note that considerable areas of unaltered, or comparatively unaltered, Silurian schists are met with in the part of the district lying to the westward of the Aorere Valley. This fact, and the extent of these rocks, will be made clear in a further quotation from Mr. Park's report on the district. Meanwhile, to continue: "While, on the West Coast, granite again appears. The mica-schist and clay-slate zone—which, in a breadth of fifteen to twenty miles, includes principally the Anatoki and Haupiri Ranges, probably continues in a southern direction through the whole chain of the New Zealand Alps—contains in its quartz veins and beds the matrix of the gold. The gradual denudation of the mountains, continued through countless ages, has produced masses of detritus, which were deposited on the declivities of the mountains in the shape of conglomerates, and, in the river-valleys, in the shape of alluvial gravel and sand. In this process of deposition, carried on under the influence of running waters, Nature herself has effected a washing operation, during which the heavier particles of gold contained in the mountain detritus collected themselves at the bottom of the deposits and close to their source, so that they can now be obtained by digging and washing. The conglomerates accumulated on the slopes of the mountains are the proper fields for the 'dry diggings,' while, from the gravel and sand of the beds of rivers and smaller streams, the gold is obtained by 'wet diggings.' The latter were those first worked. Nearly all the rivers and creeks running from the Anatoki and Haupiri Ranges, either east to the Takaka Valley, or west to the Aorere Valley, or, like the Parapara, towards the north into Golden Bay, have been found to be more or less auriferous.

"The Aorere diggings are situated partly in the main valley itself, partly in the numerous side valleys intersecting deeply the slate-rock at a distance of from five to twelve miles from Collingwood. The gold is washed from the alluvium of the rivers by sluice-boxes and cradles. It is a scaly gold, with rounded particles, which prove that it has been exposed to the action of running water, and brought thither from a greater or less distance. Yet nearly every valley, and even creek, contains gold of somewhat different appearance. While most of the gold is very pure, that of Slate River, for example, has always a brown ferruginous coat. On the Appos River the gold is accompanied by crystals of iron-pyrites, which remained behind in the process of washing; in other places magnetic iron, or titaniferous iron, is found in company with gold. The fact that the heaviest gold is found in the upper parts of the streams points clearly to the mountains as the original source of the metal.

"But it would be improper to speak of an Aorere goldfield if the gold were confined to the deep and narrow gorges of the streams, cut down into the clay-slate rock. The whole region of the eastern side of the Aorere Valley, rising from the river-bed towards the steep sides of the mountains at an inclination of about 8°, and occupying from the Clark River to the south, to the Parapara on the north, a superficial extent of about forty English miles, is a goldfield. Throughout this whole district, on the foot of the range, we find a conglomerate deposited on the top of the slate-rocks, attaining in some places a thickness of 20ft. Pieces of drift-wood changed into brown coal, as well as the partial covering of the conglomerate with Tertiary limestones and sandstones at Washbourne's Flat indicate a probable Tertiary age of this conglomerate formation."

This question—viz., the age of the different auriferous gravels in the Aorere Valley— will be discussed further on, but here it is important to note that Hochstetter recognised that some of these underlie the limestones of Tertiary age that are found in the low grounds and along the east side of the Aorere Valley. "Where a ferrugenous cement binds the boulders and the gravel together, this conglomerate is compact, in other places only fine sand lies between the larger stones. Quartz and clay-slate boulders are the most commonly met with. This conglomerate formation is not only cut through by the deep gullies of the larger streams, but in some places washed by the more superficial action of water, and is thus divided into parallel and rounded ridges, of which that portion of the district called the Quartz Ranges is a characteristic example. This conglomerate formation must be regarded as the real goldfield, prepared in a gigantic manner by the hand of Nature from the detritus of the mountains for the more detailed and minute operations of man.

"While the less extensive, but generally richer river diggings afford better prospects of gain to the individual digger, the dry diggings in the conglomerate will afford remunerative returns to associations of individuals who will work with a combination of labour and capital. The intelligent and energetic gold-digger, Mr. Washbourne, was the first person who has proved the value of the dry diggings in the Quartz Ranges, and he has demonstrated the fact that gold exists in remunerative quantities in the conglomerate. I am indebted to Mr. Washbourne for the following interesting details. He writes to me: 'In the drifts into the conglomerate of the Quartz Ranges, the average thickness of dirt washed is about 2ft. from the base rock, and the gold produced from 1 cubic yard of such earth would be, as nearly as I can calculate, worth from £1 5s. to £1 10s. This includes large boulders, so that a cubic yard of earth, as it goes through the sluice, is, of course, worth more, as the boulders form a large proportion of the whole. When the whole of the earth from the surface to the rock is washed, the value per cubic yard is much less, not more, perhaps, than from 3s. to 6s. per yard, but it would generally pay very well at that.' These are the words of one of the most expert Nelson diggers, who paid his men for working in the Quartz Ranges wages from 10s. to 12s. a day, and still made a considerable profit for himself. With these data, while at Nelson I ventured to make the following calculation in order to encourage the public to a more extensive enterprise in the working of the goldfield: If we reckon the superficial extent of the Aorere goldfield at thirty square miles, the average thickness of the gold-bearing conglomerate at 1yd., and the value of the gold in each cubic yard of conglomerate at 5s., the total value of the Aorere goldfield amounts to £22,500,000; or, in other words, each square mile of the goldfield contains gold to the amount of £750,000. Of this, the above-mentioned sum of £150,000 already obtained is, of course, only a very small part."

"The Parapara diggings are the northern continuation of the Aorere Goldfield, at the mouth of the Parapara River, four miles east of Collingwood, on the shores of Golden Bay. A striking phenomenon at the Parapara Harbour is the large masses of sandy-brown iron-ore protruding from the white quartz-boulders in the form of rugged rocks of a dark-brown appearance, and giving rise, from their striking resemblance to volcanic scoriæ, to the erroneous supposition that volcanic forces had been active on the Parapara."*

Since 1866, work has been continued on the Aorere Goldfield, but in alluvial workings no new important localities have been opened up, and the systematic working of poor ground on a large scale has been slow of introduction, mainly owing to cost and difficulty of bringing large supplies of water on to alluvial- or cement-deposits at high levels; but of late years a move has been made in this direction by the Parapara Hydraulic Sluicing and Gold-mining Company, by the extending and bringing in of a race from the Parapara River, opposite the source of Lightband's Creek, to work the deeply-involved gold-bearing drifts of the upper part of Appo's Creek Valley, Appo's Flat, and a continuation of the first line of deep ground along Glengyle Creek to the Parapara, and thence by way of Glenmutchkin Claim across the intervening ridge to the Parapara Flat. The company commenced with good hopes of speedy success, but various difficulties interposed, and now that the works have been for some time in operation, it would appear that the results are not more satisfactory than was anticipated. Nevertheless it is beyond question that the gravels, &c., which the company have acquired the right to and propose to work, are auriferous, and may yet yield an abundant recompense for the cost and labour that has been expended to develop them. At the present moment, also, others have in hand the development, by means of hydraulic sluicing on a large scale, of different leases held or to be acquired by them, at Appo's Flat, Golden Gully, and on the Quartz Ranges; and dredging on the Aorere River, though for the time being suspended, will, without question, in the near future, be carried on wherever the bed of the river contains gold sufficient, and offers facilities for this particular form of gold-mining.

Mining for gold in quartz has also been carried on for a considerable number of years, and in some cases for a time with payable results. Yet, on the whole, up to the present quartz-mining has not been an unqualified success, and the Johnston's United is the only mine within the Aorere Valley that at the present time is working; while work on the Red Hill property has long since been suspended. At the present there is a mine being opened in the district immediately west of the Aorere Valley, in which, at Golden Ridge, as reported by Mr. Low, the managing director, a large and continuous body of stone has been found, which yields gold at a rate that should pay handsomely.

Without doubt there are many reefs within the Aorere watershed that contain gold, and should pay to work. Reefs and large bodies of quartz are very abundant between the Parapara and the Aorere, below the Slate River junction, and it is in this area that are situated the only quartz lodes discovered to be gold-bearing and partly worked.

Description of the District.

"Immediately on leaving the Town of Collingwood a large tract of alluvial ground is entered on, which stretches away some eight or nine miles in a south-westerly direction. This plain is bounded on the north-west by the Aorere River, on the north by the sea, and on the east by Te Parapara. Towards the south-west the drift deposit, of which it is composed, ends on the slopes of slate and schistose hills near Bedstead Gully, &c. The most striking feature about this flat land is the succession of terraces by which it rises as it recedes further inland, and also a few islands and rocks which here and there rise above the level of the surrounding drift." †

The general character of the southern side of the Aorere Valley, west of Parapara Inlet, is a gentle and regular slope from the base of the southern mountains to the low lands of the valley, or from about 1,500ft. to 2,000ft. above the sea to from 300ft. to near sea-level. Hochstetter says the slopes decline at an angle of 8°, but makes no mention of a marked succession

* Hochstetter's "New Zealand," pp. 99–107. † Davis, "Geological Reports," 1870–71, p. 131.

of terraces; but Mr. Davis probably meant to indicate the terraces of the lower valley between Collingwood and Appo's Flat and Creek, and which are also well marked on the north-western side of the valley between the lower course of the Kaituna and the Aorere River. The great features of the Aorere Valley are: (1) Its straightness from the Clark River and Brown River junctions to the sea; (2) the abrupt slopes of the mountains on the north-west side; and (3) the gentle and regular slopes of the southern side of the valley up to the 1,500ft. or 2,000ft. level. All this is as seen from the lower end of the valley in the neighbourhood of Collingwood; the lesser streams draining to the Aorere River from the southern mountains, however, cut through the sloping table-land; and on closer examination the valleys of these streams below the general level are found to be exceedingly broken and rugged, and this closer inspection completely dispels for the time being the first impression—the idea of uniformity and general smoothness.

North-east of Appo's and Lightband's Creeks the broad *pakihis* on the south-east side of the valley are, indeed, nearly level, and all too uniform in their apparent barrenness and seeming irreclaimability. The better lands of the lower valley lie along the river, and constitute the lower flats to the first terrace. On the northern side of the river, below the Kaituna Junction, the low lands on the banks of the river stretch to the foot of the mountains, and on that side of the valley there are no high-level terraces along the lower valley. Above the Kaituna Junction, on the same side, a succession of terraces are well marked, resting on the lower slopes of the Tertiary hills that, for a distance of two miles, fill this part of the valley. These Tertiary hills lie opposite the junction of the Slate River, above which terrace-flats again occur on the north-west side; and, again, there are hills formed of Tertiary or Cretaceo-tertiary rocks opposite the junctions of Big Boulder River and Salisbury Creek, and the bridge across the river on the road to the Quartz Ranges. Shingle flats and gravel terraces of moderate breadth and elevation above the channel of the river extend along the north-west side of the valley to the junction of Brown River.

Mr. James Park, between the months of March and May, 1889, explored the greater part of the Aorere Valley and surrounding district, and subsequently supplied a valuable report on the geology of the district. Of the mountains bounding the Aorere watershed, he says,—

"The Haupiri Mountains extend, as an unbroken chain of high peaks, from the northern extremity of the Douglas Mountains, at the source of the Boulder and Anatoki Rivers, east to the sources of the Waikoromumu. Their southern slopes are exceedingly steep, but towards the north they throw off at different points along their course high secondary ranges, generally running at right-angles to the trend of the main range itself. The most westerly of these subsidiary ranges is Lead Hill, which is almost a direct northerly continuation of the Haupiri Range, to which it is connected by the low grassy ridge dividing the head of Boulder River from Clark's. Lead Hill is about 5,400ft. high. It is composed of grey granite, and possesses all the characteristics of a mountain. Its slopes are steep and rocky, and above 4,000ft. almost quite destitute of vegetation of any kind. Similar in composition and outline is Mount Olympus, standing adjacent, and separated from Lead Hill by Clark's River. It attains a height of about 5,500ft., and belongs to the Douglas Mountains, to which it is connected by the low-wooded ridge running between Clark's and Granity River.

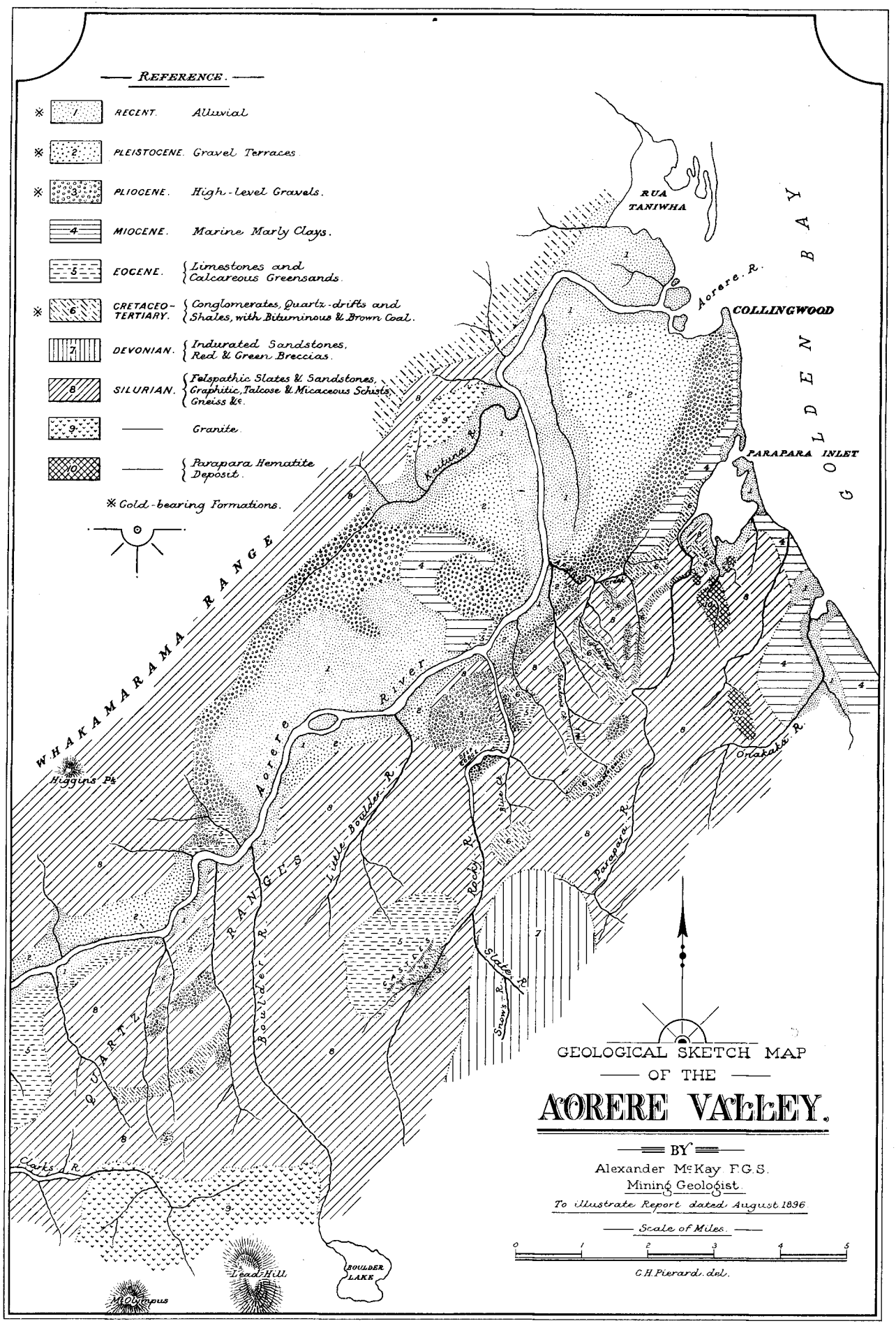
"Next to Lead Hill, we have Rocky River Peak dividing the Boulder from Snow's River; and farther east Slate River Range, dividing Snow's from the Slate. East of the Slate, and running parallel with the coast, we have Parapara Range, whose higher peaks are drained by the Parapara River, and the large streams which enter the sea [Golden Bay], between Waitapu and Parapara Inlet. The north-west side of the Aorere Valley is bounded by the Whakamarama Range, which extends from the Pakawhau Inlet to the Gouland Downs, whence it trends southward, and joins Mount Domett Range, situated between the sources of the Spey and Heaphy Rivers.

"Collingwood County is drained by two large river systems [of which] the Aorere drains all that portion enclosed by the Whakamarama Range on the one side, and the Douglas and Haupiri Ranges on the other. . . . On its northern side, the Aorere flows close under the foot of the Whakamaramas, and consequently receives no tributary of any size from that side, except the Kaituna, which has cut a deep gorge through the range, and thus drains a large basin lying on the West Wanganui side.

"At the upper end of the Quartz Ranges, at the point where the valley trends to the southward, the Aorere receives Brown's River, a short rapid stream rising close to the Gouland Downs, and whose valley is the straight continuation of the Aorere Valley. A few miles higher up, also on the same side, comes in the Spey River, which, with its numerous large branches, drains the wide basin enclosed by Brown Patch Range and Mount Domett. Its course is short, but the volume of its stream is, under ordinary conditions, not much less than that of the Aorere itself at the point of junction.

"The Aorere rises on the slopes of Mount Domett Range, one branch coming from the head of the south sources of the Spey, another from a saddle at the head of the Heaphy. From the south and east it receives a number of large tributaries. Commencing at the head of the valley, we have first Burgoo River and Granity, both considerable streams, rising on the slopes of the Douglas Range, the latter at the point where the ridge connecting Mount Olympus joins the main range. These rivers are simply mountain torrents, each discharging about half the quantity of water carried by the Parapara.

"Passing down the valley to the upper end of the Quartz Ranges, we next come to Clark's River, which joins the Aorere somewhat less than half a mile above the junction of Brown's. . . . It rises in a small rock-basin lying on the western flanks of the Douglas Mountains at a low grassy saddle opposite the sources of the Anatoki and Douglas Rivers. . . . The upper course of the Clark is through a wide wooded basin, but between Mount Olympus and Lead Hill it passes through a deep rock-girt gorge of great height, from which it emerges at the south-west corner of the Quartz Ranges, whence it bends westward along the foot of Mount Olympus, and


REFERENCE.
1 RECENT. Alluvial
2 PLEISTOCENE. Gravel Terraces
3 PLIOCENE. High-level Gravels.
4 MIOCENE. Marine Marly Clays.
5 EOCENE. Limestones and Calcareous Greensands.
6 CRETACEO-TERTIARY. Conglomerates, Quartz-drifts and Shales, with Bituminous & Brown Coal.
7 DEVONIAN. Indurated Sandstones, Red & Green Breccias.
8 SILURIAN. Felspathic Slates & Sandstones, Graphitic, Talcose & Micaceous Schists, Gneiss &c.
9 Granite.
0 Parapara Hematite Deposit.
※ Gold-bearing Formations.
RUA TANIWHA
GOLDEN BAY
Aorere R.
COLLINGWOOD
PARAPARA INLET
Kaituna R.
WHAKAMARAMA RANGE
Aorere River
Higgins Pk
Little Boulder R.
Boulder R.
Rocky R.
Slate R.
Snows R.
Parapara R.
Onekaka R.
QUARTZ RANGES
Clarks R.
Lead Hill
BOULDER LAKE
Mt Olympus
GEOLOGICAL SKETCH MAP
OF THE
AORERE VALLEY.
BY
Alexander McKay F.G.S.
Mining Geologist
To illustrate Report dated August 1896
Scale of Miles.
0 1 2 3 4 5
C.H. Pierard. del.

joins the Aorere about three miles below the junction of the Spey and about half a mile above Brown's. It carries somewhat less water than the Parapara in autumn and winter, but during the spring and summer it brings down a much larger body of water, mostly derived from the melting snows on the higher ranges which surround its sources.

"From the Quartz Ranges the Aorere receives Finn's, Maori, and Salisbury Streams, all of which rise on the slopes of Pine Ridge. The two former unite a short distance from the Aorere, and the latter runs in a narrow, deep ravine, or gorge from its source to its mouth.

"Passing down the valley we next reach the Boulder River, which rises in the wide, open, grassy basin enclosed by the Lead Hill, Haupiri, and Rocky River Ranges. At the lower end of this basin it enters Boulder Lake, from the lower end of which it emerges and then suddenly plunges over a rocky ledge into a ravine several hundred feet deep, through which it flows till it joins the Aorere. A few miles lower down the valley we reach the Little Boulder Stream, which drains the broken limestone area, known as "The Castles." A mile below this we reach the Slate River, by far the most important, if not actually the largest, tributary of the Aorere. It rises on the north slopes of the Haupiri Range, at the foot of the Slate River Peaks. . . . From the south-west it receives Snow's and Rocky Rivers; the former reaches back to the Haupiri Range and is separated from the Slate River itself by Slate River Range, at the north end of which stands Mount Hardy, which attains a height of almost 5,000ft. From the east the Slate receives Fletcher's and Wakefield Creeks, both small streams, occupying a prominent place in the past history of the Collingwood Goldfield.

"Below Slate River the Aorere receives Doctor's and Lightband's Creeks, both of which, with their numerous small branches, were some years ago the scene of extensive alluvial mining operations, as evidenced by the old abandoned workings which meet the eye on all sides.

"Below Rockville the Aorere receives a number of small streams from the Whakamaramas, of which the most important is the Kaituna, which has cut a deep gorge through the mountains, and possesses an extended and wide basin or watershed on what may be termed the west side of the main range."*

The lower portion of the Aorere Valley is occupied by wide gravel-terraces, forming a triangular space, extending from Parapara Inlet to Collingwood, and from there back to Rockville. From the latter place the terraces extend across the Aorere to the Kaituna, and thence along the course of the Bonny Doon Stream and the foot of the Whakamaramas to the junction of Brown's River.

"From the Quartz Ranges to Rockville, and thence seaward to the Parapara Inlet, the country presents the appearance of a great sloping table-land descending from the Haupiri Mountains to the Aorere River. The most striking feature of this sloping table-land is that the slope is not from the head of the valley to the sea, but from the ranges on the south towards the river which flows on the north side of the valley, close under the slopes of the Whakamarama Range. . . .

"Although the surface of the [Collingwood] district is very mountainous and broken, few of the conditions exist that usually accompany the presence of fresh-water lakes. Except Boulder Lake and Lake Otuhei, there are no other bodies of water deserving the name of lake.

"Boulder Lake is situated near the source of the river of that name. It is 3,250ft. above the sea, and is enclosed by Lead Hill and Rocky River Peak. It rests in what is, perhaps, one of the most perfect examples of a rock-basin in New Zealand. The scanty character of the vegetation, and the large surfaces of bare rock exposed on the flanks of Lead Hill, render the study of this interesting lake-basin a matter of comparative ease. The lake itself is about a mile long, and three-quarters of a mile wide at its widest part. At its lower end it rapidly contracts, being hemmed in by the descending spurs from the mountains on both sides. It is drained by Boulder River, which, at its outlet, flows through a narrow channel excavated in the solid rock."†

The other writers above-mentioned give us little or no account of the general aspect of the country, or a description of the physical features of the parts they had more particularly to deal with; nor, after what has been quoted from Mr. Park's reports, need any further lengthy account be given in this place.

General Geological Features.

The disposition of the rocks in every part of the Aorere Valley indicates that it was first formed along a line of earth-fracture, trending in the general direction of the present valley, and having its downthrow on the south-east side of the line of rupture.

The Upper Aorere Valley is distinct from the lower, and is purely a valley of erosion; hence, subsequent in date to that of the middle and lower parts of the watershed. The great earth-fracture that determined the direction of the middle and lower parts runs along the north-west side of the valley, and quite close under the foot of the remarkably abrupt mountain ranges on that side. Its direction is south-west from the shores of Golden Bay to the junction of Brown's River, and thence the same dislocation is indicated across Gouland Downs into the watershed of the Heaphy River. Along the mountains on the north-west side of the valley, Cretaceous, Cretaceo-tertiary, and Tertiary strata are found at high levels from the Kaituna River to Mount Burnett, and beyond the ridge of the north-east part of the Whakamarama Range they extend considerably to the south-west of the Kaituna Valley. One or other member of the series of younger rocks are also found at different places in the low grounds of the Aorere Valley, close to the steep vertical slope of the range crowned by the same beds, while on the south-east side of the valley the Tertiary and Cretaceo-tertiary beds are found as outliers on the sloping table-land up to heights 1,800ft. above the sea.

This state of things has not been brought about by the throwing of the younger strata into sharp synclinal and anticlinal foldings, and the subsequent denudation of the areas from which

* Park, "Geological Reports," 1888–89, pp. 50, 193–199. † Park, on the Collingwood District, "Geological Reports," 1888–89, pp. 50, 193–199.

they are absent. This, under the circumstances, would barely be possible, and there are no indications in the beds that remain favouring such an assumption. To the contrary, the beds on the mountains of the north-west side of the valley dip to the north-west or west, while opposite, in the low grounds of the valley, the dip is in the same direction. If, therefore, we might be justified in assuming the existence of the line of fault above indicated, and regarding it as being the chief primary cause of the features that have appeared subsequently, owing to the succeeding erosion of the area, there are yet further and conclusive evidences that disturbances and displacements of the kind indicated did take place, as may be gathered by an examination of the line of involved deposits extending from near the entrance to Parapara Inlet across Washbourne's and the intervening hills to the Parapara River; thence along Glengyle Gully and along the upper part of Appo's Creek to the saddle leading again into the Parapara Valley, the line of dislocation continues along the left bank of the Parapara River to the upper part of Macgregor's Creek, which it follows to Golden Gully and the sources of Wakefield Creek, draining into the Slate River. Further along the line in a south-west direction the evidences of dislocation and displacement of the strata is not so clear, till reaching the south-west end of the Quartz Ranges, where, between Maori Creek and the furthest to which the heavy drifts of the Quartz Ranges can be traced, the auriferous gravels are involved to an unknown depth, and along their south-east boundary cemented and indurated into a hard rock. This line, giving at the surface distinct evidences of its existence, runs sub-parallel with that along the low grounds of the north-west side of the Aorere Valley, in which the evidences of actual fracture are not so clear, but are sufficiently convincing. The line from Parapara to the Quartz Ranges limits to the south-east the younger rocks within the Aorere Valley; also, it limits to the south-east the sloping table-land which has already been described. Along the south-east side of the watershed the mountains rise as rugged heights, which, from their irregularity, indicate varying degrees of resistance to atmospheric or sub-ærial denudation.

Gravels of different ages, underlain by Tertiary clays, form the rocks of the lower part of the Aorere Valley. From beneath the Tertiary clays, shelly limestone appears on the north-west shore of Parapara Inlet, and in the beds and on the banks of the Aorere, from the junction of Appo's and Stanton's Creeks to the source of Brown's River. Limestones of the same series also dot the surface of the sloping plain at all heights, from the Limestone Knobs on Appo's Creek to "The Castles" on the Rocky River and the limestone rock at the foot of the Pine Ridge, at the south-west end of the Quartz Ranges. The coal-formation is only developed at high levels on the north-west side of the valley, and on that side is followed by conglomerates and quartz-grits underlying limestone of Tertiary age. This, without the coal-measures, is the succession of younger rocks seen on the south-east side of the valley, while in addition, as respects the south-east side of the valley, it has been proved that the conglomerates and quartz-grits are auriferous, and at places rich in gold. The other rocks of the part of the Aorere Valley with which this report is concerned consist of Silurian strata, more or less altered, or completely metamorphosed, and the granite masses of Lead Hill and Mount Olympus. Between the Lower Parapara and the shore of Golden Bay there are limestone and steatite and gneissic rocks, all of which must be regarded as forming part of the Silurian series.

The Parapara hæmatite or iron deposits, though occurring in great mass and forming hills of considerable height, can hardly be regarded as a distinct formation, but must be classed among the Recent rocks of the district.

TABLE OF FORMATIONS.

I. Recent.
   Low-level alluvial deposits: Aorere Valley, Parapara Inlet, and coast-line.
II. Pleistocene.
   Gravel terraces not being added to, and but little denuded. Largely developed in Lower Aorere Valley.
III. Pliocene.
   (*a.*) Old high-level gravels: Coast-hills, Collingwood to Parapara, south-east side of Aorere Valley, between Appo's Flat and Quartz Ranges.
   (*b.*) Older Pliocene gravels: Hills between Lower Kaituna Valley and Rockville.
IV. Miocene.
   Marine marly clays: Aorere Valley and shores of Golden Bay, south-east of Collingwood.
V. Eocene.
   Limestones, shelly or compact, calcareous greensands: Middle part of Aorere Valley.
VI. Cretaceo-tertiary.
   (*a.*) Conglomerates and quartz-drifts, brown coal: Both sides of Aorere Valley.
   (*b.*) Conglomerates and shales, with bituminous coal: North-west side of Aorere Valley.
VII. Devonian.
   Indurated sandstones, red and green breccias: Source of the Slate River.
VIII. Silurian.
   Felspathic slates and sandstones; graphitic, talcose, chloritic, and micaceous schists, gneiss, &c.: Aorere watershed, south-west of Appo's Flat, Parapara River.
IX. Granite.
   Both sides of Aorere Valley.
X. Parapara hæmatite deposit.

I.—Recent.

In the Lower Aorere Valley the Recent alluvial deposits constitute farming lands on both sides of the river. The bed of the river is known to be auriferous, and for a time a dredge was at work on it; but this was of insufficient power; and, besides, objections to its working were raised by the settlers on the banks of the river, and compensation not being granted by the Government, this also may be a cause why dredging has been discontinued.

Above the junction of Appo's and Stanton's Creeks the banks of the river have in places been worked for gold, and in the recent gravels of the beds and banks of the Slate River, and most of its tributaries, gold-workings have been carried on since the early days of the Collingwood Goldfield.

There is in the vicinity of Rockville a considerable breadth and area of gravel-terraces which, though now considerably higher than the bed of the river, are by Park—and I believe rightly—referred to the Recent period. Above the Suspension Bridge, on the road to the Quartz Ranges, there are recent deposits on both banks of the river; but of these the more important lie on the left bank, while behind these rise higher terraces of gravels that are properly referred to the next older series.

In the Parapara watershed the low flats at the head of the Inlet belong to this series.

The Parapara Hydraulic Sluicing and Mining Company during the past year erected an elevating plant to work an area of these deposits held by them. The drifts thus intended to be worked have resulted mainly from the destruction of the gravel and cement hills that lie to the westward between Washbourne's Flat and the Lower Parapara River. This flat forms a portion of the area reported on by Sir James Hector in 1890, and the elevating-plant has been erected at the further or northern end of No. 3 lead, of which Sir James says: "The gravel of No. 3 lead seems, therefore, to have been dispersed in a thin layer over an area of about forty acres, and a rough estimate of the contents gave 2,000,000 loads, which, at 2dwt. per ton, would give a value of £800,000."

When I visited the locality during the present year the elevating-plant had just been erected, and was scarcely more than in working order. A shaft had been sunk from which it was said a good prospect had been obtained—a prospect greater than would be required to warrant Sir James Hector's estimate of the auriferous contents of this area. However, on account of the shaft caving in, this prospect, taken by one of the workmen, could not be confirmed personally by the manager. The elevating-plant, after being completed, was at work for some time, but the result has not yet been made public. The general opinion is that the ground did not turn out as rich as anticipated.

Appo's Flat has a deposit of recent gravels swept down from the upper part of the watershed and deposited partly on the felspathic sandstones and slates, towards the upper end of the flat, and partly on beds of auriferous quartz-drift underlying on the middle and lower parts of the flat. These recent gravels along the creek, and at the upper end of the flat, yielded in the early days a considerable amount of gold, and Mr. F. West, who, for a considerable number of years has been the only miner on the flat, followed the gold-bearing superficial wash by driving to the dip as far as the water would admit or the ground could, with the means of draining it, be profitably worked. Mr. West informs me that, from first to last, a value of about £5,000 has been taken from Appo's Flat. This is irrespective of the gold obtained from the gorge of the creek above Appo's Flat, and from the upper valley of the creek as far as the Red Hill battery site, which was a considerable amount. The gold in Appo's Creek, and the superficial auriferous deposits over Appo's Flat, has clearly not been derived from the felspathic sandstones and slates, and quartzites of the neighbourhood, but from the quartz-drifts and coarser conglomerates occurring as deeply-involved strata along the upper valley of Appo's Creek, and also present on the hills surrounding Appo's Flat, as well as underlying the recent drifts of the flat itself.

A portion of the gold won from Lightband's Gully was obtained from the recent gravels of the bed of the creek; but this was directly and immediately derived from the older quartz-gravels that corresponds to those of the lower Parapara, and Golden Gully at the other, or south-west, extremity of the line of involved strata. Several localities to the north-east of the Slate River, notably Golden Gully, Macgregor's Creek, and Lightband's Gully, have derived their auriferous gravels from the underlying or neighbouring older quartz-drifts by a process of denudation and concentration that thus produced, as a special example, the rich superficial drifts of the northern part of the Golden Gully area. As the older deposits, from which the more recent have been derived, will have to be described under another heading, further reference to the more modern derived deposits is unnecessary. In the Slate River, and its many tributaries, gold has been traced to beyond the line of Golden Gully, the Castles, and the Quartz Ranges; and, what is remarkable, as the streams are followed to the south-east of the line of involved strata, the gold is of a finer grain than north-west of or below the line.

II.—Pleistocene.

These rocks have their principal development in the lower Aorere Valley, where they form broad, swampy terrace flats, or *pakihis*, that constitute very uninviting country from an agricultural, or even a pastoral, point of view. These beds are, however, to some extent gold-bearing, and one or two gullies immediately south-west of Collingwood have been prospected, and decided indications of a paying prospect obtained. Lashe's claim, near the junction of Appo's and Stanton's Creeks, may show the presence of recent gravels, but, preferably, I have considered them as Pleistocene. The same indefiniteness also applies to the classification of the gravel terraces between Doctor's Creek, the Slate and Aorere Rivers, but it is really a matter of little consequence whether particular gravel deposits, of which there may be doubt, are referred to recent or Pleistocene.

I have shown an area of Pleistocene gravels between the Lower Kaituna and the Aorere, because they are evidently and manifestly distinct from the gravels of the lower flats and alluvial deposits along the river. Mr. Park has mapped the same beds as Recent (see map and report of 1889, "Geological Reports"), while under Pleistocene he has included a variety of deposits that are of

older date. Some of the higher terrace-flats on the north-west side of the Aorere, opposite the Quartz Ranges, should rightly be referred to this series, and by Mr. Park they are regarded as Pleistocene, but with the same he includes the old high-level gravels capping the coastward hills between Collingwood and Parapara. These latter are distinct, and have to be regarded as of Pliocene age. Neither does he make any distinction between the low-lying gravels along the banks of the river and those on the Quartz Ranges at 1,700ft. above sea-level, and which there are faulted and involved amongst the older rocks. Mr. Park also maps the auriferous quartz-gravels of Golden Gully, Lightband's Gully, Appo's Flat, &c., as being Pleistocene, and in age not different from the beds that interpose between them and the quartz-gravels—viz., the marly clays, and shelly or compact limestones of Miocene and Cretaceo-tertiary age. There are, on the middle part of the slope leading up to the Quartz Ranges, gravels that would correspond with those on the opposite side of the valley, as also would the terraces on the eastern side of Druggan's Flat, below the junction of the Slate River. There are also high-level terraces along the valley of the Slate River that may properly be referred to as Pleistocene.

III.—Pliocene.

The Pliocene strata of the district, according to the views here expressed, constitutes a double series of gravels, of which the younger consists of very coarse gravel-conglomerates that, from the Township of Collingwood, stretch along the coast-line and cap the coastward hills to Parapara Inlet, and thence, bending more to the west, they terminate as a continuous deposit on the north-east side of Appo's Creek, below Appo's Flat. The same beds, or conglomerate gravel-deposits that may be referred to the same age, are found between Appo's Creek and the Slate River, and further to the south-west beyond the Slate River. On Red Hill Ridge these gravels are found along the line of track to Golden Gully. Along this line they occur as outlying patches up to 1,200ft. above the sea. I have not visited The Castles on the Rocky River. Auriferous gravels are there present at the eastern foot of the limestone cliffs, and these have by Mr. Park been referred to the Pleistocene. This can barely be the case, and, unless they belong to a horizon under the limestone, they must be regarded as Pliocene deposits. I gathered the information from miners in the district that at The Castles auriferous-quartz gravels are found passing under the limestone, and there has thus been shown on the accompanying map gravels both of Pliocene and Cretaceo-tertiary date. This showing of gravels of two ages seemed to be justified on account of the occurrence of quartz-gravels on the Quartz Ranges, which, underlying limestones there, are also in near contiguity to terraces that carry gravels of the younger date. Similar gravels lie at a lower level on the slope from the Quartz Ranges to the Aorere River.

On the north-west side of the valley, what is probably an older series of gravels are developed on top of the hills opposite the junction of the Slate River. And, as shown by Mr. Park, other gravels of older date stretch from the Kaituna River along the north-west side of the Aorere Valley to the suspension bridge over the Aorere River above Rockville. These gravels are sometimes very coarse, and between Appo's Fat and the Pakihi Plain large boulders indicating glacier action are frequent, or, rather, abundantly met with. These gravels are believed to be auriferous, but there are no gold-workings at the present time in them.

IV.—Miocene.

These beds, as dark-coloured marly clays with septaria or cement concretions, are found mainly along the coast-line from south of Parapara Inlet to Collingwood. They contain fossils, but these have not yet been collected so as to determine what is the actual age of the beds. These same beds occur, forming hills, on the road from the Lower Kaituna to Rockville; but, according to Mr. Park, they are not known in the Upper Aorere Valley. The same beds should be represented on the north side of the valley. They overlie the limestone, and, as I am inclined to consider that as of Upper Eocene age, the clays overlying should be regarded as not older than Lower Eocene.

V.—Eocene.

This series of strata consists of shelly or indurated limestone, or calcareous greensands. The beds at places are full of fossils, and, from collections made at different times during past years, it would appear that these beds should be referred to the Mount Brown series of the Geological Survey classification, and consequently to the Upper Eocene period. Mr. Park, however, regards the limestones and underlying calcareous greensands as belonging to the Cretaceo-tertiary series, and, as belonging to this, distinguishes two limestones of similar character—one in connection with the Grey Marl series, and another belonging to the Ototara series; but in the Aorere Valley it does not appear that this distinction can be maintained.

Of the limestones and associated marly greensands, Park says: "In the Collingwood district they are chiefly confined to the north side of the Aorere, where they extend from the Kaituna, with occasional breaks, to a point half a mile above the junction of Clark's River. Their fossil contents tend to show that they are probably more nearly related to the Mount Brown series than to the Grey Marl series; but as it is difficult, even in the typical localities of the Waipara and Weka Pass, to define the boundaries between these two series, I have for stratigraphical reasons placed them in the lower."* The evidence from fossils show that the beds belong to the Mount Brown series. Surely, then, the beds should have been referred to that series rather than to an underlying series to which the Mount Brown beds are supposed to be unconformable. It is true that in the Waipara and Weka Pass sections the evidences of stratigraphical unconformity between the Grey marls and the Mount Brown limestones may have been to Mr. Park somewhat obscure, and in the Weka Pass no doubt it is. In the Waipara section it is different. It should also be here stated that the Mount

* "Geological Reports," 1888–89, p. 241.

Brown series was determined by Professor Hutton on purely palæontological grounds, while the stratigraphical evidence of the distinctness of the Mount Brown beds from the Ototara series was obtained at Oamaru, not at the Waipara, as implied by Mr. Park.

The limestones belonging to this series are on the south-east side of the Aorere Valley, first met with on the shores of Parapara Inlet, and there dipping beneath the marly clay of Miocene age they reach the water-level at the point where the road crosses the mud-flat. Here they are seen to be underlain by quartz-grits. Towards the south-west they gradually rise to higher levels, and a greater thickness of quartz-drift is seen interposed between the limestones and the felspathic slates and sandstones of Silurian age. Finally they pass out of the watershed of the Parapara River into that of Appo's Creek, and extend west into lower ground to within a short distance of the road from Collingwood to Appo's Flat. The limestones next appear between the lower part of Appo's Creek and the river, where the calcareous rock is seen resting on the felspathic slates. The limestones are again seen in the bed of the Aorere River near the mouth of Doctor's Creek, and show in the lower slopes of the hills on the north-west bank of the Aorere. They also form isolated hills standing above the level of the sloping tableland on both sides of the road leading from the low grounds to Bedstead Gully and Golden Gully, in which are caves of such interest as to warrant the reserving of the limestone area from sale. At a lower level, along the left bank of the lower course of the Slate River, Mr. Park shows the presence of a narrow strip of limestone or calcareous rocks of this age. This I have not examined, and, seeing that I consider the valley of the Slate River due to erosion only, it is somewhat difficult to understand how limestones of this age could occupy the position indicated. A considerable area of these rocks occur on the Rocky River Plateau, and the same rocks are found on a small outlier at the south-west end of the Pine Ridge, and beds of this age are found along the middle part of the Aorere Valley, as described by Mr. Park.

VI.—Cretaceo-tertiary.

(a.) Conglomerates and Quartz-drifts underlying Limestone on the Southern Side of the Aorere Valley, Parapara, &c.—These beds, as far as concerns this report, are, on account of their auriferous character, of considerable importance. They are first met with in the north-eastern part of the district, on the north-western shore of Parapara Inlet, and their line of outcrop can be followed thence along the shore of the inlet and the hill-slopes on the left bank of the Parapara River to the saddle leading west into a small tributary of Appo's Creek, which joins the main stream at the lower end of Appo's Flat. Appo's Flat proper, extending along the banks of the main creek, is nearly comprised within the freehold, lately that of F. West but now the property of the Parapara Hydraulic Sluicing and Mining Company. But an equal or greater extent of low ground extends towards the north and north-east along the course of the small tributary creek already mentioned. Appo's Creek leaves the lower end of the flat by passing through a narrow rocky gorge, and thus a low-lying basin is formed 40 to 50 acres in extent, surrounded on all sides by hills, rising from 200ft. to 500ft. above the level of the lower grounds. To the west and north the hills are formed of coarse Pliocene gravel-conglomerates; to the north-east of marly clays of Miocene age; and towards the south-east, south, and south-west of Silurian strata, mainly composed of felspathic sandstones and slates, with bands of quartzite and quartz. The eastern hills slope at a most abrupt angle to the west and north, and along their lower slopes outliers and outcrops of quartz-gravels are found. The outliers of quartz-drift rest on an irregular surface of the older rock, which usually appears in the small gullies between these patches of quartz-gravel. Mostly the drifts are shallow deposits, and sometimes have the appearance of having been liberated from contiguous outcrops of quartz, and are partly rounded by mere exposure to atmospheric influences. At other places it is perfectly evident that we have to do with remnants of a uniformly well-rounded quartz-drift, in which the boulders are sometimes 6in. to 10in. in diameter. To the north-east these outlying patches of quartz-drift reach higher and higher, till near the saddle they attain an elevation of fully 400ft. above the sea, or higher than the saddle and the limestones on its northern side. At the foot of the western slopes of these hills the older slates and sandstones appear, but their junction-line with the younger strata dips suddenly, and they are overlain by quartz-drifts at places, but more commonly these are not seen at the surface owing to a covering of slope-deposit and creek-wash of mixed material.

On the north-east, from the saddle to the low gravels of the flat, quartz-drifts are seen to underlie the limestone at places, but generally the coarse gravels of Pliocene date, which cap the hills of marly clay, and bound the flat to the north and west, by rolling down the slope have covered over the outcrop of the quartz-drifts. On the west side from the gorge, at the lower end of the flat, slate rocks appear along the foot of the hills to near where the road to Collingwood leaves the flat. On the south-west the flat is bounded by a narrow ridge of old rock, the slope of which towards the flat is very abrupt.

Appo's Creek leaves its upper gorge a few chains above Mr. West's house on the south-west side of the flat, and it was here for a few chains along the creek and across the whole breadth of the flat the principal gold-workings were situated. Upwards, towards the south, the ground was shallow and the bed-rock slate. The workings, however, showed that the shallow ground on the slate bottom suddenly ceased, and downwards, towards the middle of the flat, the superficial wash rested on quartz-drift, itself gold-bearing. The junction between the older rock and the quartz-drift was followed to some depth, and far enough to show that the old rock dipped away at an angle of about 45°. This high dip of the junction-line was further shown by the sinking of two holes 3 chains further down the flat. One of these was sunk to a depth of 140ft., and this, after passing through about 30ft. of surface-wash, for the remainder of the distance passed through quartz-drifts. It cannot now be ascertained with certainty whether this shaft reached through the quartz-drifts to the underlying rock. By some it is so reported, and a mass of broken limestone is said to have been encountered; but this may be doubted, as there is no limestone associated with the felspathic slates and sandstones on the hills to the eastward or south-west of Appo's Flat.

The rock met with and thus described was probably a quartz-cement similar to what appears at the surface on the hill-slopes where the road-line going up the gorge leaves the flat. This cement-stone consists of fine quartz-sand cemented into a hard rock. In it are many pebbles, and sometimes boulders of considerable size; but the whole is now so closely cemented and so similar in appearance that the different parts are not distinguishable at a glance. This was probably the rock met with in the bottom of the shaft, and which was mistaken for limestone; and this would go to show that the quartz-drifts were not actually bottomed, nor the Silurian rock reached.

From their outcrop at the level of the flat the quartz-drifts stretch up the steep slope on the left bank of the creek from 100ft. to 150ft., and, unless the angle of the junction-line lessens considerably, the depth to the bottom of the drifts, towards the middle and lower end of the flat, must be very great. That it lessens is indicated by the appearance of the older rock towards the north-east end of the flat.

There cannot be a doubt that there is a considerable body of superficial auriferous wash over the south-west part of the flat, known as West's Freehold. The greater part of this has not been prospected further than that it has been ascertained that it would pay for sluicing, provided sufficient fall and get-away for the tailings could be provided. Fall, however, cannot be got to the westward along the course of the creek, and a tunnel 30 chains in length will have to be driven to carry the tailings into the Parapara watershed, at the foot of Glengyle Creek. This tunnel would have to be driven through hard felspathic sandstones and slates, and it is a question whether the probable amount of gold in the ground held by the company would warrant such an undertaking.

If, however, the quartz-drifts underlying the surface rubbly-wash prove moderately rich in gold—and where worked at the surface and shallow levels it is reported to have paid well—even if it were necessary to elevate the wash from the deeper ground, the driving of the tunnel to carry the tailings to the Parapara would thus become a reasonable undertaking, enabling the working of the area of Appo's Flat held by the Parapara Hydraulic Sluicing and Mining Company.

Part also of the north-eastern area held by West, Adams, and Fell might be worked by such a tunnel; but it is doubtful if the deeper ground in that direction could thus be worked. If to work the north-eastern part a second tunnel has to be driven, this would require to be nearly double the length of that which would serve for the south-western part of the flat.

In order to bring water at high pressure and in sufficient quantity on to the ground, a race from the Slate River is projected. This passing Golden Gully, where it is intended to utilise part of the water, would thence follow the slopes of the hills on to the ridge, leading up to the hill that overlooks Appo's Flat, from which a short but deep siphon would carry it on to the hills on the east side of Appo's Flat and the ground held by West, Adams, and Fell. As yet, however, the value of the north-east part of the flat as a gold-bearing area has not been proved, and this should be done before the projected works are carried out. So far as could be seen at the time of my visit, little or no prospecting had at any time been done, and no one could say whether the area held by West, Adams, and Fell is gold-bearing or not. Probably it is, and to a degree that might pay for working were the ground more favourably situated as regards a comparatively cheap water-supply and dump for tailings. In the meantime the ground should be prospected.

The line of quartz-drifts passes through the ridge bounding Appo's Flat on the south-west side, at a point abreast of the middle of the flat. The gravels have been prospected here, but apparently without payable results, since ground remains unworked which could easily have been driven out or sluiced away. The slate-rock is here considerably above the level of the creek to the westward of the ridge. On the opposite side of this small creek, which flows down from Red Hill, there are shallow workings, the wash over which is quartz-drifts that evidently are a continuation of those passing through the ridge into Appo's Flat.

Further up the ridge leading to Red Hill there is another small outlier of quartz-drift, from which 30oz. of gold was obtained from a small area of very shallow ground. And, again, on the steep slope leading down to the lower end of the gorge of the creek above Appo's Flat there is a more considerable patch of quartz-drift, which paid very well for working, and from which, according to Mr. West, nearly four thousand pounds' worth of gold was taken. These facts all tend to show that probably the quartz-drifts under the creek-wash spread over Appo's Flat will be found to contain sufficient gold to enable their being worked.

Gravels or quartz-drifts of this age are next met with in Lightband's Gully, from the saddle at its source, opposite the sharp bend in the course of the Parapara River, to within 20 chains of where it turns to flow to the north. On the saddle the beds consist of fine quartz-sand, which was used in the construction of the dam built by the Parapara Hydraulic Sluicing and Mining Company at the head lift of their race in the Parapara River. These sands, though at a considerable height, and in the vicinity of highly-inclined and disturbed strata of the same age, are yet in a nearly horizontal position, evidently as originally laid down. The various gold-workings that have been carried on, principally along the right bank of the creek, show that the beds dip gently to the north-west, conformably to the slope of the range in that direction. These quartz-drifts are thus as originally deposited *in situ*, and in no sense can they be considered as "a spue from the main slide," which lies along the slope to the Parapara at a considerably lower level.

Lightband's Gully was the locality of the first discovery of gold in the Collingwood district, and very considerable workings have been carried on within its watershed. A considerable area of quartz-drifts yet remains, especially along the upper part of the creek, but at the present time no one is mining for gold in this part. The claims that are being worked lie towards the north-west limit of the area over which the quartz-drifts extend. It may be taken for granted that the abandoned claims along the upper part of the creek did no longer, with the limited supply of water, pay to work. With a larger supply of water they again might, and probably will, be worked. The area of solid gravels or quartz-drifts is somewhat considerable in comparison with what has already been worked, and extends west across the spurs, in the direction of Druggan's Dam.

Lower down the slope two claims are being worked—Druggan's and Cottir's. These are in heavy bodies of rusty-coloured quartz-drifts; and it may be presumed that it is due to the scarcity of water that not more claims are being worked in the similar deposits, as more or less extensive patches are scattered over this part of the sloping tableland between the Parapara and the Aorere Rivers. This line of isolated patches of quartz-drifts trends westward somewhat, down the sloping table-land in the direction of the Limestone Knobs and the lower part of the Slate River; beyond which, so far as is known to me, they have not been traced.

Returning to the Parapara Inlet, on the southern side of this there is a considerable development of the quartz-drifts and gravels under consideration. In this part of the district these, for the most part, have been taken up by the Parapara Hydraulic Sluicing and Mining Company, with a view to their being worked for gold. For a series of years prior to the formation of the above company prospecting was carried on in these gravels; and from the early days claims in these gravels were worked and again abandoned. In some of these a considerable amount of work was done, both on the face to Washbourne's Flat and on the opposite side of the ridge in Glenmutckin Claim; and up till the purchase by the company work in connection with these drifts may be said to have been continuous in Glengyle Gully.

At various times the Director of the New Zealand Geological Survey, or his officers, made examinations of these deposits; and in the Progress Report for the year 1890–91 Sir James Hector brings together all the information relating to these deposits that was at the time available. He describes the quartz-drifts of the south-eastern side of Parapara Inlet as lying in and extending along a line of fracture, traceable from the mouth or entrance to Parapara Inlet to Golden Gully, or beyond that to the Castles on the Rocky River. The north-eastern part of this line was more particularly examined by him; and he so far satisfied himself as to the auriferous and payable character of the deposit that the Parapara Hydraulic Sluicing and Mining Company commenced operations with apparently good prospects of immediate returns from the works which they projected and then had (in 1892) in course of construction.

Unfortunately, up to the present time the results obtained by the company have scarcely been what was anticipated by some. And there are those who maintain that the basis of facts upon which Sir James Hector calculated the amount of gold which each particular area was theoretically supposed to contain may have been erroneous—*i.e.*, the prospects obtained, or that unwittingly were thought to represent the conditions, were unduly favourable, and therefore did not constitute an indication of the average richness of the ground. Nevertheless, there is no occasion for sweeping condemnation in this matter, since it behoves any company to satisfy themselves as to the correctness of the estimates made before undertaking heavy and costly works.

That, in the determination of the main slide, and the description he gives of it, and the different leads connected therewith, Sir James indicates a great source of wealth in the Collingwood district, those best competent to judge will admit, and that at places the quartz-drifts were fully as rich in gold as his most extravagant estimate requires will also be admitted. The whole error lay in assuming a constant and continuous yield of the estimated amount per ton throughout a great body of drift.

In the Lower Parapara Basin, the line of deep ground containing auriferous gravels commences on the shore of Golden Bay, a little to the east of the entrance to Parapara Inlet, and extends south-west across the mud flats to the western side of the flat lands at the head of the inlet. The Parapara Hydraulic Sluicing Company prospected the Mud Flat, and proved the existence of a line of quartz-drifts underlying the recent deposits of the inlet, and the occurrence of gold on the outer beach in the line of its extension north-east indicates the continuity of the lead so far in that direction. On the main land the line continues to the south-west, and at the head of the flat shows in the low spurs before reaching the dividing ridge separating Washbourne's Creek from the Parapara. In the north-east face of the higher ridge the gravels are clearly exposed as nearly vertical strata, showing strata of various material more or less mingled with quartz-pebbles and grit. Usually the gravelly beds are yellowish brown. These strata, extending through the ridge to the Glenmutchkin Claim and the Parapara, have on the north-west side limestones of Silurian age; on the south-east side, talc schists. The width of the gravels, &c., is variable, but may be taken at from 3 to 6 chains; and the depth to which the gravels reach is variable from considerably below sea-level towards the north to slightly above sea-level at points beyond the Parapara.

Over the flat to the south-east of the line of gravels, *in situ* Secondary deposits, largely derived from the gravels in the hills, are spread over a considerable acreage. This area has been distinguished as Lead No. 3; the gravels in Leads Nos. 1 and 2 are *in situ* as first deposited, preserving their original stratification, and consist largely of pure quartz-gravels mixed with bands of dark pyritous clay.*

Crossing the Parapara, the lead of deeply-involved gravels is next found running along Glengyle Creek to the saddle by which it leaves that and enters the valley of the upper part of Appo's Creek. In Glengyle Creek the gravel strata have been extensively worked, and might have yielded large profits had it not been that the walls of the slide or fissure in which the auriferous gravels are lodged are so broken and disturbed by the movements that have taken place that on the removal of the auriferous gravels slips of great volume are liable to, and have in the past, buried the workings, and great cost has been incurred in clearing away the *débris* thus brought into the workings. These difficulties more than a want of a payable prospect in the actual wash-drift of the ground, debars this ground from being worked. The shallow ground gave wages for working, and the difficulties began when the foot was removed from the hill-slopes, thus provoking the slips that have been referred to.

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* For a more extended description of these and the other ramifications of the Main slide, the reader is referred to the special report by Sir James Hector. See Progress Report for the year 1890–91, pp. x.–xxii.

On the saddle leading from Glengyle Gully to Appo's Creek very good gold-bearing wash was found, but, by a collapse of a shaft and drive, the owner of the claim lost his life, and no one has since ventured to again open out or work the ground. Usually, rich ground is not so abandoned, despite one or two accidents, more especially such as might be guarded against, and it seems that we have to look for some other explanation why little has been done at this place for a considerable series of years. The ground is now the property of the Parapara Hydraulic Sluicing Company.

The run of deep alluvial ground continues at a great depth between steep hills, along the upper course of Appo's Creek to the Red Hill battery-site, above which for some distance there appears to be a blank in the continuity of the gravels, though the line of fracture along which these lie is continued, as is shown by the occurrence of the gravels at the saddle, at the source of the creek, where was situated the Richmond Hill Claim, now also the property of the Parapara Sluicing and Mining Company. Here, as at every point along the line so far, the gravels are standing at high angles, nearly vertical, and associated with banks of clay and shaly bands; these have yielded some evidence of the age of the beds, or of some of the beds, involved along the line of fracture.

We have next the continuation of the line on the slope to the Parapara, opposite the saddle, at the source of Lightband's Creek. The quartz-gravels along the upper part of Lightband's Creek are thought by Sir James Hector to be "a spue from the main slide," but it has already been shown that the gravels and sands at the head of Lightband's are in the position in which they were first deposited, and cannot be considered as derived from the gravels of the main slide by any process whatever.

Between opposite the head of Lightband's and the point where the line of fracture touches upon Macgregor's Creek and Golden Gully there is no definite information as to the character or amount of the auriferous drifts involved along the line of fracture.

In the Golden Gully area the gravels are mostly quartz-drifts, but at the west side of the northern part, within the watershed of Golden Gully, there are slaty breccias that correspond with the breccia-conglomerates at the base of the auriferous quartz-drifts of Otago. These breccias are also present further west along Sailors' Gully. The great bulk of the gravels, however, are quartz-gravels, though in the rewash that, before the gold-workings commenced, covered the northern part of the area there are a great number of large sandstone and quartzite boulders, which are not represented in the quartz-drifts. These larger boulders may have been derived from an extension over this area of the Pliocene high-level conglomerates that have already been described, and which are yet present on the hills contiguously to the north of Golden Gully.

The Golden Gully area of auriferous drifts, whether as shallow ground or involved deeply along an extension of the fracture already traced from Parapara Inlet to opposite the head of Lightband's Gully, extends in length north and south a distance of about 25 chains, and in an opposite east and west direction from 6 to 12 chains, and forms a kind of plateau saddle at the sources of Golden Gully, Macgregor's Creek, Wakefield Creek, and Sailors' Gully. The average height of this plateau-like area is about 1,100ft. above the sea, and to the south-east and south it is backed by the abrupt slopes of the ridge of hills dividing it from the Upper Parapara and Slate Rivers. This higher land to the east and south affords the means of a sufficient pressure of water for hydraulic mining without the necessity of an undue length of pipe-line.

Within the area of the Golden Gully diggings the leases held or proposed to be acquired by West, Adams, Fell, and Co., include the whole of the auriferous quartz-drift area, which is estimated to extend over 200 acres. This is probably an overestimate. In the north-eastern part, along the course of Macgregor's Creek, the drifts are deeply involved along a line of disturbance in the older underlying rocks. This lies along the north-western margin of a development of limestone of Silurian age, and may be due in part to the chemical decay of the limestone; but more probably the apparent fissure is due to rupture along a line of strain and weakness in the earth's crust.

Be this as it may, quartz-drifts associated with beds of sand and dark pyritous shales or muds lie along this line, and are involved to various depths. Towards the south-west the deposit can be bottomed on pyritous felspathic slate, or on limestone; but the ground deepens to the north-east from the source and along the course of Macgregor's Creek. Along this south-east side of the area the auriferous wash and other material involved occur in an extremely broken and disturbed state, masses of quartz-drift, shales, and pyritous muds occurring, making, and pinching out, or suddenly disappearing within very short distances.

In Wilson's Claim, at the south-west end of the line, these masses of different material present the appearance of a gigantic breccia. The quartz-drifts thus intermingled with other material form a considerable proportion of the whole, and appears to be generally auriferous. Fair prospects were taken at the time of my visit from the solid of the working-face in Wilson's Claim, and a sample of gold was shown from the boxes, which seemed to speak well for the prospects of the ground. This deep ground is variable in width, and to the south a narrow band of it runs to the east of the limestone in that direction.

Within the watershed of Golden Gully proper the extent of deep ground is very limited, and almost the whole of the ground has been worked, so that there is little inducement here to bring water at considerable cost on to the ground. More to the south-west on this western side of the area there is deep ground, but partly worked out, which, extending through McKenzie's Dam, reaches to the south-west end of the auriferous area.

From McKenzie's Dam south to Wilson's Dam, for a distance of from 7 to 8 chains, there is a deep run of quartz-drift, which is known to be auriferous, but which, owing to its being bad driving ground, has not been worked. Mr. West informed me that this ground was rich, but that the difficulties met with prevented it being worked. This run of deep ground from the head of Golden Gully unites in its south extension with the deep ground along the south-east boundary of the quartz-

drift areas, and to the north-west of Wilson's workings forms a hill of quartz-gravel that have yet to be worked. In this the strata are standing nearly vertical, but are more regular in their disposition than farther to the eastward and in Wilson's Claim. In Sailors' Gully, which lies the furthest to the west of the different divisions of the Golden Gully area, there is again a development of the breccia-conglomerates that underlie the quartz-drifts. These, though gold-bearing, have not the importance of the overlying quartz-drifts, neither as regards bulk nor the amount of gold which they are supposed to contain. They are, however, of great interest otherwise owing to their being in a nearly vertical position, more especially at the head of Golden Gully. At this place their exposure at the surface is but a few yards wide, but a shaft sunk in them reached a depth of 130ft. without reaching bottom.

This particular locality was examined with considerable attention and care, as it did not appear on a cursory examination that the breccia-conglomerates could descend to such great depth with hard rock of Silurian age within 12ft. or 15ft. on each side of the mouth of the shaft. This shaft was sunk many years ago, and the depth reached is a matter of commnon report and comment among the miners, and has also been the occasion of the supposition and conclusion arrived at by others who have examined this part of the area that a great body of drifts are deeply involved between the older rocks along this western side of the northern part of the area. My examinations, however, showed that such is not the case, and that the breccia-conglomerates extend but a few yards farther to the north-east, and that they shortly, in that direction, wedge out altogether; nor is there any trace of them along the same line farther to the north-east.

At the time of my visit, during November last, mining was at a low ebb on the Golden Gully area, three parties only being at work. This was occasioned by the working-out of the shallow ground and the scarcity of water for mining purposes. It is proposed to alter this by bringing in a water-race from the upper valley of the Slate River, which race, with a constant supply of fifty Government heads, may be made available under a pressure of 300ft. This work, which is proposed to be undertaken by West, Adams, Fell, and Co., should enable the moving of much ground known to be auriferous, the working of which could not be undertaken or completed under the old system and with the means formerly available. It would be rash to prognosticate, or without qualification to make the statement, that this work, when carried out, must prove a financial success; but, in view of the past history of Golden Gully and the prospects that are yet to be obtained, there is hope for the undertaking.

Lying between the Parapara and the Slate River, at the source of Blue Creek, is a flat-topped hill or broad ridge, which may be spoken of as the Blue Creek Plateau. This is in part covered with a deposit of coarse gravel resting on an irregular surface of Silurian rocks. These gravels occur at a height of 1,550ft. above the sea, and are thus fully 400ft. above the level of the Golden Gully deposits of somewhat similar character and of the same age. The gravels on Blue Creek Plateau dip at gentle or moderate angles to the westward, and consist of coarse boulders derived from the rocks of the immediate neighbourhood, mixed with finer quartz-gravel and quartz-sand. The lower part, at least, of this deposit is auriferous, and work has been carried on in it for a period approaching twenty years. Evidently, however, the gain in precious metal has not been very great, as the principal workings have been made by one miner, who is even now engaged in the work single-handed. These lie at the north-eastern end of the deposit, and, though others working there may be on different parts of this area, I heard nothing of them, and they were not visited by me. This ground is so situated that water, under no great head of pressure, but perhaps sufficient, could be brought on to it, and it is finely situated for the disposal of tailings.

In as far as concerns this report, the chief interest attaching to the gravels of Blue Creek Plateau lies in the fact that they so much resemble the gravels and quartz-drifts of Golden Gully that in view of the occurrence of several small patches of quartz-drift at intermediate heights on the ridge leading from the Golden Gully to the plateau, there can be no doubt but at one time the two were connected. There is, however, an apparent change in the character of the gravels, but the considerable proportion of quartz-drifts indicate further the connection between the two deposits.

The Castles lie on the left bank of Rocky River, and nearly in a line between Blue Creek Plateau and the Quartz Ranges. These consist of limestone or calcareous sandstone similar to what lies at lower levels in the Aorere Valley. The locality was not visited by me, but it is reported as well known that quartz-drifts underlie calcareous rocks, and that these, on being prospected, proved gold-bearing. Gold-workings have been at the eastern base of the calcareous cliffs, and there, there may be gravels of a different type, in which the gold was principally found; but, nevertheless, it seems beyond dispute that the quartz-drifts under the limestones are gold-bearing.

Between the Castles and the Quartz Ranges, commencing on the south-west side of Salisbury Creek, nothing is known as to the occurrence of intermediate patches and small areas of quartz-gravels occupying the same horizon in the geological series.

The Quartz Ranges is the last and the largest connected area of these gravels in the south-west part of the district. They occupy part of the area lying between Salisbury Creek and Clark's River, and extend along the foot of Pine Ridge and the granite mountains on the south-east side of the Aorere Valley. They do not constitute distinct ranges, and their name is thus in some sense a misnomer. They are in reality the upper higher levels of the sloping plain on the south-east side of the Aorere Valley, separated from Pine Ridge by the depression in which, for the most part, the auriferous drifts lie. On the downward side, towards the Aorere, the one side of the depression along which the auriferous drifts are found forms, with the slopes to the lower levels, a ridge or series of ridges which must be considered the Quartz Ranges proper. Towards the north-east this ridge is fairly well marked, and continues so through the middle part; but towards the south-western end of the line of auriferous gravels it merges into the general slope from Pine Ridge to the Aorere.

The Quartz Ranges auriferous deposits are for the most part in place as originally deposited, and occur at levels varying from 950ft. to 1,550ft. above the level of the sea. They extend south-west from the brink of the great chasm of Salisbury Creek to the fall into the lower valley of Clark's River. The gravels are all locally derived, and towards the south-west contain large boulders of quartz and quartzite, or highly siliceous schist. The whole has the appearance of having been deposited in a valley depression declining from south-west to north-east, and bounded as already described by Pine Ride on the one hand and the broken ridge of the Quartz Ranges on the north-west side.

Within the northern and middle parts the chief bodies of wash lie on the south-east side of the valley. South-west of Maori Creek the filled-in depression has been cut across by the lesser streams of modern date that find their way from Pine Ridge to the Aorere. Consequently, on the ridges between the beds of these streams the auriferous drifts form deep ground, extending from spur to spur along the line, but not showing in the beds of the intervening creeks which have cut through the gravels to the bed-rock.

The average breadth over which the auriferous gravels are exposed is between 7 and 8 chains, and the thickness of the deposit varies from 4ft. or 5ft. to 50ft. The gravels are generally auriferous, but towards the south-west, and where the wash is coarse, the gold is chiefly in the last 2ft. or near the bottom of the gravels. Towards the north-east the wash is finer, and the gold, apparently, more evenly distributed throughout the wash or lower part of the gravels. Outside the particular depression along which these auriferous drifts have been deposited there is little wash in the immediate neighbourhood, but down the slope there are several bodies of gravel that have already been alluded to. No payable gold-wash has been found in these outside deposits. The gravel-deposit hitherto worked for gold therefore extends from Salisbury Creek south-west a distance of about, or fully, two miles. The area is for the most part taken up as special extended claims for mining by means of hydraulic sluicing.

In the south-west part the area held by West, Adams, Fell, and Co. is to a large extent untouched, and towards the south-west extremity of their holding the ground appears to be deep and involved along the south-east side, after the manner of the same deposits on the south-east side of Golden Gully. Along this side the quartz-drifts are cemented or indurated into a hard rock resembling brecciated quartz. These quartz-cements protrude above the general surface like outcrops of reefs, for which they have been mistaken. More to the north-west the gravels are not cemented, and one or two holes have been sunk in them to a considerable depth. I could not learn with what results. On the north-west side the ground shelves to shallow, and the quartz-drifts again appear, but resting at low angles on the schist-rock. Towards the north-east in this part the wash is coarse, and large boulders are plentiful in it. The wash, also, is to some extent cemented, or, at least, solidly compacted, but not so much but that it may be easily worked under a good head of water. Though requiring considerable pressure to pull it down, the gravel treats well after it has fallen. The gold is shotty, or coarse, occasional pieces weighing up to half an ounce being met with.

The middle area, held by Zinnan and Company, does not show such deep faces of drift, and the wash lies mainly on the slopes of the south-east side of the valley depression along which the gravels extend. In the lower part Graham's Spur shows a considerable area over which there is a good depth of gravel and wash. Over this section gold-workings have been carried on at many places. Large stones occur in the wash here, but they are not so abundant as farther to the south-west. The wash is rather hard, and generally harder than in the workings more to the south-west. This area is not quite so favourably situated for getting rid of tailings, though at the same time the conveniences for the disposal of these are sufficient. The gold here proves to be as coarse as further to the south-west.

The north-east end of the auriferous belt is held as a special area by West, Adams, Fell, and Co , and in respect of its position, the character of the material, and the favourable situation for disposal of tailings this area has distinct advantages. The breadth of the deposit is at first, towards the south-west boundary, somewhat restricted, but it gradually widens to the north till where it terminates in Salisbury Creek the width is as much as on any part of the line. The middle and northern part of this area is decidedly, as a field for sluicing, the most promising part of the Quartz Ranges. The ground gives evidence of being generally gold-bearing, being riddled with holes and in part driven out from these or from the brink of the deep ravine of Salisbury Creek. The wash is finer and less tightly compacted than more to the south-west, and consists more of quartz than in the other parts of the Quartz Ranges. The gold also appears to be distributed throughout the whole depth of the wash, and the get-away for the disposal of tailings is into Salisbury Creek, which runs in a ravine 500ft. below the level of any workings likely to be opened out. To reach this ground, if taken from Clark's River, the water would have to be brought along the top of the terrace and ridge to the south-east of the run of gravels, and to obtain sufficient pressure perhaps a greater length of pipe-line would be required than to most parts of the other holdings.

The water intended to work the auriferous deposits of the Quartz Ranges is proposed to be brought from Clark's River or from Boulder Lake ; probably from the first-mentioned source, in which it is said there is a minimum supply of forty Government heads. The race has not yet been surveyed, and it even appeared doubtful, when making inquiries on the subject, if the whole line of it has been closely explored. And not having been over the ground, nor seen Clark's River at the point at which the water will have to be lifted, I can express no opinion as to the volume and permanence of the water-supply, nor the height overlooking the Quartz Ranges to which it can be brought.

The principal areas over which auriferous deposits of this age are found have now been described ; and, as there has been included under this head deposits which by other geologists have been regarded as belonging to a different period, something more will have to be said in support of

the conclusions which have here been arrived at. Mr. Park regards the gravels at several of the localities above indicated as being of Pleistocene or newer Pliocene age, and of these he says: "Along the courses of the streams intersecting the sloping table-land there are the remains of old river-drifts, which have always been richly auriferous and have yielded most of the alluvial gold of this field. These drifts are best seen in Appo's and Lightband's Gullies and their numerous small branches. They are composed mostly of slate, sandstone, and quartzite pebbles, but contain no granite. At Golden Gully they are largely composed of quartz pebbles, which have evidently been derived from the adjacent quartzites. Drifts of a similar nature, in places also highly auriferous, occur at the Quartz Ranges along the upper courses of Finney's, Maori's, and Salisbury's Creeks. In his report on the Collingwood Ranges in 1881 Mr. Cox says he thinks it probable that these drifts were brought down by some river from the direction of the Gouland Downs. I see no reason for calling in the aid of this ancient and hypothetical river, of which no trace whatever remains. The drifts are mere patches in extent, and could easily have been formed by the present streams at the time when their courses were steeper, and their transporting-power thus proportionally increased. Besides, the material forming the drifts is obviously derived from the area within the watershed of the streams on which they occur. In Washbourne's old claim angular fragments of soft slate are not uncommon, showing that they have not travelled far."*

Besides the localities named in the above quotation from his report of 1889, in which the principal auriferous gravel deposits are said to be of Pleistocene or newer Pliocene age, Mr. Park recognises the existence of gravels and quartz-sands, which he regards as belonging to a position or horizon below the limestone of Eocene or Cretaceo-tertiary age, and in the following extract made from the report above quoted he says: "On the sloping tableland on the south side of the Aorere Valley the limestone is underlain conformably by a variable thickness of loose quartz-sand, or hard-cemented grit, and hæmatite rock. Where the limestones rest on the quartz-schists or quartzites the underlying sands are usually pure white and free from foreign matter. This is well seen at Cave Hill, and at the Collingwood Caves at Canterbury Hill, where the sands are so clean and sharp that they might be used for glass-making. At the Quartz Ranges, where the basement rock is slate, the limestone rests in places hard upon the old floor, and in other places is separated from it by a foot or two of brown grit mixed with a wash of clean white quartz pebbles. At the lower end of Doctor's Creek a similar grit also rests upon the slates; but there it is cemented by brown hæmatite into hard flaggy masses. . . . At Appo's Flat and Sailor's Gully, where the brown coal-measures are present below the limestone, the grits and cements are absent, or are but feebly represented. At Parapara Inlet the ferruginous cements expand to a great thickness, and pass in places into brown hæmatite of fine quality."†

Mr. Park, it will be seen from what has been quoted from his report, has simply separated and described as belonging to different formations deposits which are here considered to be one and the same, and it needs but to show that the deposits referred to the younger period could not have been produced by the agency to which he ascribes them, the gravels so produced, and of quite different character, being yet present in the district.

Before setting out proofs as to the manner and time of the formation of the auriferous drifts under consideration, it may be well to quote Sir James Hector on the subject. Sir James remarks: "The alluvial gold, of which nearly one million pounds' worth has been obtained in the Collingwood district, has been attributed to various sources. In 1860, Von Hochstetter . . . was of the opinion that the Aorere River and its tributary streams had been the chief agents in the liberation of the gold from its original matrix, and its distribution through the extensive gravel terraces that skirt the wide valley of that river. . . . On the other hand, my own surveys of this goldfield in 1866, and on several subsequent visits, had convinced me that the gold was chiefly derived as a rewash from an ancient alluvial drift, the distribution of which was quite different in its origin from the present drainage system of the country. This has also been the idea underlying the reports of various geological surveys of subsequent date, such as Hackett, Davis, Hutton, Cox, and Park, all members of the Geological Survey staff, but they still only attributed the richer alluvia to former channels of the Aorere River system that remain at a high level along the eastern side of the more recently excavated Aorere Valley of the present period." Sir James then quotes from the report of Mr. Davis the passages in the manner which has been done in the early part of this report, and adds as follows: "The drift is composed almost entirely of quartzite, quartz, and schist in small pieces, but in a few instances I noticed the presence of angular fragments. Gold may be found in all parts of the drift, but only in payable quantities in a few localities, which appear to me to be those places where the materials have been reassorted and the gold concentrated by the action of running water subsequent to their original deposition. . . . In partial support of this view, Professor Hutton attributed the wonderfully rich deposits at Golden Gully to the degradation of the schists on which they rested, and claimed the schist as the source of the heavy deposits of quartz pebbles that form the auriferous wash.‡ Mr. Cox was, on the other hand, explicit in the opinion that the drifts were not local." Mr. Cox is quoted from to that effect, in which citation the strong point is made, of which use will be made further on, that the drifts are not local, seeing that on the Quartz Ranges there are no granites in the drifts, which might have been expected considering the near vicinity of Lead Hill and Mount Olympus. On the other hand, the views put forward by Mr. Park, which have already been quoted, are cited to show that Mr. Park thought that the gravels originated since the last appearance of the land, and are wholly due to the action of the tributaries of the Aorere that, down the sloping table-land on the south-east side of the valley, drains from the mountains on that side of the watershed.

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* "Geological Reports," 1888–89, p. 242. † "Geological Reports," 1888–89, pp. 239–240. ‡ Professor Hutton, "Geological Reports," 1871–72, p. 152.

Sir James continues thus: "I never felt altogether satisfied with the explanation that attributes the origin of the gold to ordinary drift gravels, and have visited this goldfield on many occasions during the last twenty years with a feeling of surprise that such enormously rich finds should have been made in the early days, and that they should not have been followed up, as in other gold-mining districts, by more permanent, though perhaps less rich, discoveries. Want of concentrated energy and capital in order to secure a sufficient water-supply to enable the modern methods of mining to be adopted, has seemed to me the chief difficulty, and it was with great interest that I lately took an opportunity of re-examining a property there on behalf of the Parapara Sluicing Company, which seems to be the first effort that has been conceived on the right method of working for the proper development of the district. . . . Gold was also washed out of the sands on the sea-beach at the mouth of the [Parapara] river, and along the coast to the eastward; also in the bed of the river as far up as the first gorge, about a mile from the tidal water. At one time there was a considerable mining population in this district, but, owing to the difficulty of procuring a sufficient water-supply for sluicing the gravels, the miners gradually abandoned the place. From the first gorge the gold seemed to leave the Parapara River and follow a line to the southwest, crossing a succession of low saddles that divide the waters of various streams, and intersecting the richest diggings, such as Glenmutchkin, Glengyle, Appo's Creek, Richmond Hill, Golden Gully, and Rocky River. It was at Golden Gully that the first important discovery was made, and, from report, the richness of the claims was most remarkable. The sinking was only 5ft. deep, and I find the area worked was only about 50,000 square yards. This gives about a hundred thousand loads. From this area, in a few months, 40,000oz. of gold were obtained and sold on the ground to storekeepers, or at the rate of nearly ½oz. to the load. Patches of the ground were, however, so rich that the yield was frequently 1oz. of gold from a single dish of stuff; and yet only a portion of the gold was secured, as the tailings have been worked over and over again, and a few miners are still so employed. The gold, in this instance, was obtained from a thin layer of loose quartz-gravel resting on the denuded surface of soft slate rock; but along the east side of the shallow diggings deep ground was discovered, and at the head of Blue Creek* a shaft 120ft. deep was sunk in a very compact, coarse conglomerate without reaching any bed-rock. Gold was found in every part of the conglomerate taken out, but, on failing to find a definite lead, the work was abandoned. The workings in Appo's Gully also throw light on the peculiar distribution of those auriferous gravels. In its upper part, the creek follows a line of deep ground, but crosses it obliquely, so that towards the Richmond Hill Saddle the lead has been smothered by heavy landslips from the eastern side of the valley. Lower down, where the richest surface-workings were situated, deep ground was discovered, and a shaft was sunk by Messrs. Travers and Washbourne; but, so I am informed, this prospecting work was also abandoned at a depth of 140ft. without any gutter or lead being found, or any change being encountered in the nature of the material. The gold-bearing lead continues to follow a bearing of N. 40° E. over the saddle which separates the Hit-or-Miss Claim from Glengyle Creek; and, just above the junction of the latter creek with the Parapara River, a third trial-shaft was put down in cement ground from the river-level to a considerable depth, and this shaft also failed to disclose any change or limit in depth for the deposit. It thus appears probable that we have to deal with a more or less vertical stratum of auriferous gravel or cement which follows a fault-line—which, for convenience, I may term a main slide—that is independent of the present contour of the country, and that we have also to deal with secondary and concentrated gravels derived from this main-slide cement. This view is supported by the following well ascertained facts: (1) Streams which intersect the line of the main slide are auriferous only in that part of their course which is below the intersection—such, for instance, as the Parapara River, Appo's Creek, Lightband's Creek, Golden Gully, Sailor's, and Blue Creeks, Slate River, and its tributary Rocky River; . . . (2) smaller streams which intersect the terrace-gravels in lines parallel with the above, but rise short of the intersection of the main slide, are not auriferous; (3) there are several auriferous reefs in the district now being worked by Johnstone's United Company which yield gold of a different chemical quality from that in the main-slide cement, the latter being extremely pure and bright, while the former is tarnished by contact with arsenical pyrites and other metallic sulphides Now, the area where these reefs crop out at the surface is isolated from the main-slide gravel, and within this area—as, for instance, Bedstead Gully and Coles's Creek—all the alluvial gold, of which a considerable amount was obtained in the early days, had a characteristic greenish tarnish and a garlic odour on being heated, which proved its local origin from these reefs, and thus accounts for its presence under circumstances that precluded its having been derived from the main slide."†

Having knowledge of the particular views of the workers who have preceded me in this field, naturally my work had direction as to many things which otherwise might have been overlooked; but more especially were the evidences bearing on the origin and history of the gravels involved along the line of fault on the south-east side of the Aorere Valley considered, and the relation of these to the Cretaceo-tertiary or older Tertiary strata on the same side of the valley. With the views of Von Hochstetter and Cox I cannot but disagree, and in part also with those expressed by Mr. Park. With the views of Sir James Hector those to be here put forward are much more in accord, and differ seriously in one or two particulars only: First, with reference to the source of the gold found in the main slide; and, second, with respect to the absence of gold in the upper valleys of such streams as cut through the main slide and take their rise from the south-east water-divide. The gravels of the upper Slate River and its tributaries, Snow's and Rocky Rivers, are well known to be gold-bearing in parts where their auriferous contents could not have been supplied from the drifts involved along the line of fracture running from the mouth of the Parapara River to the

* This is the same locality that has already been mentioned as the head of Golden Gully .† "Geological Reports," 1890–91, Progress Report, pp. x–xv.

Quartz Ranges; and, with respect to the gravels on the lesser streams—Appo's Creek, Lightband's Creek, Golden Gully, Sailor's and Blue Creeks—being enriched from the main slide in the middle and lower parts of their courses, the answer is that none of these streams reach to the south-east of the line of fracture or the occurrence of the quartz-gravels. And so, though in part they may have derived gold immediately from the Silurian rocks through which they have cut their way, either the gold from the main slide has not travelled far beyond where the quartz-drifts ceased to occur or a mixed sample of gold must be the result below where auriferous reefs strike across the water-channels. This argument will also apply to the auriferous gravels of the Slate River, north-east of the point where the line of fracture crosses the valley of that stream.

Thus Slate River gold is said to be distinguishable from gold from other sources in the terraces for some distance below the junction with the Aorere. But, apart from all this, as a general rule alluvial gold tends to become purer the longer it has been freed from its matrix; and this ought to be a sufficient explanation of the difference between that in the gravels of the main slide and that which for a much shorter period has been liberated from the original matrix. The gold in both cases may have been derived from the same rocks. Nor is it easy to see how the one variety of gold could have been derived from a distance without being in part mingled with that derived from the rocks of the locality where now the quartz-drifts lie.

In almost all parts of the South (Middle) Island the lower beds of the coal-bearing formation are characterized as being composed of coarse breccia conglomerates or of well-rolled gravels. Usually the older and very lowest beds are breccia conglomerates, and these, disregarding the coal-measures, are followed by quartz-drifts which, though younger, have not always the breccia conglomerates under them. These vast accumulations of breccia and gravels were the result of a long-continued denudation of the land-surface that, antedating the marine beds overlying the coal-measures, had continued from Jurassic times till the submergence of the land, locally and generally, during the middle and latter parts of the Cretaceous period; and it is as part of such breccia-conglomerate or quartz-drift formation that we have to regard the greater portion of the material involved in the main slide or fracture that has already been described. These gravels vary in thickness in different parts of the Aorere Valley, and that within short distances; and on the north-western side of the valley the thickness of the gravels and breccia under the limestone is very considerably greater than on the south-east side.*

On the south-east side of the valley, after a very considerable denudation of the overlying limestone and marly clays of younger date, the various strata successively exposed were covered over by heavy beds of gravel of younger Pliocene date; and, more especially along the north-east part of the line of fracture, these younger were involved with the older beds of Cretaceo-tertiary date. This will account for the great number of large boulders that occur involved with finer quartz-drifts in Glengyle Creek and the upper part of Appo's Creek; and they may in part be accounted for as belonging to the original breccia conglomerate and quartz-drift deposit.

The quartz-drifts on Appo's Flat, along Lightband's Creek, and at Golden Gully completely disprove the theory that the auriferous gravels on this side of the valley are due to the action of the Aorere in former times, or to that of some river the whence, the whither, or the period of which cannot now be traced. I have in a former report† shown that quartz-drifts such as are now being considered are not the product of any New Zealand river of the present time; also, that it is highly improbable that such gravels could be produced by the action of any river that at the same time could carry along the much coarser detritus with which the quartz-drifts are sometimes mixed. Nor could a rapid stream, having many tributaries from the mountains on each side of the watershed, owing to the continued influx of fresh material, produce gravels of one kind of rock only—and much less a purely quartz-gravel—in a country where there is a considerable variety of rocks.

But these difficulties to a great extent disappear if we suppose the sea to be the agent concerned in the production of the quartz-drifts of the Aorere Valley, and assume the existence of a gradually-sinking land, giving opportunity for the pounding and reduction of the softer rocks, and the conversion of the harder material of these into water-worn material, mainly quartz-gravel, such as occur in the particular district here dealt with, where are numerous quartz reefs, and where, in addition, large bodies of quartz-rock are associated with the more argillaceous rocks, mica-schist and carbon slates. Thus could be easily accounted for the local character of gravels on the Quartz Ranges and on Blue Creek Plateau, at both of which localities there is a mixture of coarse locally-derived material and quartz-drift, which latter is in all probability derived from the rocks of the vicinity.

More to the north-east I have pointed out that Pliocene gravels may have been engulphed along the line of fracture, and here, therefore, foreign material may be expected to occur. I therefore regard the gravels of the main slide as being, on the whole, local, there being no great river during the time of their deposition which carried *débris* from the distant interior to the part of the coast that then was, but now forms the south-east side of Aorere Valley.

VII.—Devonian.

Rocks of this age are described by Mr. Park as found within the watershed of the Aorere Valley, around the sources of the Slate and Snow's Rivers. These, however, do not come under consideration, as they were not examined by me during my recent trip to the Collingwood district.

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* Report on Collingwood County by James Park, "Geological Reports," 1888–89, p. 238. † Report on the Older Auriferous Drifts of Otago.—C.–4, 1894.

VIII.—Silurian.

These rocks, which probably are, throughout the Aorere Valley and the adjoining district to the north-west, of lower Silurian age, are more or less metamorphosed throughout; for though they yield *graptolites* at Golden Ridge, and at the south-east side of the Aorere are often called "felspathic slates and sandstones," I fully satisfied myself that the great body of the formation consists of metamorphic rock. Siliceous schist and quartzite, or quartz-rock, abound in some parts of the area covered by it, and this formation also includes areas of chloritic-schist, steatite, and crystalline limestone.

In the dark carbon-slates of Bedstead Gully and north-eastern bank of the Slate River occurs the Johnstone's United Company's Mine. In this the reef mined for gold dips at low or moderate angles to the eastward, or apparently, as contended for by Mr. Park, the auriferous quartz is a segregation along the bedding planes of the rock in which it occurs. The Johnstone's United is the only quartz mine being worked in this formation within the Aorere Valley, and, owing to the easterly dip of the vein or segregation, the area of stone on the line or shot of gold is limited, and another and longer tunnel at a lower level than the present will have to be driven to reach the stone towards the dip which contains the further continuance of the shot of gold.

IX.—Granite.

This rock has its chief development over this district in Lead Hill and Mount Olympus, and as occurring at these localities it has been sufficiently described in the reports by Messrs. Cox and Park, and my work did not lead me so far as to examine either one or other of the granite areas.

X.—Parapara Hæmatite.

In company with the Messrs. Washbourne, I examined this deposit and satisfied myself that a very large proportion of the ore is comparatively free from earthy impurities, such as quartz pebbles and grit. Formerly I was of opinion that, owing to the impurities present, the percentage of pure ore would be thereby lessened in some parts considerably; but it so chances that at the north end of the deposit, which is naturally the easiest of approach, and thus the first to be examined, there is an unusual amount of scattered stones and quartz-grit in the hæmatite. The western margin of the deposit also contains a greater percentage of the impurities mentioned; but the central and eastern parts contain an enormous body of ore of comparative purity. The deposit may be estimated at from 10 to 12 chains in width, 20 chains in length, and in places at least 200ft. in depth. More to the south there are other less extensive and less accessible deposits of the same kind. These hæmatite deposits have been the subject of notice and special remark in the reports of Messrs. Cox, Park, and J. G. Binns, and here it is not necessary to say more than a few words on the question as to how these deposits have been brought about.

Besides the larger accumulations extending southward on the coastal slope to Golden Bay, similar but much smaller deposits of hydrous hæmatite are met with on the sloping table-land on the south-east side of the Aorere Valley; and masses of limonite are met with in connection with the gravels of the main-slide both at Parapara and at Golden Gully. At many places also, the felspathic schistose rocks, by the oxidation of the iron contained either as minute crystals of pyrites disseminated through the mass or a change of the silicate to an oxide, becomes ferruginous in colour, and till more closely examined such rocks protruding above the surface appear to be limonite. In the neighbourhood of Parapara, where cuttings into the talcose-schist have been made, the rocks exposed at first were unoxidized, but afterwards became coated with a thin covering of iron oxide, and small botryoidal or kidney-shaped pellets, aggregated from this, strew the surface and indicate the source and manner of accretion of the larger masses.

To the eastward of the main mass of limonite there runs for some distance an exceedingly massive lode of iron-pyrites, which to the westward has not a clearly defined wall, but on this side passes into pyritous slate. From the decomposition of the sulphides in this pyritous slate and the removal by water of the products of oxidation and their subsequent precipitation, have arisen the mass of the Parapara hæmatite, or rather limonite, deposit. It has been said that the limonite deposit contains many masses having pyritous cores, thus implying that the deposit to a considerable extent resulted mechanically from the breaking-up of a large pyritous reef and subsequent oxidation from the surface affecting the masses more or less deeply. Pyrites are often met with at places in the deposit, but usually as thin veins in joints and lining cavities, but never, so far as I have observed, in such amount as would lessen the general usefulness and value of the ore.

Alex. McKay.

APPENDIX A.

The following letter was written under date from Collingwood for Mr. Gordon's information. Others have also been supplied with copies of it, and, as it could not be embodied at one place in the main report, nor if broken up would it represent that which has already been circulated, it has been deemed advisable to print it as an appendix to the report "On the Geology of the Aorere Valley, Collingwood County, Nelson."

17th July, 1896. Alex. McKay.

Dear Sir,— Collingwood, 15th November, 1895.

Since my coming to Collingwood, I have made the various examinations specified and described underneath: 1. Appo's Flat: (*a*) The freehold of F. West, now held by the Parapara Hydraulic Sluicing and Gold-mining Company; (*b*) the north-eastern part of the flat held under lease by West, Adams, and Fell. 2. Glengyle Gully, including Hit-or-Miss Claim, on the saddle between Glengyle Gully and the upper part of Appo's Creek; Glenmutchkin, the two working-faces

opened out by the Parapara Company, and the works in the mud-flat where the elevator has been erected. 3. Washbourne's hæmatite property, and the Onehunga Iron Company's lease to the south of Washbourne's property. 4. Golden Gully, with reference specially to the areas held and proposed to be acquired by West, Adams, and Fell. 5. The Blue Creek plateau. 6. Lightband's (in part). 7. The Quartz Ranges, with special reference to the areas held by Ziman & Co.; and, lastly, the general geology of the district. As various interests are involved, I shall deal with each locality and holding separately; but, before doing so, will say a few words on the geological structure of the district, and the relative age of the different strata to be considered.

On leaving Collingwood for Parapara and Appo's Flat, the road leads along a *pakihi* plain, due to the action of the Aorere when running at a higher level than at present. A lower terrace interposes between this and the lowest flat reaching to the banks of the river. The materials forming these terraces are ordinary river-gravels, necessarily derived from all the harder rocks within the Aorere watershed, and, let it be specially remarked, include a fair sprinkling of granite boulders.

To the eastward of the higher terrace on the east side of the Aorere Valley, and extending from Collingwood to Parapara Inlet and the north-east part of Appo's Flat, there is a line of hills overlooking Golden Bay, Parapara Inlet, and Appo's Flat. These towards the north are flat topped and covered with gravel similar in character but considerably coarser than those forming the Aorere terraces as above described. Towards their southern end these hills are no longer flat topped, but form a series of rounded elevations, the sides of which show the presence of marly strata which for the present may be regarded as of Cretaceo-tertiary age (their actual age not being readily or as yet determinable). At the north-east corner of Appo's Flat the gravels capping these hills strike away to the westward, and terminate near the mouth of Appo's (Stanton's) Creek, close to the Aorere River. At the north-east corner of Appo's Flat begins quite another feature, characterising the east side of the Aorere Valley as far as the Clark River. This is an uniform slope of the country to the north-west and the low grounds of the valley, from heights 1,200ft. to 1,500ft. above the sea, which slope, as seen from a distance, appears to be remarkably uniform, both as regards its dip towards the low grounds and as regards its extension along this side of the Aorere Valley, and suggests at once the idea of a plane of marine denudation, which, by the elevation of the mountain region to the south, has acquired a steeper slope than it had when it was first formed.

This sloping plain explains much, and itself requires explanation in order to rightly apprehend the peculiarities of the distribution of the auriferous drifts of the district. Along its south-east boundary extends the deeply involved auriferous drifts of Glengyle and the upper part of Appo's Creek; the Parapara, from Richmond Hill to the junction of Macgregor's Creek; and Golden Gully to the upper part of Wakefield Creek. This line from its south-western limits, to Parapara mud-flat, is along a line of fracture, and the wash involved is usually tilted so as to stand at high angles, and often so disturbed as to suggest the idea of its having tumbled into a vast chasm or rent rather than being gradually caught up by the progressive movements along a regular line of fault-fissure. Appo's Creek, and Lightband's Creek, and Coles's Gully Creek cut deeply into the soft carbon schists, and readily decomposed felspathic schists, that form the fundamental rocks of the sloping plain between the deep rim of auriferous wash and the Aorere River. These lesser streams simulate in a remarkable manner the action of the larger streams further to the south-west, the deep-cut channels of the main watercourse and its tributary branches differing only as regards the scale of the operations that have been carried on; Slate River with its tributaries, Rocky River and Snow's River, finding an exact parallel as regards the features described in Appo's Creek and Lightband's Creek. The fracture, and deeply-involved line of auriferous wash, extended north-east and south-west from Parapara mud-flat to Golden Gully, ends at the southern end of the Golden Gully area, and so far as explored is not repeated to the south-west until reaching the Quartz Ranges.

The average height of Golden Gully is between 1,100ft. and 1,200ft. above the sea, but in the saddle, between the southern part and the Upper Parapara, the quartz-drifts are 150ft. to 200ft. higher, and are involved between the older rocks as vertical strata. Above these elevations, and to the south towards the Slate River, the auriferous gravels on Blue Creek plateau are not involved as they are to the north-east, but, as nearly horizontal beds, occupy a slight depression in the slate rock and have their greatest length in a south-west and north-east direction. The material of the wash on Blue Creek plateau is coarser, and mixed with a good deal of slate derived from the immediate neighbourhood. It is also more solid and compact than in Golden Gully, and the stratification, quite undisturbed, shows, in beds of fine grit and quartz-sand in the higher beds, an approach to the conditions obtaining during the accumulation of the Golden Gully deposit. I have not examined the country between Slate River and the Boulder River, but it presents in the higher grounds a line of uniform heights, that are continued across the Boulder River and Salisbury Creek to the south-east margin of the Quartz Ranges, towards the south-west end of which they cease to be isolated hills, and form marked and nearly level terraces. Beyond the Quartz Ranges these terraces are continued into the bush-clad country towards the Clark River.

Blue Creek plateau is 1,550ft. above sea-level. The Castles, between Rocky River and Little Boulder River, reach to about the same height. The terraces mentioned as being at the south-west end of the Quartz Ranges are 1,530ft. above the sea, and there is thus a remarkable coincidence in the equal levels of the various points bounding the south-east limits of the higher line of auriferous wash between Blue Creek plateau and the south-west end of the Quartz Ranges. Towards the south-west end of the Quartz Ranges the streams cutting into the sloping plain are again of no great volume, and Doctor's Creek and Maori Gully are the counterparts of Appo's Creek, Lightband's and Coles's Creeks, in the north-east part of the line of slope or tilted plane of marine denudation that has already been indicated. The higher part of this slope in the south-west is fully 1,500ft. above the sea; but from Blue Creek plateau to the north-east corner of Appo's Flat it gradually declines to 385ft., and the floor of schistose rock reaches sea-level at the point where the road from

Collingwood to Takaka reaches Parapara Inlet. This lowering of the back line from Golden Gully to the sea is accounted for by the presence of the fault along this part, and the greater displacement of this towards the north-east.

I have spoken of a plane of marine denudation tilted, so as to have a considerable slope descending from the south-east to the north-west, and of a line of auriferous drifts extending along its south-east margin, and it may already be inferred that these drifts are by me regarded as being of marine origin. Partly this is the meaning intended to be conveyed; but, before pronouncing definitely on this question, it is well that some further evidence bearing on the point raised should be adduced.

It has been noted that the schistose rocks reach sea-level on the northern shore of Parapara Inlet. There they are immediately overlain by a comparatively inconsiderable thickness of quartz-grits, which, however, are not different from those being mined by the Parapara Hydraulic Sluicing Company, saving in certain particulars of secondary importance, which shall be mentioned in due course. These quartz-drifts on the north side of the inlet are directly overlain by limestone, which for the present may be regarded as of Cretaceo-tertiary age. The limestone can be followed, gradually rising in elevation as it is followed to the south-west, till at the north-east corner of Appo's Flat it has passed the water divide between the Parapara and Aorere Valleys, and entered on that of the latter. Here beneath the limestones the quartz-drifts have a greater development, and are probably auriferous, as, indeed, they are said to be on the shore of Parapara Inlet.

At the north-west corner of Appo's Flat the limestones for a time terminate, being overlain by marly clays, and these in turn by the coarse gravel-beds of the seaward hills between the higher Aorere Terrace and the sea. But from beneath the limestones, the quartz-drifts extend north-west across and south-west along and into the deeper part of Appo's Flat, and stretch upwards to the south-east on the plane of denudation described, to a height of 430ft. above the sea.

Towards the south-west the quartz-drifts are washed away, denuded from the hill-slopes, and appear only on the lower slopes towards the eastern margin of the flat, and over the flat proper (West's freehold), they are completely covered up by the recent gravels brought down by the creek. Their presence, however, in the flat has been proved by mining, partly by open gold-working and dip-drives carried on by Mr. West, and partly by two deep shafts further to the north-west and near the middle of the flat. These deep shafts showed the presence of some 30ft. to 40ft. of superficial creek-gravel, below which they entered and were continued in quartz-gravel, yielding gold to a depth of 130ft. from the surface. This deep pot-hole of quartz-gravel is bounded by schist-rock on all sides, but above the level of the flat a deposit of quartz-gravel runs through the spur by which the road leads up to Red Hill house and mine, and the hill-slopes facing the north, *i.e.*, on the south side of Appo's Flat, are covered with a deposit of auriferous quartz-wash, rising to a height of 150ft. above the flat. This deposit was in part very rich in gold, yielding, it is said, 1,000oz., and the greater part of the southern part of it has been worked out.

Yet higher up the spur, on the road to Red Hill, a similar but smaller patch of auriferous quartz-wash, less than a chain square, has been worked, yielding, as reported, 30oz. of gold. These areas were shallow ground in both cases.

The quartz-gravel extending through the spur at the lower level is continued to the opposing slope of the next gully, and is now being worked for gold.

The ridge to the south-west separating this creek from Lightband's is without quartz-gravel, but shows schist highly charged with quartz-reefs and intersected by massive bands of quartz-rock. Lightband's Gully lies immediately beyond, and in its upper part has deposits of auriferous quartz-drift on both sides of the gully right to the saddle overlooking the Parapara at Richmond Hill, and descending the spurs to about two-thirds down its course to the junction with Appo's Creek. The quartz deposits on both sides of Lightband's Gully are original and *in situ* as at first deposited, and are in no sense "a spue from the main slide." They are clearly stratified, and in the upper part, except at the saddle, conform to the slope of the hill. Lower down the slope the drifts assume a more horizontal position, but the rising of a ridge of schist prevents their reaching to the Aorere River. Near the mouth of Stanton's Creek—that part of the watershed of Appo's and Lightband's Creek below the junction of the two streams—the limestone appears, and between it and the Slate River a claim is being worked, which in the past gave good results. On the spurs south-west of Lightband's, and thence to the middle and lower parts of Coles's Gully, there is a considerable development of quartz-gravels, and five or six sluicing-faces have been opened out and worked for many years in this part, but, as golden claims, they languish for lack of a sufficient supply of water. Round the rocky bush-clad hill east of the Mammoth Caves the gravels stretch to lower levels on to Druggan's Flat, and on the road to Bedstead Gully pass under the limestone, and at lower levels towards the river are intercepted by a slate ridge, or covered over by the gravels of the Aorere.

Coles's Gully, the upper part of which is Golden Gully, I have not yet examined in the middle and lower parts. The upper part, Golden Gully, will be described under that heading. Here the auriferous gravels are partly involved along the line of fracture, and partly resting at low angles on the slate-rock.

Dealing with this, the north-eastern part of the slope, on the south-east side of the Aorere Valley, which I have called a plane of marine denudation, it may have been noted that towards the low grounds the auriferous gravels at places pass under the limestones of supposed Cretaceo-tertiary date, while at the higher levels along the south-east margin of the quartz-drift area the limestones are absent. Further to the south-west the limestones appear at both the higher and the lower levels. The limestones are present in the low grounds of the valley from about opposite the mouth of Slate River to the ford above the foot-bridge over the Aorere, on the road to the Quartz Ranges, and are well seen at and for some distance above the bridge, where they rest on the schistose rock directly, and without the interposition of the quartz-drifts. But, while this is so, the limestone at

higher levels, at the Castles and on the Quartz Ranges, shows the presence of auriferous drifts underlying. At the Castles the drifts under the limestone have been worked for gold. On the Quartz Ranges the limestone becomes much mixed with quartz in the lower beds, but nothing has been done to prove the presence of free drifts underlying. It, however, need not be doubted but that to some extent such drifts are present, and that they are more or less gold-bearing.

The Quartz Ranges auriferous deposits are for the most part in place, as originally deposited, and, at levels varying from 950ft. to 1,530ft., extend south-west and north-east from the brink of the chasm of Salisbury Creek to the fall into the lower valley of Clark's River. The gravels are all locally derived, and towards the south-west contain large boulders of quartz and quartzite or highly-siliceous schist. The whole is deposited in a valley depression declining from the south-west to the north-east, within the northern and middle parts of which the chief bodies of wash lie on the south-east side of the valley. South-west of Maori Creek the filled-in depression has been cut across by the lesser modern creeks of the range; and, consequently on the spurs between these auriferous drifts, deep ground extends from spur to spur along the line, but does not show in the beds of the intervening creeks. The average width of the auriferous gravels is between 7 and 8 chains, and the thickness of the deposit varies from 4ft. or 5ft. to 50ft. The deposit is generally auriferous, but towards the south-west, and where the wash is coarse, the gold lies chiefly on and near the bottom. Towards the north-east the wash is finer, and the gold, apparently, more mixed throughout the wash. Outside this valley there is little wash of any kind, and no payable gold down the slope till the terraces immediately overlooking the Aorere are reached.

NOTE.—I shall now describe the different special localities, as indicated at the commencement of this letter, but not in the sequence stated, because I may not be able to go over the whole before the mail closes for Nelson. Should it so happen, that which cannot be got through with will be posted the following mail.

LOCALITY NO. 1B.

Appo's Flat, north-east part, comprising lease of 50 acres held by West, Adams, and Fell. This property lies wholly to the north-east of Appo's Creek, in that part where it passes through Appo's Flat, and lying to the south-east of the road-line, stretches north-east to near the upper end of the basin, and south-east to the lower slopes of the ridge of hills separating Appo's Flat from Glengyle Gully. The ground to the south-west is supposed to be deep alluvial, or quartz-drift ground, a continuation north-east of that within West's freehold, which has been proved to be at least 130ft. deep before reaching the slate rock. There are indications of quartz-drifts at and near the surface in the south-west and middle part of the lease, but towards the north coarse boulder-wash from the adjoining hills forms the surface of the flat and prevents the white quartz-wash being traced in that direction. Probably this upper stratum is not of great thickness, and where present the quartz-wash should be reached without serious difficulty. Slate shows along the south-east boundary, and also in the north-east corner of the lease. Isolated patches of white gravel lie outside the lease to the north-east, and in this direction also lies the out-crop of white quartz-drift that passes under the limestone. The ground has not been prospected, it having been considered deep ground presenting difficulties greater than miners single-handed or in small parties could successfully contend with.

It is moderately certain that part of the area is deep quartz-drift country, and, to enable this to be worked, it is suggested that a tail-race should be brought in from the Parapara watershed, the length of which, Mr. West informs me, would be about 70 chains to reach the south-west part of the ground; but, of course, considerably less to reach the north-east corner of the lease. The elevation of the flat at Mr. West's house is 240ft. above the sea, while the northern part of the flat is higher by some 20ft. to 30ft. After allowing for "dump" into the Parapara river-bed at near sea-level, and a sufficient fall in the tail-race, the flat could be worked to a depth greater than by any other means usually practised in alluvial mining. The tail-race would, if taken in the shortest and most direct line, have to be driven through schist-rock; but, if the slate dips as rapidly north of the saddle as it does at the junction of the quartz-drifts in the line of Appo's Creek, by a slightly longer tunnel part of the driving in slate might be avoided.

The prospects relied on are these: About five thousand pounds' worth of gold has been taken from about an acre of ground in the upper part of Appo's Flat. The quartz-drifts are known to be auriferous, and said to be payable for hydraulic sluicing, yielding gold as far as sunk upon. These drifts have not been bottomed, and it is hoped the lower-beds are richer than the middle and higher, and there is every reason to expect their extension to the north and north-east, through a considerable part of this holding. Though, as regards this particular lease, these anticipations have not been actually proved, the enterprise must be regarded as legitimate, and, as far as the lower south-west part of the lease, hopeful. The water-supply, it is intended, shall be brought from Slate River, this being part of the scheme for bringing in water to command most of the old diggings between Golden Gully and Appo's Flat.

The tail-race and the bringing of the requisite water on to the ground will entail considerable expense, while from the evidence above given, it will appear that there is not more than a probability of the final success of the undertaking. Some attempt should be made to prospect the ground in its shallower parts, and, if anything like a fair prospect were obtained, it might reasonably be concluded that there is warrant for the carrying out of the works necessary to effectually work the ground held within this lease.

GOLDEN GULLY.

The leases held or proposed to be acquired by West, Adams, and Fell, include nearly the whole of the auriferous quartz-drift area, estimated at some two hundred acres—this is probably an over-

estimate. The northern part contains deeply involved ground along Macgregor's Creek. This was not examined by me north-east of McKenzie's hut, but it is said to extend to the Parapara River. West of this is the source of Golden Gully, and the area from which so much gold was obtained in the early days of the diggings at this place. Most of this ground is shallow, and has been worked over down to the slate rock. At the very head of the gully, deep ground begins and extends to the south into Macgregor's Creek, and south-west into Wakefield Creek watershed. Within the watershed of Golden Gully proper the extent of this deep ground is very limited, and while the tailings might pay to be again sluiced, this part of the area would not of itself pay for bringing water from Slate River on to the ground. But from McKenzie's dam south to Wilson's dam, some 7 or 8 chains, there is a deep run of ground and a considerable body of wash, of which report says that as far as worked it proved very rich, but was bad ground to work in driving out. This, continued to the south-west, forms a hill, on the south side of which a very considerable amount of work has been done, evidencing the presence of gold in paying quantities.

Between the hill mentioned and Wilson's Dam there is a ridge of 5 or 6 chains or more in length, which is wholly composed of quartz-gravels, or beds of other materials associated therewith. Workings have reached to the foot of this on the western side from the outcrop of the slate rock to the south-west, and extend along its whole length to the north-east; but the hill or ridge itself has not been worked; and this in spite of the fact that it appears to be composed of promising material. East of this there is deep ground from Wilson's Claim to the head of Macgregor's Gully, and the greater part of this is unworked over a length of 10 or 12 chains, and a width of 4 to 7 chains. From the head of Macgregor's Gully a line of deep wash goes south through the spur in the direction of the Parapara. How wide this is I could not determine.

There is yet in Golden Gully a large area of ground of an auriferous character that could be conveniently sluiced into Wakefield Gully on the one hand, or into Macgregor's Creek on the other. The eastern side of the ground is deep—evidently very deep in parts; but, unlike the deep ground along Glengyle Gully, there are no large stones to contend with, and, except where there is limestone, the walls of the fissure are likely to stand. The width of the fissure is also considerably greater, enabling the reaching of a greater depth without involving danger from the sides. I saw a prospect washed from Wilson's Claim. It was taken from where I directed, and as a sluicing prospect was quite satisfactory. In fact, I do not doubt that, wherever there is bulk of wash in Golden Gully but that it will pay to work, provided a good supply of water is brought on to the ground.

The deeper ground may eventually become troublesome, as was the case in the Glengyle workings, but there is plenty of shallow ground, or ground of moderate depth, for many years of sluicing. One favourable circumstance is that dump can be had in both directions, and the tailings from the first can be got rid of at several points where it may be considered advisable to commence sluicing on an extensive scale.

It may be remarked that limestone is usually not far distant along the south-eastern involved side of the auriferous area, and the solution and removal of this has caused much crush and movement in the adjoining parts of the wash deposit, so that it is now as much disturbed and confused as any that may be seen along Glengyle Gully, or in McCartney's Hill at Parapara.

The Slate River is the source whence it is intended to bring water on to the ground. The minimum supply is estimated at fifty Government heads. Plenty of pressure, with a comparatively short pipe-line, can be had, and altogether it seems highly probable that the scheme for working Golden Gully by hydraulic sluicing should prove a success, and be sufficiently remunerative to those undertaking the work of bringing in and applying the water.

Quartz Ranges.

This area has already been partly described. In the south-west part the ground held by West, Adams, and Fell, is to a large extent untouched. The ground towards the south-east side appears in places to be deep, there being indications of a fault along this side of the auriferous area. On the north-west side the ground shelves to shallow outcrops. Large stones are moderately plentiful in the wash, and the wash is throughout cemented rather tight, and will require some pressure to pull it down. It, however, appears to treat well after it has fallen. The gold is a fine sample of shotty or rough gold. I saw a piece of 9dwt., and pennyweight pieces are not rare.

The gold in the southern end of the area lies mainly on the bottom, but at places it is found 6ft. or 7ft. up in the wash. The middle area, held by Ziman and Co., does not show such deep faces of wash, and this lies mainly on the slopes of the south-east side of the depression or gully. In the lower part of this Graham's Spur shows a considerable area, over which there is a good depth of gravel, and over the lease generally gold-workings have been carried on at many points. Large stones occur in the wash here, but they are not so abundant as farther to the south-west. The wash is, however, at places even harder than in the south-west part. Ziman and Co.'s area is not quite so favourably situated for getting rid of tailings; though at the same time the conveniences for the disposal of these are ample. The gold here is as coarse as farther to the south-west.

The north-east end of the auriferous belt which is held by West, Adams, and Fell, is at first somewhat restricted as regards the width of the deposit, but towards the middle and northern part is decidedly the most promising part of the Quartz Ranges as a field for sluicing. The ground gives evidence of being generally gold-bearing, being riddled with shafts and in part driven out, where it can be reached from the brink of the deep ravine of Salisbury Creek. The wash here is finer and looser than that farther to the south-west, and consists more of quartz than in the other parts. The gold also appears to be more or less right through the wash, and as regards the getting

away of tailings, these can be shot into a ravine more than 500ft. deep, along which a considerable stream flows.

The water to work the auriferous deposits of the Quartz Ranges, it is intended shall be raised from Clark's River, in which, it is estimated, there is a minimum supply of forty Government heads. The race, it is said, will not exceed five miles in length, to bring it over the shoulder of Pine Ridge to the south-west end of the ground. From this it can be carried in an open race along the ridge to the south-east, so as to command with good pressure all parts of the Quartz Ranges.

I must now conclude, as the mail is closing. I have, &c.,

ALEX. McKAY,
Mining Geologist.

H. A. Gordon, Esq., F.G.S., Inspecting Engineer,
Mines Department, Wellington.

THE PROSPECTS OF FINDING WORKABLE COAL-SEAMS AT GORDON DOWNS, NELSON.

REPORT on, by ALEXANDER McKAY, F.G.S., Mining Geologist.

Mr. A. McKAY to the UNDER-SECRETARY of MINES.

SIR,— Wellington, 9th June, 1896.

As directed, I examined on the 18th October last the outcrops of coal exposed at the base of the northern slope of Gordon's Knob, Waimea County, Nelson, and have the honour to submit the following report on the same:—

REPORT.

The position of the coal outcrops at Gordon Downs is such that it is not likely the seams can be profitably worked in the meantime. The supply for local needs could scarcely keep a mine going, and the transit overland to the Town of Nelson would prove too costly in competition with local and sea-borne coals. Nor is it certain that a great quantity of coal can be won from the seams, outcrops of which show in connection with very disturbed strata on the side of the range just where that sinks to the rolling downs that strike along the base of the mountain in this part, and its continuation northward to the gorge of the Wai-iti. In one place only did I see an outcrop of coal. This had been opened out on, by a cut being made across the strike of the seams; but the works had so fallen in and obscured the seam that its thickness could not be determined. The coal-measures dip at an angle of 60° into the range to the eastward, and thus appear to—and in part do—pass under the older rocks of either the Maitai or the Te Anau series. The coal itself is apparently of high quality, being black and lustrous; but owing to the heavy pressure it has sustained, and the movement of the associated strata in near contact with the older rocks, it is tender in the extreme, and the face so far as exposed showed only culm.

Mr. N. D. Cochrane, Inspector of Mines for the district, visited this outcrop when it was in a condition that better showed the thickness and character of the seam or seams. He speaks of what he saw as follows: "The highest-up coal-seam on the left-hand branch of the small stream is exposed by a short-cut, and shows coal 5ft. 6in.; carbonaceous earthy parts, 2ft.; then coal, 2ft. 6in., lying at a high angle, say, 60°, and dipping to the north-east." . . . . "The coal itself is very friable, but is bituminous, and probably of excellent quality."

These coal outcrops and their associated strata are of Cretaceous or Cretaceo-tertiary age. There is here no evidence indicating their exact age; distinct evidence bearing on this question is to be found only on the Wairoa River, below the gorge, and in the Maitai Valley, near Nelson, in near connection with the area in which the Enner Glynn Coal-mine is situated.

The line of outcrop, though not seen, may be traced by indications at the surface to the point where it must cross the Wai-iti River, near Mr. Ellis's Home Station. More to the northward I could not find distinct indications of a continuation of the line of outcrop, the coal-measures either underlying the Miocene gravels or abutting against the older rocks, have in this direction so been cut off or terminated. In the opposite direction, I doubt not that the coal is continued across the valley of the Motueka, and along the same line into the area of the Big Bush, within which indications of coal are to be met with on the road to Top House.

The outcrop at Gordon Downs cannot be of importance, other than locally, as no great extent of coal is possible, but the same seams in their extension south-west may be found over a large area, and if of a bituminous character would be of national importance. I did not bring a sample of the coal, but do not think it is bituminous.

A. McKAY,
Mining Geologist.

The Under-Secretary, Mines Department, Wellington.

THE PROBABILITY OF FINDING COAL IN THE WAIROA GORGE, WAIMEA COUNTY, NELSON.

REPORT on, by ALEXANDER MCKAY, F.G.S., Mining Geogolist.

Mr. A. McKAY to the UNDER-SECRETARY of MINES.

SIR,— Wellington, 9th June, 1896.

On the 21st October, 1896, I examined the Wairoa Gorge for the purpose of determining the nature of the indications of coal said to occur there, and which were reported to the Department about the middle of 1894. Below I have the honour to report what the nature of these indications are.

REPORT.

At the mouth of the Wairoa Gorge, where the river leaves the hills to traverse the Waimea Plain to its junction with the Wai-iti, there is a development of soft brown sandstones and shaly beds, followed to the westward by more marly strata, containing concretions of cement stone, that are often crowded with a variety of fossils, chiefly marine shells. The fossiliferous higher beds of this series have always been considered as of Miocene age, and in some ways the correspondent of the shelly beds at the base of the Port Hills series, near the town of Nelson. The brown sandstone at the base of the series might, however, be of the age of the Jenkins's Hills coal-bearing series, and, before making the examinations about to be described, I naturally assumed that the discovery had been made in these younger strata.

On examining the banks of the river, no trace of recent prospecting could be discovered till the older rocks at the mouth of the gorge were reached. Making inquiries, I learned that the discovery of coal had been made at a point nearly half way through the gorge, and in a locality at which it was moderately certain no Cretaceo-tertiary coal-bearing rocks could be present. Calling on Mr. Silcox, on whose land the prospecting for coal had been carried on, he showed me what had been done. The so-called outcrops of coal are situated on the left bank of the river close to the water's edge, but at the time of my visit no coal-seam could be seen, nor was there any indication that such would be found. Throughout a given thickness of strata numerous carbonised plant remains were present, and these when of sufficient mass formed small nests of bright coal, or, where less in size and aggregated in greater numbers within a given space, they formed a coaly shale. I saw one or two bands of this description, but they continued for no distance exceeding a few feet, were not more than 6in. or 8in. thick, and were so impure that no part of them could be called coal. The formation belongs to the Upper Trias or Otapiri series, and consists of conglomerates that are more or less breccias—sandstones and sandy shales. The rocks specified recur as distinct strata again and again, as shown in the section along the bank of the river, and the whole forms a syncline, the sides of which dip N.W. and S.E. at an angle exceeding 45°. These rocks rest on the *Monotis salinaria* and *Mytilus problematicus* beds, and the beds in which these fossils are found have by Hochstetter and others been determined as of Triassic age. These and the overlying beds, arranged as a syncline, stretch along the outer range of hills from Richmond to Eighty-eight Valley, and at one time or another have been fully explored by me. In different parts of the hills to the south-west of the Wairoa Gorge the beds prospected for coal have been closely examined, not, indeed, with the view of finding coal, for that, indeed, does not exist, but for the purpose of collecting the fossil remains, of which this horizon is a great repository, both of marine and terrestrial forms. And yet, during the various examinations that at different times have been made, no trace of a coal-seam has been discovered. It is true that many ferns and rare plants have been collected from the beds, but these occur associated with marine organisms in such a way as, with the nature of the rocks in which they lie imbedded, teaches clearly that the conditions were not favourable for the formation of regular coal-seams.

At the time when these beds were being prospected for coal some samples were tested in Nelson, and, it is said, proved to be bituminous coal of excellent quality, containing not more than 4 per cent. of ash. There can be no doubt that the coal is, or the carbonised plant remains as above described are, of a bituminous character; this merely agreeing with the evidence as to the nature of the thin coal-deposits that occur in this formation in many places in the South Island. The Lias, Rhætic, and Trias formations have in all parts of New Zealand given signs of being coal-bearing, but no coal-mine has ever been worked in any of these formations.

ALEX. McKAY,
Mining Geologist.

The Under-Secretary of Mines, Wellington.

THE ENNER GLYNN COAL-MINE, AND THE COAL-BEARING AREA WITHIN BROOK STREET VALLEY, NEAR THE TOWN OF NELSON.

REPORT on, by ALEXANDER MCKAY, F.G.S., Mining Geologist.

Mr. A. McKAY to the UNDER-SECRETARY of MINES.

SIR,— June 12th, 1896.

Between the 15th October, 1895, and the end of the month I made different examinations of the area of coal-bearing rocks situated within the upper part of Brook Street Valley, Nelson, within which the Enner Glynn Coal-mine is being worked. I also made some examinations to the south-west, in the direction of Jenkins's Hill, and the extension of the same coal-measures; thence

along the north-western foot of the range between the Waimea Plain and Aniseed Valley, and in the opposite direction traced the same rocks into the Maitai Valley, about three miles above the Town of Nelson. The result of these different examinations I beg leave to report as follows:—

REPORT.

The existence of coal-bearing rocks at Jenkins's Hill, lying at the foot of the higher range, east of Bishopdale, has been known since an early period of the settlement of the Nelson District. At the date of Von Hochstetter's visit (August and September, 1859) the coal at Jenkins's Hill had been partly explored and worked. The works were visited by the learned German *savant*, and his account of the formation, and the position of the coal, is given in his work on New Zealand, English Edition, 1867, page 82, where he remarks as follows: "The first point I examined is Enner Glynn, four miles south of the City of Nelson, and about 200ft. above the level of the sea, close by the foot of the steep rising ranges of clay slate. Mr. Jenkins has the merit of having proved to the inhabitants of Nelson, by several trial shafts, that here they have coal in the immediate vicinity of the city. Through a tunnel driven about 250ft. in an easterly direction, into the slope of the mountain through sandstones, conglomerates, and shales, several brown-coal seams, from 3ft. to 6ft. thick, were cut, which, with a very steep inclination of 50° to 60°, dip towards the east, apparently under the older slate formation. The structure of the coal, however, indicates violent disturbance in the stratification of the layers in consequence of a pressure from the east, which has wholly bent and inverted the strata. In consequence of this pressure the coal has lost all consistency; it is specular-cleft, and crumbles in small very glossy scales or laminæ. Between this crushed coal there are isolated nests of a remarkable jet-black coal, with perfectly conchoidal fracture, and a bright gloss, presenting the appearance of Obsidian. In the ferruginous sandstone flanking the coal, indistinct petrifactions are found, fossil leaves of dicotyledon plants, similar to those at Drury." [Those as described in a footnote have been named by Professor Dr. Unger, as *Phyllites Nelsonianus*, *Ph. brosinoides*, *Ph. quercoides*, *Ph. eucalyptroides*, and *Ph. leguminosites*.]

The disturbed state of stratification and the crumbled appearance of the coal were not favourable to the mining enterprise, which was soon given up.

Ever since 1875, the date of my first visit, the works have been ruinous and fallen in; nor has any one since the visit of Hochstetter had equal opportunities for making at this place as accurate and correct examinations.

Within the past three years coal has been discovered within Brook Street Valley, and in a like position as respects its occurrence at the foot of the higher range to the eastward, and also as regards its high dip apparently under the older rocks to the east. This discovery has been made on Mr. Bryant's land, and that gentleman has granted the mining of the coal under lease to a company, the shares of which are held principally in Nelson. After some preliminary prospecting, an adit was driven, which cut the coal, on which subsequently a shaft was sunk 37ft. to reach the level of the adit. Below the level of the inner end of the adit, the coal has been followed to a depth of 200ft., and at the greatest depth it is said that a thickness of 10ft. of coal was found. Coal was traced in the shaft almost continuously, although at some places the seam was thin, and at a particular level not more than 1ft. in thickness. Mr. Cochrane, Inspector of Mines, under date of 7th February, 1895, gives the dip of the seams seen in the adit-drive as being south-east, at an angle of 70°, but the coal from this level to the bottom is found continuously in the shaft. This is but slightly inclined from the vertical, and consequently the coal itself in the lower levels must be nearly vertical. The adit-drive at its inner end followed the coal till the seam thinned to less than 1ft. in thickness; near the surface the thickness of the principal seam was 5ft. Below the adit-level for a considerable distance the thickness was not more than 3ft., but from 20ft. from the bottom of the shaft the thickness was 10ft., as reported to me by the manager at the date of my visit to the mine. The area of coal-bearing rocks has a length of about 20 chains south-west of Brook Street Valley Stream, and nowhere more than a breadth of 6 chains. Small though this be, the coal is wholly confined to a narrow strip along the south-east boundary of the area. This is due to the highly-tilted, almost vertical, position of the strata, the barren measures lying on the north-west side of the area. The depth to which the seam can reach is necessarily limited, though this may be greater than is likely to be reached by the means readily available, or than that at which it would pay to win the coal from. However this may be, it is more than probable that, as the tilted seam is followed to the south-west, the depth to which it will reach below the level of the present mine-mouth will become less and less, until finally through this cause the seam pinches out altogether. The same thing is likely to happen, and within a lesser distance, as the seam is followed to the north-east.

Even with the data at hand it were a difficult matter to estimate the quantity of coal contained in the area to the south-west of Brook Street Valley Creek. The seam is certain to be variable as regards its thickness; and there must be a considerable amount of coal in a crushed and culmy condition, which, as a hydrous coal, renders it unfit for general consumption; nor is there any warrant that the coal will be regular in thickness in the further and deeper parts to which it may reach as it is followed to the south-west; so that the contents of the seam may amount to anything between 10,000 and 40,000 tons, and the amount that can be worked, or may be worth winning, will certainly prove considerably less.

The coal-bearing area within Brook Street Valley, both to the south-west and north-east of the stream, does not exceed three-quarters of a mile in length; and the seam—the only workable seam, of coal—being nearly vertical and running along the south-east boundary of the area of coal-bearing rocks; and, further, being of uncertain depth, it follows that the quantity of coal is not to be estimated by the total of the area of the associated coal-bearing rocks. The mine being worked may continue to be worked with a comparatively limited output for many years, but it cannot afford

facilities for works on a large scale; and, consequently, though it may for a number of years yield profitably, the sum total of its product cannot be of vital importance to New Zealand.

It has been said that this area in Brook Street Valley is distinct from the coal-bearing area to the south-west formerly worked at Jenkins's Hill. Both lie along the north-western side of the same line of fault, and intermediate between the two there is a smaller area, also deeply involved, along the line of fault. The area within which Jenkins's Hill Mine is situated has a considerable extension in a south-west direction, and reaches as far as a point between Stoke and Richmond. But this south-western part has not been prospected. Further yet to the south-west the coal-measures may be traced as far as the road leading from Hope into the lower part of Aniseed Valley, and it is probable that the soft sandstone showing in the banks and bed of the river at the foot of the Wairoa Gorge are a continuation of the same series of rocks.

In the opposite north-east direction the line of fracture, to the existence of which the presence of coal is due, can be traced along the slope of the range on the east side of this middle part of Brook Street Valley to opposite Mr. Stuart's homestead, where coal-measures and traces of coal are again found. These indications can be traced across the saddle, lying about east of Stuart's farm, into the valley of a small tributary of the Maitai River that flows north-east to the main stream.

On the saddle and on the north-east slope, thence towards and into the Maitai watershed, though the rocks of the coal-bearing series are much indurated, they yet differ wholly from the underlying and nearly-contiguous slates and sandstones of the Maitai series; and from these they are so sufficiently distinct and different in character that no confusion should arise, even in the mind of a tyro in such matters, as to the limits of the two formations. This distinctness is further emphasized by the occurrence of fossils in the younger formation, which, of distinctly Tertiary species belonging to the genera *Struthiolaria*, *Turritella*, and *Cucullæa*, have in some astonishing manner been regarded by some, who pretend to a more than ordinary knowledge of geology and palæontology, as proofs of the Carboniferous age of the rocks in which they (these fossils) are found. It has been gravely asserted, in reports to the Enner Glynn Coal Prospecting Association or company, in the Press, and announced in lectures before the public, that these Brook Street Valley coal-measures belong to the Carboniferous period, and are the representatives of the true English coal-measures, resting on Devonian and Silurian rocks, and containing organic evidences of this their assumed age. If this be true, it is singular how, within a distance of less than three miles, Carboniferous fossils can be collected from the so-called Silurian rocks, or how dicotyledonous leaves, characteristic of Tertiary times, together with the fossils mentioned above, can be obtained from the rocks of the Enner Glynn coal-measures themselves. Yet more, Hochstetter, Haast, Hector, Hutton, Hacket, Davis, Cox, Park, and myself all agree as to the Tertiary or Cretaceo-tertiary age of the beds in question. The above proofs, and this unanimity of opinion as to the age of the beds, should be sufficient answer, and for ever place this matter of the age of the beds at rest and beyond controversy.

ALEX. McKAY,
Mining Geologist.

The Under-Secretary of Mines, Wellington.

A DEPOSIT OF CHROMATE OF IRON ON THE NORTH-WESTERN SLOPES OF MOUNT STARVEALL, WAIMEA COUNTY, NELSON.

REPORT on, by ALEXANDER McKAY, F.G.S., Mining Geologist.

Mr. A. McKAY to the UNDER-SECRETARY of MINES.

SIR,— 10th June, 1896.

By your direction I visited the outcrops of chromic iron situated between the Serpentine and Lea Rivers on the north-western slopes of Mount Starveall, and have the honour to report on the same as follows:—

REPORT.

The locality of the chromic outcrops was visited between the 26th and 28th October last. My guide was Mr. Busch, of Aniseed Valley, the discoverer of the different outcrops of ore which it was wished I should examine. The particular outcrops examined lie along both sides of the eastern mineral belt and partly within the watershed of the Serpentine River but mainly within that of the Lea River. The different outcrops of ore occur at heights varying from 2,550ft. to 3,100ft. above sea-level. The principal outcrop lies within the watershed of the Lea River, at a height of 2,650ft., and consists of three bunches or blocks of ore, the first two of which, nearly connected with each other, make a total length along the line of supposed lode of 14ft. In breadth the outcrop is from 5ft. to 6ft., and in depth it may measure as much as in length. There are no signs of the presence of a lode or lode-fissure in which the ore might extend in length and depth, the mass of chromic iron being enclosed in olivine rock, which, encasing it, show no signs of walls that usually indicate the existence of a true vein. While lesser masses and small nests of the ore can be found along a line equidistant from the slates and sandstones that bound the mineral belt on the east, yet this merely indicates a horizon at which the ore-nests are found in greater abundance than elsewhere in the olivine rocks.

About 150 yards south from the outcrop above described a third mass of ore is seen lying on the left bank of the creek flowing into the Lea River. This has the appearance of being a loose mass that has fallen away from the outcrop higher up the hill. These are the principal outcrops

and masses of ore; and it is certain that there are not more than 300 or 400 tons of ore showing there, or, indeed, to be collected from all the outcrops, large and small, that are in this neighbourhood. The mineral belt, consisting mainly of dark compact olivine rock, is here about half a mile wide, and the outcrops of chrome lying along its eastern border strike N.S., and seem to dip W. at an angle of 45°.

On the opposite western side of the belt there is a second and corresponding line of nests or bunches of chrome iron-ore. Among these, samples completely crystallized and of great purity, are to be obtained, but there are no masses of ore of good quality equal to those found along the eastern line. There is, however, a considerable development of olivine rock containing chromic iron disseminated through it, and forming of the whole from 10 per cent. to 20 per cent.; but this, at least, in the position in which it occurs would be quite useless as a commercial commodity, and it could not be concentrated at or near the locality of its occurrence.

As regards the richer ore, even did it occur in greater quantity than it does, the cost of transit to the Port of Nelson would be so great as to prevent its being worked to profit. It has been thought that an aërial tramway could be constructed to land the ore in the low grounds of Aniseed Valley, whence it could be carted to the Hope Railway-station; but, more than this, the ore would have to be carted from the mine on to the saddle where the mine end of the aërial tramway would be. This, though not more than half to three-quarters of a mile, would add considerably to the cost. But, referring back to the ore itself, the quantity in sight and presumably within reach, is, to my mind, insufficient to warrant the construction of the works that would be required to land it at the Railway-station or Port of Nelson.

ALEX. McKAY,
Mining Geologist.

The Under-Secretary of Mines, Wellington.

WILSON RIVER AND PRESERVATION INLET GOLDFIELD, FIORD COUNTY, OTAGO.

REPORT on, by ALEXANDER McKAY, F.G.S., Mining Geologist.

Mr. A. McKAY to the UNDER-SECRETARY of MINES.

SIR,— 4th July, 1896.

I have, as directed by you, examined the district of the south-west part of the Fiord County, Otago, embracing the goldfield of Wilson River and Preservation Inlet. This work was effected between the 3rd January and the 12th April, 1896, and the results of this examination are given in the report which I have the honour to submit herewith.

ALEX. McKAY.

REPORT.

Narrative.

I left Wellington on the 3rd January, by way of the west coast of the Middle Island, for Preservation Inlet, but, owing to the prevalence of excessively stormy weather, I was not landed at Cromarty till the 16th of the month. Here, again, owing to a continuance of the most excessive inclemency, practically no work could be done for the remainder of the month. Nor, with regard to the character of the weather, was the month of February in any respect an improvement on that which preceded it, and it was not till the 20th March that any improvement in the state of the weather took place. The rainfall in January, as determined at Puysegur Point Lighthouse, was 31·70in.; about an equal amount fell during February, while the first three weeks of March proved to the fully as stormy and wet as the two preceding months. Throughout, high winds prevailed, and at frequent intervals storms of extreme violence occurred, blowing either from the north-west or south-west. Boating on the waters of the inlets was thus rendered unsafe, and at one time it appeared as though the boating trips contemplated must be abandoned—at least, for the season. Work was therefore pushed in a north-east and east direction, over the country surrounding the head of the Wilson River and Kiwi Burn, and along the coast-line towards the mouth of Big River.

After leaving Cromarty the first camp was placed on the ridge dividing Kisbee Bay from the upper basin of the Wilson River; afterwards a camp was established at the north-western source of the Wilson River, and the water-divide between the Grey River and Kiwi Burn followed for several miles on to the granite belt. The weather being extremely unpropitious much time was lost, and such fine days as there were could only be employed in short trips, from which return was made to the principal camp. Had the state of the weather permitted it was intended to make a number of trips, lightly laden with special provisions, into the rugged granite country around the sources of the Kiwi and Princess Burns for the purpose of determining the limit of the granite belt in that direction, and ascertaining the nature of the rocks that to the north and north-west make contact with the granite; but this proved wholly impracticable, and work had, under many difficulties, to be continued in an easterly direction between the flanks of the granite mountains and the sea.

Therefore, from the western sources of the Wilson River the flanks of the granite mountains were followed to the Kiwi Burn, and the boundary-line determined between the granite and the gold-bearing Silurian rocks to the sea at the mouth of Kiwi Burn. Here for a time camp

was pitched on the coast-line, but, owing to the extreme inclemency of the weather, the advance camps pitched among the mountains could not be brought in, nor was any advance possible along the coast-line to the eastward. This work, embracing an examination of the head-waters of the Grey and Wilson Rivers, Coal and Gold Burns, to the western banks of Kiwi Burn, occupied till the 22nd February. From the mouth of the Kiwi it was intended to follow the coast-line to the mouth of Big River, but owing to bad weather this work could not be effected till the 7th March.

From the 8th March till the 22nd March was employed in an examination of the coastward region from the mouth of the Kiwi to the shores of Preservation Inlet, after which date, the weather improving, the examinations by boat were made in both Preservation and Chalky Inlets, which work was finished by the 8th April. The eastern side of Kisbee Bay from Cromarty to Longbeach was next examined, and, having determined to leave the district by the steamer "Invercargill," work was so arranged that I was able to leave by her on the 18th April, and I arrived at Wellington on the 22nd of that month.

Description of the District examined.

The district examined comprises that portion of Western Otago south of a line drawn from the West Cape, Fiord County, across the head of Edwardson Sound to a point east of Long Burn, where stands Houseroof Hill, and west of a line drawn thence to the sea at the mouth of Big River. Some parts of the district were examined with considerable care; others, the more inaccessible parts, could not be so examined, and the nature of the rocks had to be guessed at; yet in the distinctions attempted as between granite and mica-schist there is not much likelihood of error. The boundary-line between the two formations can be traced, with care, by the eye from the top of any of the higher mountains of the district, and thus was gained a general idea of the distribution of the granite and schist rocks. Afterwards, at several points along the line, examinations were made, which proving these surmises correct gave confidence in the determinations made over the whole line.

The great feature of the district is the presence of a wild and tumultuous assemblage of mountains, composed of granite and schist, into the far recesses of which long arms of the sea—Preservation and Chalky Inlets—penetrate and send off branch sounds in various directions. The south coast from Puysegur Point to the mouth of Big River presents between the granite mountains and the sea an area five to ten miles in breadth, which declines gradually, or in terrace-like steps, from 1,200ft. to within 200ft. of sea-level, the land, as a rule, terminating in a line of cliffs. Above the general level stands a line of rocky projections that have received the name of hummocks, but which in reality are hills of considerable size. These alone seem to break the general uniformity, except to the north, where around the sources of Sealers' Creeks (Nos. 1 and 2) the heights at the back of Long Beach, however viewed, appear as hills standing apart, and reaching a height of about 1,000ft. above sea-level.

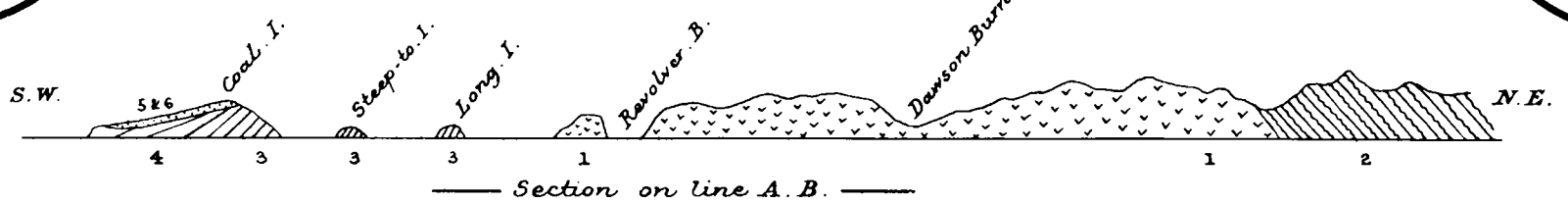
Though such may be the general appearance of this part of the district, the passage across it of the several small streams and lesser rivers have been the means of cutting deep gorges and cañon-like channels, or, in the case of the larger streams, broader valleys, the sides of which are sculptured into ridges and gullies that, covered as they universally are by a dense forest growth, form difficult country for getting about in. North of this the outer granite mountains, as seen from a distance, have smooth outlines, but, passing the first heights, the country is very rugged within the granite-belt, more especially around the sources of the Kiwi Burn and Cavendish River.

In the western part of the district, Preservation and Chalky Inlets penetrate what is at first hilly bush-clad country, rising often abruptly, but to no great elevations. Indeed, the belt of sloping table-land in the eastern part of the district is distinctly traceable over the western and north-western parts, though when the surface falls below the general average level it may be sculptured so as to present outlines that are sufficiently rugged and uninviting. Further towards the interior, on entering upon the granite belt, scenery of a different type presents itself: the middle and lower slopes of the mountains bordering on the Sounds are very precipitous, often vertical walls of rock rising to heights of from 1,000ft. to 1,500ft. These rock-faces are often bare of vegetation, but where a stunted forest growth can cling the lesser slopes are covered thickly with a variety of trees and shrubs which in favourable situations acquire the dimensions of forest-trees of considerable size. At heights approaching 2,300ft. above sea-level the trees become stunted and scrubby, and at the height mentioned grasses of various kinds begin, but above 3,000ft. the tops of the mountains are wholly devoid of vegetation. Towards the upper parts of Long Sound and Edwardson Sound, at the head of Chalky Inlet, the rocks are mica-schist, and form mountains that above 3,000ft. are bare of vegetation, and present quite different features to what appear within the granite region. Houseroof Hill, as the name of a schist mountain, exemplifies this.

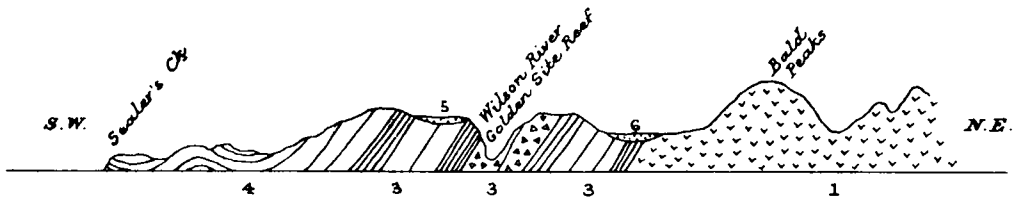
Preservation Inlet, being a port of call for the Union Steam Shipping Company's steamers when making the yearly excursion-trips to the sounds of the West Coast, is thus fairly well known to the pleasure-seeking or health-conserving portion of the travelling public. Yet there may be those into whose hands this will come who have not made the Sounds' trip, and to whom some further description of the two Sounds that principally concerns this report will be acceptable.

Preservation Inlet.

The main or western entrance to this lies between Gulches Head, on the northern side, and Coal Island, and is from two to two miles and a half wide. Gulches Head has an outer and an inner point. The outer is formed of granite, and at sea-level these granite rocks are continued out to sea, and form a series of dangerous reefs for some distance from the mainland. The inner headland is composed of conglomerates, sandstones, and shales; these rocks, though from their nature less able to resist the fury of the south-west gales that beat with terrible force on this part of the coast-line, nevertheless form high cliffs, but, at the same time, these waste at a comparatively rapid rate. On



Section on line A. B.



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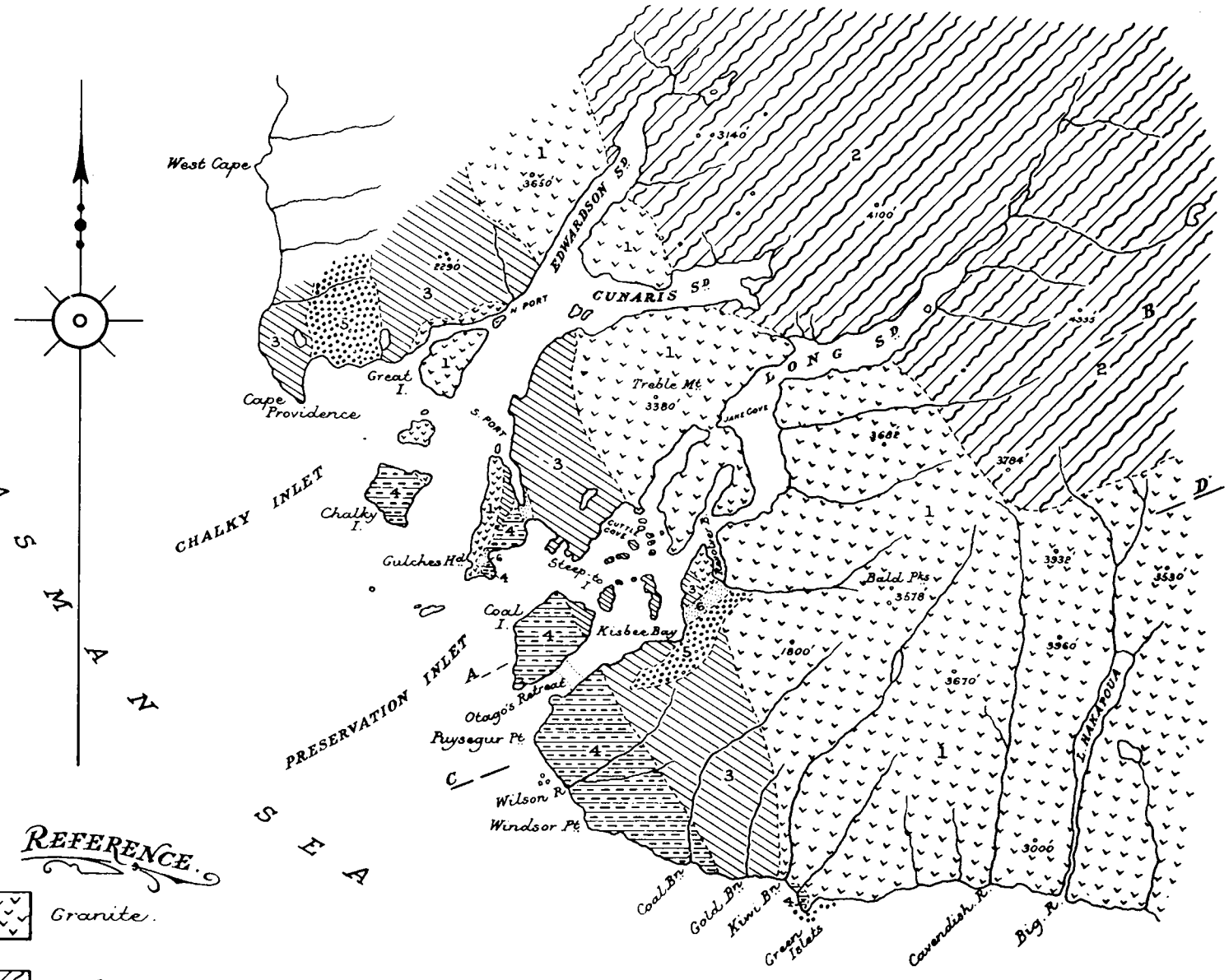

REFERENCE.

- ※ 1 — Granite.
- ※ 2 — Archæan Metamorphic.
- ※ 3 — Lower Silurian.
- 4 — Cretaceo-Tertiary. (Coal-bearing).
- ※ 5 — Post Pliocene. _ Glacier deposits.
- ※ 6 — Recent.

※ Gold-bearing Formations.

GEOLOGICAL SKETCH MAP — OF THE — WILSON RIVER - PRESERVATION INLET GOLD-FIELD.

By Alexr McKay. F.G.S. Mining Geologist.

SCALE OF MILES.

0 5 10 15

To illustrate Report dated August. 1896.

C.H. Pierard. del.

the opposite side of the entrance Coal Island presents a continuous line of cliffs of equal height, while inside the Heads the waters of the inlet expand to form the outer or lower basin, which has its greatest breadth between the Neck and the northern angle of Coal Island. From the Neck the shore-line trends south-east to Cavern Head, between which and Coal Island the waters of the inlet are reduced to half their width at the entrance. On the south-eastern side, Coal Island presents an unvarying line of cliffs, above which the interior parts of the island have comparatively smooth outlines, which, no doubt, as seen from a distance, is due to the dense forest growth with which it is covered. On the northern side the shore-line is varied by smooth sandy beaches at Price's Beach, the Neck, and Te Whara Beach, between which bold rocky promontories or stretches of high rocky coast intervene. Between the Neck and Gulches Head the country is broken into hills and valleys, and along the western side of the peninsula granite rocks form a series of rounded peaks that are parted from the eastern area, formed of slate and gold-bearing rocks, by the valley of Back Creek.

The Neck, so called, is an area of flat land, having a width east and west of not more than three-quarters of a mile, while to the north it stretches from the waters of Preservation Inlet to the head of South Port, the first southern arm of Chalky Inlet. This low tract is not more than 50ft. above sea-level, and, being formed by alluvial deposits of comparatively recent date, and having on it a good soil, it is densely covered with heavy forest. Clearly at no distant date in the past the Neck formed a connecting passage between the two inlets, at which time Gulches Head Peninsula formed an island, and one of a chain of islands extending right across the entrance of both inlets. On the eastern side the low grounds of the Neck are bounded by high cliffs that run from inlet to inlet; and, reaching from Chalky into Preservation Inlet at the point indicated, are there reflected to the south-east, and continue till they terminate at the north-west end of Te Whara Beach.

Te Whara Beach lies in front of a low saddle by which Cuttle Cove is reached, having Cavern Head and the associated hills on the right hand. In front of Te Whara Beach lies Te Whara, the island stronghold of a tribe of Maoris respecting which there are still traditions circulating among the miners of the district. Cavern Head itself is formed by a remarkably bold and outstanding point of rock which, being in the fairway of the incoming seas during south-west gales, resists the full force of these, and, as a consequence, is worn and weatherbeaten, seamed, and full of cavernous erosions, through which surges the tide in moderate weather, but over which and the lower part of the headland leap the giant seas during storm and more than ordinary gales.

Passing Cavern Head the second division of the inlet is entered upon, consisting of two areas, hardly distinct basins. That to the north-east stretches between the mainland and a series of islands that separate it, from that to the south and south-east. Cuttle Cove lies on the northern side of this northern part snugly sheltered behind the hills stretching north-east from Cavern Head. To the north-east Cuttle Cove Bay is separated from Isthmus Sound by a long, narrow ridge, ending in a number of islands that shut out the view of the entrance to Long Sound. Some of these islands are very picturesque, and thus forms the most scenic and romantic part of these inland waters.

To the south of Steep-to Island, Crayfish, Doughboy, and Long Islands lies Kisbee Bay and that part of the inlet inside of Cavern Head and Coal Island that forms the south-east area of the second expansion of its waters. This has connection with the outer sea by means of the narrow entrance between Coal Island and the mainland to the south. On the shore of Kisbee Bay stands the Township of Cromarty, which is situated on a limited area of flat alluvial ground between the lower course of the Grey River and the shore of the bay on which the township is located. The south-east shore of the inlet from Cromarty to Long Beach is bold and rocky—a steep slope, thickly bush-clad, rising to a height of 900ft. or 1,000ft. Behind Long Beach the cliff or steep slope is continued to Observation Point and Otago's Retreat where, narrowed between Coal Island and the mainland, the eastern entrance, lying between Coal Island and the northern shore of the mainland is approached from between Puysegur Point and the south-west extremity of Coal Island.

Immediately north of the Township of Cromarty lies a small cluster of very bold and precipitous mountains of slate and granite, which form the eastern side of the entrance to Long Sound. Between these mountains and Long Island is a comparatively narrow strip of water which, beyond the entrance to Long Sound, is continued north in Isthmus Sound to the foot of Treble Mountain, which, composed of granite, forms the highest land between Preservation and Chalky Inlets, south of the Cunaris Neck and Sound. Isthmus Sound maintains an uniform width of less than a mile, and in its upper part trends about north-north-east, and has between it and Jane Cove, an indentation on the western shore of Long Sound, a narrow neck of rugged broken country showing granite only. The whole of Isthmus Sound, except one or two islands to the left of the entrance to it, shows the presence of granite rock on its shores. Its shores are bold and precipitous, but not so high as those of Long Sound and the two sub-sounds that branch off from it—viz., Useless Bay and Revolver Bay.

Immediately on entering Long Sound high cliffs present themselves on the south-eastern side, with cliffs of lesser height on the north-western side. The narrowed entrance, about half a mile in width, leads into a sort of basin, from which Useless Bay extends to the north-north-east and Revolver Bay to the south-south-east. Useless Bay penetrates about two miles into and divides the peninsula area between Isthmus Sound and the lower part of Long Sound, and terminates surrounded by cliffs of granite. Revolver Bay penetrates nearly as far to the south, and its head receives the Grey River flowing along the west side of an alluvial flat formed by the infilling of the upper part of the bay by *débris* carried along the river-bed. Revolver Bay, and the rocky walls which inclose it, presents in the clearest manner the evidences of ice action, and it is evident that it was filled by a stream of ice that reached 900ft. to 1,000ft. above the present level of the water in the Sound.

East of the entrance to Useless Bay, Long Sound contracts to less than a quarter of a mile in width, and its sides become proportionately high and steep, sheer vertical walls of bare granite descending to water-level, and below that to the full depth of the Sound, which here ranges from thirty to forty fathoms. At Sandy Point the Sound has widened somewhat, and for seven miles, trending nearly north, has over this distance a width of a mile and a half. Sandy Point, at the mouth of the Dawson Burn, is the only beach to be met with in the main sound; but there are beachy shores at the head of Jane Cove and Last Cove, both on the west side of the Sound. Above Sandy Point the Sound trends nearly due north for six miles, and then, trending north-east, terminates after a further distance of twelve miles. To Last Cove, which lies opposite the head of Cunaris Sound, a branch of Chalky Inlet, the middle part of Long Sound is still within the granite region, and is hemmed in by very steep slopes and vertical precipices 800ft. to 1,000ft. in height.

On the west side the precipices are usually nearly vertical, and bare of vegetation growth of any kind, while on the eastern side, up to 1,500ft., there is a mixture of bush-clad steep slopes and bare crags of granite rock. Jane Cove lies in the upper western angle of the middle or northern reach of Long Sound, and is a snug shelter for boats at all times, and from winds from whatever direction; and Last Cove, though not in certain winds so easy of access, is equally secure for small craft. Here the granite ceases, and on this side of the Sound is followed by mica-schist, which thence continues to the head of the Sound. On the eastern side the junction between the granite and mica-schist is two miles higher up.

In that part in which the Sound has been scooped out of the granite-belt, the sides of the submerged valley are usually very precipitous, while the higher mountain-slopes are more moderate; but within the schist region the slopes from a moderate height above the water-level are less steep and more uniform to the tops of the mountains. This distinction can easily be made out from any point of vantage in the neighbourhood of Cuttle Cove, and by the trained eye such distinctions may be determined from Price's Beach and Gulches Head. Half a mile north-east of Last Cove a low portage not more than a mile in length leads into Cunaris Sound, or, rather, first into a tidal lagoon, and thence into this Sound. The portage between Te Whara Beach, at the Neck, and the upper part of South Port has been made available for the transporting of boats overland into Chalky Inlet, thus avoiding the dangerous passage that otherwise must be made in rounding Gulches Head and Balleny Reef.

Chalky Inlet.

This, inside Chalky Island has a width of two miles to two miles and a half for a distance of seven miles to the point where it divides into two arms—viz., Edwardson and Cunaris Sounds. Edwardson Sound is the direct continuation of the lower inlet, and the general trend of Chalky Inlet and Edwardson Sound is north-north-east, and thus this part of the whole is directly exposed to the southern swell from the ocean. South Port in part separates Gulches Head Peninsula from the larger peninsula area of Treble Mountain, and, trending nearly north and south, is well sheltered from the prevailing south-west winds, and in part also from north-westers. The Cunaris Sound, six miles higher up the same or eastern side of the inlet, trends nearly east and west, and opens out into the main sheet of water with a considerable width—nearly two miles. The coast-line between Gulches Head and the entrance to South Port is bold and, in some parts, extremely rugged, and on the western side of South Port the hills, thickly bush-clad, are steep, but not markedly precipitous. On the opposite or eastern side of South Port the slopes are moderate, and a certain breadth of terrace-land covered with heavy forest extends along this side. Outside of South Port the eastern shore of the inlet again is precipitous, and very steep slopes or high cliffs continue on this side too, and on both sides of the Cunaris Sound to its upper part, where are some limited areas of more gentle slopes or flat land. The north-western shore of the inlet from North Port, and both sides of Edwardson Sound, as they are followed inland, become higher and bolder till, from the steep rugged height of the Kakapo Range, granite cliffs descend to the level of the water, and, even in the schist country at the head of Edwardson Sound, the same general character prevails.

The block of country extending between Edwardson Sound and West Cape on the outer coast-line from heights of 3,500ft. gradually declines towards the south-west and appears comparatively smooth in outline. This part of the country was not examined, and the nature of the rocks can only be inferred from what was learned respecting them at North Port and along the shores of Edwardson Sound, and by a trip along the shore between Landing Bay and Great Island. It is probable, however, that the lower grounds in this part, up to 700ft. or 800ft. above the sea, carry over the structural rocks a covering of glacier detritus, probably rearranged by the action of the sea or running water, this inference being rendered highly probable by the existence of such deposits over considerable areas lying more to the south-east, over which the balance of the evidence goes to show that the sea, subsequent to the retreat of the glaciers that formed or at one time filled the sounds, has reached levels that are now 750ft. above its present level. Mr. Linck was engaged for a week in making the necessary examinations along the shores of Chalky Inlet, South Port, North Port, Cunaris, and Edwardson Sounds, and his report on this part of the district will appear as an appendix to this.

Geology.

General Sketch.

The main body of granite in the district reaches the coast-line between Kiwi Burn and the Ana River, east of Big River, and stretches inland north-east beyond the boundary of the district here being described. From this, in a north-west direction, a belt of granite of the same character extends across Long Sound, between the entrance thereto and Last Cove, and, occupying the intervening country between Preservation and Chalky Inlets, appears in the Lump between Cunaris and Edwardson Sounds, on the north-western shores of which it is met with between North Port and a point within three miles of the head of Edwardson Sound.

To the north-east of this north-west extension of the granite lies an area of highly-metamorphic schist, the age relation of which to the granite is difficult to determine. On its south-western side the granite is flanked by Lower Silurian strata more or less metamorphic, the strata in nearer conjunction with the granite being completely metamorphosed, while the middle and higher parts of the series are less altered. In the higher beds the change has not been sufficient to obliterate the organic remains (*graptolites* mainly), which, at Long Beach and along the upper part of Sailors' Creek, can in places be collected in abundance. These Silurian rocks in the eastern part of the district are much shattered and invaded by veins of granite, which, however, are different in character from the great mass of the granite lying to the north and east. Quartz lodes are of frequent occurrence in this formation, and some of these contain rich shoots or pockets of gold-bearing stone. Lodes of pyrites, and reefs carrying a mixture of iron, galena, copper, and zinc ores that contain both gold and silver, are found with the granite veins that cut the lower part of this formation, as well as in the granite that, lying further inland, underlies this formation.

Cretaceous or Cretaceo-tertiary coal-bearing rocks stretch along the coast-line from Green Islets to the shores of Preservation Inlet, and in this part the formation has a maximum breadth of four miles and a half. It also stretches from Observation Point to Puysegur Point, and covers the whole of Coal Island except a small part of the north-eastern end. The same rocks are present on the Gulches Head Peninsula, where they are in contact with both Silurian slates and granite; they form almost the whole of Chalky Island, but it is doubtful whether they appear on the mainland between North Port and Cape Providence.

Glacier *débris*, for the most part reassorted by the action of the sea or running water, are found over the country between Wilson River and the eastern shores of Preservation Inlet, over the whole of Coal Island, part of Steep-to Island, some of the high lands at the back of Te Whara Beach, and between Red Head and Gulches Head, extending through the peninsula to Price's Beach. Generally these deposits may be found over the district towards the sea at heights below 1,000ft. above sea-level.

TABLE OF FORMATIONS.

I. Recent.
  (*a.*) Raised beaches, river-alluvia, &c.

II. Pleistocene or Newer Pliocene.
  (*a.*) Glacier-drifts usually reassorted by the action of the sea.

III. Cretaceo-tertiary, including the coal-bearing series.
  (*a.*) Limestones, marly clays, and soft sandstones.
  (*b.*) Shales, sandstones, and grits.
  (*c.*) Coarse breccia conglomerate.

IV. Silurian.
  (*a.*) Sandstones and graphitic shales, or mudstones, cherts, carbons, slate, and mica-schist.

V. Mica-schist.
  (*a.*) Highly-metamorphic schists north-east of the granite belt.

VI. Granite.

I.—RECENT.

(a.) Recent Raised Beaches.—These are of limited extent, either on the ocean coast-line or along the shores of the shallower waters within the inlets. The flat upon which the Township of Cromarty has been surveyed may be regarded as coming under this head, as, also, the low alluvial lands between South Port and Preservation Inlet, and a strip of beach under the high terrace at Gulches Head. There are also gravel-terraces along the east side of South Port which have to be considered or mentioned under this head. None of these alluvial littoral deposits already mentioned are markedly gold-bearing, except it may be that at Price's Beach, Gulches Head, and even there it is only at the north-east end of the beach that payable gold has been found. At the mouth of Moonlight Creek, on the north-east point of Coal Island, there is a raised beach, only a few feet above the level of high-water mark, which from time to time has been occupied by a varying—sometimes a considerable—number of miners, to whom it has yielded variously but sometimes rich patches of gold. The gold has evidently been derived from the glacier-drifts, both reassorted and as originally deposited on the higher levels of the island, and from a cemented, waterworn gravel that appears on this part of the island, but which is doubtfully to be referred to as deposit by glaciers. It may be of greater age, yet not belonging to the conglomerates and breccia conglomerates that lie at the base of the coal-measures. The sea has encroached on and cut away part of these cemented gravels, till they now present a cliff-face to the shore-line some 40ft. or 50ft. in height. Moonlight Creek has also carried to the shore-line much *débris*, which has been reassorted by wave-action. A process of concentration thus going on, the gravels of the raised beach have acquired gold sufficient to make them payable for working. The gold in this deposit is both coarse and fine. The fine gold is fairly evenly distributed, and rather too widely so for profitable working of the deposit; but at wide and somewhat uncertain intervals larger pieces of gold are found, sometimes to a value of £12 or £14 in one piece, and the chance of finding such a piece of gold still retains one or two parties of miners on the ground. The area of ground at this place is not extensive, but it may yet for some time afford untouched ground to the one or two parties, usually of two, who are on the ground.

On the other side of the narrow strait that separates Coal Island from Steep-to Island there is on the latter a raised beach at the head of a little cove which, now worked out, yielded a considerable amount of gold. At the opposite or northern end of Steep-to Island a similar but

larger area of raised beach lies between the higher grounds and the shore. This, over less than an acre of extent, was worked, and proved remarkably rich in gold. A total of several hundred ounces of gold was taken from this ground, but statements as to the actual amount vary so much that the value obtained may be put down at any sum between £800 and £2,000; but, whatever the amount may have been, this little patch is regarded as having been very rich, and, the gold being easily obtained, one of the best-paying patches on the goldfield. After careful examination of the ground there seemed to be no other source for the gold than the rocks on which the beach-deposit rested and the similar or same rocks that form this extreme part of the island. On the top of the ridge, immediately opposite the rich ground on the beach, there is a deposit of gravel, but this is subangular, and seemingly a cemented slope-deposit from the hill that rises to a higher level to the southward. The Silurian rocks at this point contain bunches of quartz in sandstones and graphitic slates and from a flat-lying patch of such quartz, rich gold-bearing specimens were obtained, which led to a considerable amount of prospecting for defined reefs which were supposed to exist in the spur. Such prospecting did not prove successful, and the works have been abandoned.

At Long Beach gold-bearing specimens of quartz are frequently picked up upon the strand, the finding of which led to the tracing of similar specimens along the bed of the creek and the discovery of the Morning Star line of reef. Within the crescent-shaped area between the rocky points at the two ends of the beach there is a probability of workable gold-bearing deposits, but the ground in the middle part will probably prove too deep unless rich gold should chance to be found. Quite close to the beach, and thence extending south to the foot of the steep part of the range, the material showing at the surface is slope-deposit from the range at the back, and therefore it is likely that any gold found in this will prove to be specimen gold liberated from the reefs on the range, and, as a consequence of the deposit not being concentrated or assorted, such gold will be erratic in the mode of its occurrence, and possibly not payable to work; but it may be different with respect to the gravels of a former beach which may underlie these.

At the mouths of Sealers' Creeks Nos. 1 and 2, sand-dunes penetrate inland up the valleys of these creeks for a short distance, but there are no signs of gravel-deposits, and there does not seem to have ever been any gold-mining in the lower valleys of these creeks. Towards its mouth Wilson River is sluggish, and the sands at its mouth are not reported gold-bearing. At Gates' some gold-mining has formerly been carried on in the gravels of the creeks entering at the two angles of the little bay there formed. No workings are now to be seen at the mouths of the Coal Burn or Gold Burn, though gold is known to be present in the sands of the beach at and near the mouth of the Gold Burn. The mouth of Kiwi Burn is not much more than half a mile distant from the Gold Burn, and at this place a party of three are working for gold in the beach-sands, and are netting, so they aver, fair returns. Gold has also been found, and has been worked, by the same party at Green Islets, and it also occurs on the beaches farther to the eastward.

(b.) River-alluvia.—So far as could be gathered, Kiwi Burn has not been worked for gold, but a short distance from its mouth the Silurian slates that occur on the western side of its valley cease, and the further course of the stream is wholly through granite.

Gold Burn, why so called is uncertain, except on the assumption that the beach-sands at its mouth are auriferous. A short distance inland from the beach this stream flows through an impassable gorge, beyond which it breaks up into a number of branches, and takes its rise from the southern margin of the granite area. The Coal Burn, on the other hand, is passable through its gorge, in which some gold-workings were about two miles and a half from the beach. Near the southern edge of the granite country the gorge terminates, and beyond this point, towards the sources of its several branches, though there are evidences of prospecting having been carried on at several places, such works clearly indicate that the search for gold was unsuccessful. At one place a hole had been sunk on the point of a low spur to a depth of 4ft. to 5ft. in decomposed granite under the belief that the disintegrated granite was an alluvial deposit. It may be here mentioned that along the northern edge of the slate-belt, and over the granite area within the watersheds of the streams mentioned, there is hardly any wash in the creeks, and none whatever on the higher grounds, the granite materials breaking up usually fine enough to be carried forward to the coastward region in times of flood.

Wilson River is a stream of greater volume than either the Coal Burn or the Gold Burn. It takes its rise by several branches from the granite mountains lying between the source of the Grey River falling into Revolver Bay and the upper part of Kiwi Burn. The various source-streams flow across a lower-lying tract, mainly over granite, and converge to junction as one stream a little above the upper end of the gorge. The upper or granite area of its watershed, though prospected, has not afforded payable gold. The boundary between the slate and the granite is at least a mile to half a mile above the upper end of the gorge; yet, although the rocks belong to the same formation as that seen at Golden Site Claim, above Golden Site Claim no recent gravels of any account are formed, and below the Golden Site, for two miles, or to the foot of the gorge, gravels of any kind are confined to the moving shingle of the bed of the stream. Near the foot of the gorge there are one or two patches of gravel at a level above the action of the stream. But it is from the foot of this gorge down stream that any considerable deposits of auriferous gravels occur. These are found on both banks of the river at levels up to 60ft. or 70ft. above the bed of the stream, and are ordinary moderately-fine or very coarse bouldery river-gravels, containing examples of all the rocks of the watershed above the point where they occur. The gold occurs usually not far from the bank of the river, the gravels, lying along the immediate base of the hill-slopes, consisting mainly of higher flood deposit and slope material unconcentrated, which has simply gravitated from the heights that bound the river valley. Below the point where the road from the landing at Otago's Retreat reaches the river its valley still retains the character of a deep narrow valley, in which the areas of alluvial deposit are small, and alternately first on the one and then on the other bank of the

stream. A considerable amount of mining has been carried on in these deposits, but gradually the payable parts are becoming worked out, and the miners, as they work out the claims held by them, are at a loss to find fresh ground that will pay, and thus their number on Wilson River is gradually diminishing. The bed of Wilson River, it is admitted by the miners, is rich in gold, but, owing to the prevalence of floods, the working of it is very costly, and now few care to make the attempt. The gravels of the river are payable to work for gold only below the Golden Site Claim, and it is clear that the gold in that part has its immediate source from the Silurian rocks that form the gorge. Half a mile below the Golden Site Claim the tops of the plateau-like hills on each side of the valley show the presence of well-washed gravels containing gold, the destruction of which over the intervening space must have yielded gold to the gravels of the river; also the grits and conglomerates at the base of the coal-bearing series have proved, probably, a factor in the enrichment of the gravels along the lower part of the river valley. The conditions are not favourable for the development of hydraulic sluicing, there being neither material to operate upon on a large scale nor ready facilities in the way of water-supply for doing so.

Macnamara's Creek rises in the *pakihi* tableland lying between the lower valley of the Grey and the most westerly branch of the Wilson River. Below the tram-line and the road from Otago's Retreat to the Wilson River it has been at places worked for gold, but at the present time no one is at work within the watershed. In the upper part of Sealers' Creek No. 1 a relatively considerable amount of alluvial mining has been carried on, but the auriferous gravels are now poor or exhausted. The gold here, as in Macnamara's Creek, evidently has been derived from at least two sources—viz., the auriferous slates of Silurian age and the high-level glacier-drifts that have overspread this part of the country up to heights of 900ft. above sea-level.

II.—Pleistocene or Newer Pliocene.

(a.) Glacier Drifts usually reassorted by the Action of the Sea.—These rocks are spread over the area between the Wilson River to the east and the Grey Valley and eastern shore of Preservation Inlet to the north-west, and from a mile north-west of the Tram Line from Cromarty to Wilson River extend, in patches more or less connected, to the sea between the mouth of Sailors' Creek and the narrows between Coal Island and the mainland. On Coal Island they form fully three-quarters of the area of the surface-rock, and are also largely developed at Gulches Head Peninsula, and to a lesser extent between Te Whara Beach, the Neck, and South Port. Over the long, gentle coast-ward slope from Treble Mountain they are in part developed to heights corresponding to those at which they are found on the eastern side of the inlet, while inland of Landing Bay, near Cape Providence, their presence has been reported, and it is probable that they attain to somewhat similar heights to the north of Chalky Inlet to those reached between Cromarty and Wilson River. The only patch of gravel to the east of Wilson River, that occurring at a high level may or should be considered under this head, lies opposite Dunedin Flat and between the Wilson River and the upper part of the Coal Burn Gorge. No workings have been carried on in these beds.

On the opposite side of the Wilson River Valley, at a height of 800ft. above the sea, well-rolled gravel forms the surface of Dunedin Flat, and in these several holes and paddocks have been put down. Gold was obtained, but the results do not appear to have been sufficient as the ground has not since been worked. These gravels give evidence of the action of the sea, and this is the highest altitude to which, subsequent to the maximum development of the glaciers flowing west and south, the action of the sea has been distinctly traced. On the height of land between the gorge of the Wilson River at the Golden Site Claim and the shores of Preservation Inlet at Cromarty, glacier drifts reach a height of 950ft., but on the northern face of this ridge rearranged glacier-drifts do not appear higher than 755ft. to 800ft., but below these levels the evidences of the action of the sea are abundant to the present sea-level.

From above the bend in the course of the Grey River the northern slope of the ridge formerly indicated is deeply covered with glacier *débris*, so that the Silurian slates and sandstones are completely hidden from view except in the channels of some of the more abrupt creeks descending to the Grey. At places the glacier drifts appear as deposited, but usually the upper part has been modified, at the higher levels but slightly, but in the middle and lower parts of the slope the material acted upon has been separated into coarse bouldery-wash and beds of finer sand. Below these reassorted drifts there is usually an unascertained thickness of unmodified glacier deposits, which is readily distinguished from the former by the angular character of the material and the presence of clayey material giving this lower deposit the appearance of *till*. At several places these beds have been prospected, and at one place an attempt has been made to work them; but after a time the work was abandoned on account of the low returns and the inability of the miners to reach the bottom of the deposit, it being thought that could the bed-rock be reached richer deposits would be found. This might have been so where the upper reassorted drifts rested on the bed-rock; but, as might have been foreseen, in trying to bottom the raw glacier-drifts, scarcely better prospects could be expected.

Over the greater part of the sloping table-land around the source of Sealers' Creek No. 1 glacier-drifts are or have been present, and by the cutting-down of the upper valley of the stream through the glacier-drifts, and deeply into the underlying Silurian rock, a mixed gravel has resulted, which for a time proved payable to work for gold. The richer parts of this have now been exhausted, and at the present time there is very little alluvial mining being done at Sealers'. Gold-bearing quartz reefs crop out in the bed of the creek at Langley's claim, and these are being prospected to the neglect of alluvial mining.

Between the landing at Otago's Retreat and the Puysegur Point Lighthouse there appears on the flat-topped spurs on each side of the road a very coarse but well-rounded gravel, and a small creek cutting through this has its bed choked with granite boulders of large size. This is therefore

a glacier deposit, first reassorted by the sea and afterwards cut through by the creek, so that the shingle in the creek is much concentrated, and, being auriferous, has to a limited extent been worked for gold. The great abundance of large granite boulders in the channel of the creek and in the terraces, more perhaps than the lack of gold, prevented the profitable working of these deposits.

On Coal Island the highest part is below the level to which the sea reached on the ridge between Cromarty and the gorge of the Wilson River. Four-fifths of the island is covered by morainic deposit; and the upper part of this, it is evident, must have been modified and the material rearranged by the action of the sea, which, as the land rose, left it, from the greatest height towards the eastern end, a gradual slope to the sea. Across this slope, creeks made their way and gradually cut into the reassorted part of the morainic deposits, and into the glacier material that underlay, and finally into the coal-rocks or the Silurian rocks themselves. In this way, and due to the concentrating process that would naturally take place, the alluvial deposits along the valleys of the different creeks on Coal Island came to be so enriched with gold as to pay for working, while the source of the gold, the morainic drifts, are themselves too poor in gold to pay. As a consequence, most of the gold-workings on Coal Island are situated along the bottom or on the sides of the valleys of the different creeks. On the Cuttle Cove side of the inlet there are no glacier deposits north-east of Cavern Head.

Between Te Whara Beach and the Neck are coarse gravels, with large granite boulders, that are evidently reconstructed glacier material. Close to the Neck these, mingled with angular gravels locally derived, fill deep gulches in the shore-cliffs, and at places cap the cliffs themselves. At the foot of the cliffs the coarse bouldery-wash on the beach, on being prospected, proved payably gold-bearing, and for the past twelve months three or four parties have been engaged working these gravels and the gold derived from them now mingled with the more modern deposits on the beach.

The ridge to the west of Glennie's Creek and east of the low ground of the Neck is capped by, and carries on its eastern slope, a thickness of coarse bouldery-wash, in which occur many large and more or less rounded granite boulders. No such wash appears on the Neck, or on the terraces or range-slopes on each side of South Port. At Price's Beach and Gulches Head there is a very considerable extent of these beds, having an area of about three-quarters of a mile square. The higher part of these beds have, as on Coal Island and elsewhere, been reassorted by the action of the sea. At the northern end of Price's Beach these beds are being worked for gold, and the workings there show the distinctiveness of the lower purely glacier deposit from the upper modified and reassorted gravels. The auriferous deposits at this place form the subject of a special report, which, following this, may be referred to for more particular information respecting these beds, the manner of their formation, and their source. No examination of these beds was made in the district north and west of Chalky Inlet.

Somewhat surprising is the absence of morainic material over hill-slopes of the north and north-west side of Preservation Inlet, more especially considering the thick covering of such material that appears on the opposite side of the inlet, and the evidences that appear that the northern side did not escape the smoothing and grinding action of a large body of ice making its way southward to lower levels. During its maximum development the surface of the glacier must have been at least 1,100ft. or 1,200ft. higher than the sea-level at the present time. Passing from the upper part of Long Sound, a part of it passed by way of Jane Cove into Isthmus Sound, and only the higher part of the ranges between that and the lower part of Long Sound would be above the level of the ice. Nearly opposite, on the eastern side of the ice stream, a large branch separated from the main body about where now the Dawson Burn falls into the Sound. This followed the valley of the left branch of Dawson Burn, and, by a low saddle at its source, passed into the valley of the Grey River, which it followed for about a mile and a half, and then, due to the pressure of another large body of ice coming from the north, and passing south through Revolver Bay, the Dawson Burn Stream took a course more to the eastward; and to this is due the vast accumulation of morainic matter that lies on the northern slope of the ridge between Kisbee Bay and the gorge of Wilson River.

The stream of ice from the main body of the glacier, which, passing along Revolver Bay, coalesced with that in the valley of the Grey River, was deflected so as to pass over the site of Cromarty at the head of Kisbee Bay, and this was joined by a second stream coming from the principal glacier and passing between the two hills at the back of Cromarty to make junction with the north-western side of that from Revolver Bay. These and the main body of the glacier, on entering the middle basin of Preservation Inlet, tended again to unite into one stream, and, overflowing all the islands in this part, swept over Coal Island and the mainland to the eastward as far as Sealers' Creek No. 1 and Puysegur Point; and on the northern side of the entrance the glacier deposits at Price's Beach and Gulches Head may also be referred in part to the action of this great stream of ice.

The glacier deposits at Gulches Head may have been supplemented by material carried by ice from the direction of Chalky Inlet, through South Port and across the Neck, thus forming a lateral supplement to the great body of ice progressing seaward from Long Sound and the inner basin of Preservation Inlet. This supposition is supported by the evidence afforded by a greater abundance of Silurian slate and sandstone in the *débris* at Price's Beach and Gulches Head, and the fact that such rocks lie on both sides of South Port and extend along the south-east side of Chalky Inlet to the entrance to Cunaris Sound, and that it would be this south-east margin of the Chalky Inlet glacier that would leave the main body by way of South Port to join that in Preservation Inlet.

III—.Cretaceo-tertiary, including the Coal-bearing Series.

(*a.*) *Limestones, Marly Shales, and Soft Sandstone;* (*b.*) *Shales, Sandstones, and Grits, with Coal-seams.*—The higher of these beds, the (*a*), in the eastern part of the district, show only at Gates's, a small harbour on the coast-line, between the Coal Burn and the mouth of the Wilson River, and

at Green Islets. The divisions (*a*) and (*b*) are at Green Islets of lesser thickness than in the western part. At Green Islets light-coloured or bluish marly strata form the highest member of the series. These rest on sandstones that in turn repose on the lowest member (*c*) (coarse breccia conglomerates), that at Green Islets form the more conspicuous development of the Cretaceo-tertiary series. At Gates's, the higher beds (*a*) and (*b*) do not exceed 300ft. to 400ft. in thickness, and the highest beds (*a*) form chalky limestones on the eastern headland; (*b*) are exposed in the middle and lower parts of the hill and cliff-face, the horizon of the coal being at the water-level. The beds (*b*), containing indications of coal but no actual coal-seams, extend east to beyond the mouth of the Coal Burn. Near the mouth of the Coal Burn the beds, a short distance above the coal horizon, consist of soft sandstones and shales, or marly shales, containing concretions often fossiliferous. Some of these fossiliferous concretions contain examples of a species of *Ostrea* of great size. The beds as seen at Gates's are nearly horizontal in position on the Coal Burn; they are inclined at high angles and dip to the south.

The calcareous higher beds are not again met with east of Preservation Inlet, but the beds (*b*), resting on (*c*), have a very considerable development between Gates's and the lower valley of the Wilson River, and thence across Macnamara Creek and Sealers' Creeks No. 2 and No. 1 to the shores of the inlet and the open coast-line between Puysegur Point and Coal Island. The section of these beds which may be studied along both banks of Sealers' No. 2 shows from the base of the series at first a dip at moderate angles to the west, which, seaward of where the track first crosses the creek, changes to the eastward, and thus a syncline is formed. This is followed by a roll in the beds which again changes the dip, and thus an anticline is formed, which arrangement of the strata again brings the coal-bearing horizon to the surface at a point about two-thirds down the valley of Sealers' Creek. A coal-seam showing a workable thickness of the mineral is said to have been found on the left bank of Sealers' Creek, on the south-west slope of the anticline indicated, but this could not be rediscovered, and consequently it is mentioned here from report only. Lower down the creek and at its mouth the dip is again reversed, and indications of coal—but no actual coal-seams—are met with on the coast-line. Between Puysegur Point and the landing at Otago's Retreat the arrangement of the strata is similar to what has been just described, the lower south-western dip continuing till the beds (*b*) are seen resting on the breccia conglomerates of Observation Point.

In the central anticline, the dips on the side of which are at low angles, coal-seams appear in the sea-cliffs outside the eastern entrance to the inlet. The coal is very irregular as regards thickness and apparent continuity, and is associated with considerable bodies of iron-ore, carbonate of iron, usually oxidized at the surface. At the entrance to the inlet, on the eastern headland, a seam of coal was discovered many years ago, and a drive was put in following the coal to the eastward; but these works have been long since abandoned, and, the locality being difficult of access at certain states of the tide, and the works having fallen in, no examination was made.

On Coal Island the section is everywhere practically the same as that which may be examined on the mainland. On the northern side of the island the breccia conglomerates interposed between the lower of these beds (*b*) and the slates are reduced to an inconsiderable thickness. At Gulches Head the coal series is well exposed along the shore between the inner promontory and the west side of the low grounds of the Neck. The great bulk of Chalky Island is formed of the higher beds of the series, but there being no opportunity of landing on this no examinations were made. At Gulches Head a seam of coal is exposed in the face of the cliff of the inner promontory at a height of 240ft. above the level of the sea. The thickness of the seam where exposed is about 3ft., and the coal appears a brown coal of good quality. Samples of this were collected, of which an analysis has since been made in the Colonial Laboratory. This is given below:—

"*Analysis.*

"No. 3748 (2).—Coal from Gulches Head, Preservation Inlet—Brown Coal:—

Fixed carbon	46·26
Hydro-carbon	32·88
Water	14·26
Ash	6·60
	100·0

Evaporative power, 6·00lb.

A hard coherent coal of laminated structure and lustrous appearance, yielding a non-coherent coke and an ash of pale-red or buff colour.—William Skey, Analyst."

From the configuration of the hill in which this seam lies, the dip of the strata, &c., it is improbable that this seam extends over any very considerable area; certainly its extent must be limited to not more than half a mile square.

Another sample was taken from near the shore of the inlet about two miles further to the north-east from a leasehold held by J. Wilde, &c. This, on analysis, gave the following results:—

"*Analysis.*

"No. 3748 (1):—

Fixed carbon	52.89
Hydro-carbon	38·47
Water	6·41
Ash	2·23
	100·000

Evaporative power, 6·80lb."

No well-defined seam was indicated at the place whence sample No. 1 was taken, but surrounding the locality there is a considerable area of coal-bearing rocks, and within this seams of greater regularity may occur.

(*c.*) *Coarse Breccia conglomerates.*—These beds have a large development in the district, and may be also are of some importance as gold-producing to the more recent alluviums of the river and creek valleys and the littoral sands of the sea-coast. Between Green Islets and the mouth of the Kiwi Burn, these beds form high cliffs on the coast-line, which renders travelling this part, except in fine weather and at low tide, difficult to most, and to some persons impossible. Granite is the prevailing rock constituting these breccia conglomerates on this part of the coast-line as far to the westward as Gates's and the ridge between that place and the lower Wilson River. East of the Kiwi mouth, the coarser beds are interstratified with shales and gritty sandstones, containing coarse plant-impressions and thin streaks of coal. At the base of the series is a remarkable formation of what appears as a brecciated granite, which naturally seems at first sight to belong to the granite development upon which it rests. But more careful investigation showed that it in reality consisted of granite material, which had been broken up by the action of the weather and gravitated down a steep slope, thus accumulating as a comparatively thick but local deposit at the foot of the height whence it was derived. All the fragments are small, showing that the granite must have decomposed sufficiently *in situ*, so as to allow of it being easily broken up into fields of coarse granite sand, prior to this accumulating in its present position at the base of the Cretaceo-tertiary series and its being again recemented into a hard rock. This peculiar rock was not observed at any other place than on the shore-line immediately east of the mouth of the Kiwi Burn. The breccia-conglomerates do not apparently extend far inland from the coast-line between the Kiwi Burn and Green Islets; but the surface of this part is broken and so thickly covered at the higher levels with stunted yellow-pine, that the exact boundary could not be determined except by a greater expenditure of labour and longer time than the importance of the work would warrant.

Between the mouth of the Kiwi and the Gold Burn there are none of these rocks on the coast-line; but half-way between the latter and the Coal Burn the breccias again appear, heralded by a very coarse, stony beach, the material of which has been derived from the destruction of the breccia-conglomerates. The lower beds, where first seen, strike south and dip to the west at very high angles; and, owing to their unequal hardness, the erosion of them by the sea while cutting back the mass of the beds yet leaves the harder parts standing out far into the tide. Before reaching the mouth of the Coal Burn the beds have passed to the landward side of the shore-line, and abreast of Gates's the lower beds crop out on the spurs one and a half to two miles inland. Here, however, their considerable thickness, in spite of a moderately high dip to the southward, enables them to reach forward to the shore at the head of Gates's Harbour. Towards the Wilson River they thin out, till at the foot of the gorge, two miles below the Golden Site Claim, their thickness is greatly reduced, and the granite, having to a great extent disappeared, the composition of the deposit is mainly a sandstone gravel; and no longer are the beds to be characterised as a breccia.

On the saddle leading from the Wilson Valley into that of Macnamara Creek the beds retain the character of conglomerates, but have a considerably increased thickness. Retaining still the character of conglomerates, the thickness of the beds continues to increase as they are followed from Macnamara Creek into the valley of the upper part of Sealers' No. 2; and, without any alteration of their character, other than the coarseness of the material, the beds are continued northward across Sealers' Creek No. 1 to the shore of Preservation Inlet, at Observation Point, where they are of coarser grain and have again a large proportion of the material composed of granite. The beds pass across the strait to the eastern side of Coal Island, crossing which they again thin out, and almost disappear from the series on the northern shore. As well-rolled conglomerates, the beds are strongly represented at Gulches Head, where, as high cliffs, they are seen resting on the granite that forms the western part of the outer promontory. On the west side of South Port they are developed as a moderately-coarse breccia conglomerate, that contains examples of an igneous crystalline rock not elsewhere met with in the district, except as stray pieces on the beach on the Preservation Inlet side of the Neck. The breccia-conglomerate on Steep-to Island must be considered a modern slope-deposit consolidated, and consequently cannot be dealt with in this place. It has already been referred to.

These beds (the beds *c* of the Cretaceo-tertiary series) are of the age of the quartz-drifts and breccia conglomerates that lie at the base of the coal-bearing series over Southland and Interior and Eastern Otago. It has been shown that the beds of this age are auriferous over large areas in Otago and Southland, and it was naturally to be expected they might prove auriferous in the district under examination. So far as could be gathered, no one has obtained a paying prospect from these beds in this western district; yet, it were easy to show that to some extent they are gold-bearing, and have contributed gold to some parts of the coastward region over which neither glacier-drifts nor sea-terraces have extended, and which yet yield waterworn gold differing in character from that which, newly-liberated from reefs in the Silurian rocks, is of a raggedy character and largely consists of specimens. It is in Macnamara's Creek, and the upper parts of Sealers' Creeks Nos. 1 and 2, that these beds are most likely to yield appreciable quantities of gold, as in these places they are well rolled and of a considerable thickness.

IV.—Silurian.

(*a.*) *Sandstones and Graphitic Shales and Mudstones, Cherts, Carbon-slates, and Mica-schists.*—The general distribution of these beds has already been described. They extend north-west and south-east from the mouth of Kiwi Burn to the northern limit of the district examined, and constitute a belt of country the maximum breadth of which is about five miles. The strikes and dips at various parts show that generally the lower beds resting on the granite are nearly vertical,

or dip at high angles to the south and west. And, in spite of frequent reversal of the dip, this may be said to be the prevailing arrangement. The tracing of definite synclinal and anticlinal arrangements of the strata proved, over such rough and thickly bush-clad country, a practical impossibility. The lowest beds vary from mica-schists at Cuttle Cove and at the entrance to Cunaris Sound, to indurated shales and sandstones along the shores of Kisbee Bay, and thence to the upper part of the gorge of the Wilson River; while again, in the eastern part of the district, the lower beds are highly altered sandstones that have acquired a schistose structure. Cherty sandstones or non-metamorphic quartzite appears to be the next succeeding rock, the higher part of which are sandstones much brecciated, followed by carbon-slates and blue-clay slates.

It is in the rib of intensely-brecciated sandstone that the lode worked in the Golden Site Mine, Wilson River, occurs. Following this are similar sandstones, less broken, alternating with shales, that continue to the foot of the gorge below the Golden Site, where the more extensive alluvial workings on the banks of the river begin. These sandstones continue to the south-west to the hill-tops overlooking Macnamara Creek, and stretch north-west across the gorge of the creek mentioned, and the upper parts of Sealers' Creeks Nos. 2 and 1 to the highest land overlooking Preservation Inlet, between Cromarty and Long Beach.

Quartz reefs show in the upper part of these beds and on the fall to Wilson River from the saddle leading into Macnamara Creek. A reef encased in graphitic shales so closely resembles in many particulars that worked at Long Beach in the Morning Star Claim, that it may reasonably be considered a continuation of the same. This assumption is supported by the fact that the Wilson River outcrop appears nearly in the strike of the reef in the Morning Star Claim. The reefs being prospected in Sealers' Creek No. 1 lie too far to the westward, and their south strike carries these latter under the breccia conglomerates and coal-measures of the upper part of Sealers No. 2. At Long Beach the softer carbon-slates between the two headlands have a breadth of exposure of about half a mile, and are again to the south-west followed with sandstone, often charged with quartz veins, irregularly disposed and conforming to no definite strike.

The Morning Star line of reef lies towards the base or in the lower part of the softer carbon-slate country. This line of country is continued through (lengthwise) Steep-to Island, but on this island, more especially at its northern end, the rocks have been greatly disturbed, and are seen striking directly across the general trend of the Silurian belt of country. The reefs in Sealers' Creek being prospected by Langley and party appear to be in the western side of the soft belt of graphitic slate, while the Morning Star line is on the eastern side of the same, and the Golden Site line of reef lies in a belt of country considerably further to the eastward.

Yet another line shows to the westward of all these, the eastern part of which has been referred to as showing a ramification of small lodes and stringers in the sea cliffs at the south-west end of Long Beach. This line cannot be traced to the south and east on account of the superimposition of the breccia conglomerates and coal-measures on the Silurian rocks in that direction. It can, however, be traced through the eastern and north-eastern parts of Coal Island, and on the northern shore of the island it appears characteristically, showing a network of small veins and leaders of quartz. Some of these abound in iron pyrites; and from one of these Mr. William Docherty, well known as a prospector on the southern part of the West Coast, obtained samples of silver-bearing galena. This galena-bearing vein, after the death of Mr. Docherty, could not be discovered, but boulders containing galena, derived from some neighbouring reef, were discovered on the beach. The same line of sandstone country, charged with veins and leaders of quartz, appears on the opposite side of the inlet, in Cavern Head, where, partly in slate and partly in sandstone, a perfect network of quartz veins and small leaders appears. A reef rich in gold is reported to have been discovered on the western side of Cavern Head. This discovery was made in 1863, and during recent years many travellers tried to rediscover this particular vein, the quartz from which was stated to yield gold at the rate of 37oz. per ton.

Further to the north-west, at Te Whara and the Neck, the rocks are alternations of sandstones and dark-blue slates, less abounding in carbon and not so much altered as are the middle and lower rocks of the series. On the west side of South Port the Silurian rocks are identical with those at Te Whara and the Neck. At North Port slates were observed by Mr. Linck which he regarded as belonging to this series. These had numerous veins of granite intruded into them, but it was not determined whether the granite veins also cut the greater mass of granite in the near vicinity. Granite veins are numerous near the junction of the Silurian rocks with the main mass of the granite at the mouth of Kiwi Burn, and there penetrate into the Silurian rocks for nearly half a mile from the contact with the main body of the granite. The grain of the granite here intruded into the Silurian rocks is much coarser than that of the main body of the granite itself, in which no such coarse porphyritic veins are to be detected; so that, further than that the granite veins are of post Silurian date, nothing as respects the period of their intrusion can be determined, and these veins are of no assistance in fixing the age of the main body of the granite.

Besides the granite intrusions, there are at least three heavy bands of greenstone, or diorite, that form rocky promontories jutting out to seaward, between the mouth of the Kiwi and midway between the Gold Burn and the Coal Burn. This formation, containing as it does the lines of auriferous reefs that have already been mentioned, is, therefore, that which most concerns this report; but with respect to pronouncing on the prospects of the district as indicating this to be a valuable goldfield, too little has been done to afford the means of judging, and, while the district is on its trial and in course of development, an unfavourable decision would probably prove a hindrance to its progress as a gold-producing district. The rocks in which the reefs occur, and their relation to the other strata of the district, exactly parallel the mining district of Collingwood, Nelson. The auriferous rocks in that district are, as here, of Lower Silurian date. They rest directly upon granite, and are followed by Cretaceous or old Tertiary rocks. The more slaty parts of the formation in the two districts mentioned contain proofs of the age of the beds, by the occurrence in them of numerous

examples of a few forms of *graptolites*, an order that peculiarly distinguishes Lower Silurian rock. It is curious that the proofs of the existence in New Zealand of Lower Silurian rocks should only as yet have been discovered on the north-west and south-west extremities of the South Island.

Gold was known to occur in the district of Preservation Inlet, and on the northern shore of Foveaux Strait, as early as 1863, but it was not till about the middle of 1889 that payable workings were opened out on Coal Island, and at slightly later dates on Steep-to Island (Crayfish Island), and on the mainland at Wilson River, where, subsequently, the working of the river-bed led to the discovery of the gold-bearing reef within the Golden Site Claim. There is some uncertainty as to dates, and even as to who were the actual discoverers, rival claims for a reward being made. In the application of Payne, Wilson, and Davis, it is stated "that, within twelve months of their commencing work, there were at least five hundred miners on the field." The workings on Coal Island that proved remunerative being confined to parts of the beach at the eastern and north-eastern end of the island, and to the valleys of the creeks that cut through the glacier-drifts which even now cover the greater part of the island; the extent of the more concentrated alluvial wash being limited did not afford scope for the operations of a large mining community, who were also hampered in their efforts by a scarcity of water for mining purposes. The result, in spite of some very encouraging returns, has been that the mining population here and on Steep-to Island, has gradually dwindled to less than a score during the summer of 1895. At Wilson River, from the same cause, precisely the same results have ensued, and at the present time there are not more than twelve or fifteen miners on this part of the field.

The discovery of the Golden Site quartz lode in the gorge of the Wilson River, owing to the rich specimens it at first afforded, seemed to give promise of a great future for this field, and this being followed by the discovery of the Morning Star line of reef at Long Beach, there for a time seemed to be no doubt but that success was assured. Unfortunately, at the Golden Site, on being followed but a short distance to the south, the lode was cut off by a throw, or fault; and, though it is said the same reef has been found a little distance further down the gorge, its auriferous character would appear to be less, and little has been done to prove its value. Beneath where the rich stone appeared at the surface, the reef has been mined on to a depth of 40ft., to which depth good payable stone was found, but not equal to the surface stone; and, by some inadvertence, mining was carried on too near the surface, thus admitting water from the river into the workings, rendering them for the time being, and with present appliances, unworkable. On the northern bank of the river the reef was followed, at and below the level of the river, a short distance into the hill, when, less auriferous in character, it broke up into a number of leaders, which led to the supposition that the real body of stone had taken another course. Prospecting work has since been carried on at higher levels on the northern side of the river, and in two adits quartz reefs have been found, but up till the present these have not yielded payable stone. Under these discouraging circumstances, work has for the present ceased; but it is to be hoped that capital and energy will again be provided to thoroughly prospect this lode.

The Morning Star is the principal claim on a line of lode at Long Beach, a general description of which has been already given. This at first gave very encouraging returns, and a considerable body of payable stone was discovered in the northern part of the workings. But on the works being pushed south at three different levels the stone became poor in gold, and scarcely paid to crush; in fact, the first or northern shoot of gold was passed through, and, while the stone as a reef maintained itself without on the average any diminution in thickness, and is easily traceable, it has not been followed; attention being turned to that part of the mine in which payable stone was known to exist. In the No. 2 level the last stone taken out prior to the commencement of the present year yielded at the rate of 6dwt. to the ton, which was an improvement on the yield of stone previously taken from the same drive. On consultation with the writer of this report, the directors determined to push No. 2 level some distance ahead, in the hope that another and distinct shoot of gold had been touched, as indicated by the improved returns obtained from the last parcel of stone from this level that had been crushed. There is reasonable hope to believe that such is the case; and should the results of the carrying forward of this level be as it is hoped it will be, the work now being done will go far to establish the permanence of this mine, and the lode or line of reef as being worthy the attention of mining speculators. There are a number of other claims situated on this line on the mainland. But little prospecting on most of these has been done, and the location of some of them is unknown to me.

The same line of reef trends north through Steep-to Island, at both ends of which indications of reefs were discovered. These indications were prospected, and an adit was driven from the east into the southern end of the island, without, however, cutting any reef. At the northern end rich gold-bearing specimens were found imbedded in a vein or deposit of "pug," but prior to January last this lead had been worked out, and it could not be determined whether these occurred *in situ* or not. A patch of quartz, lying at a low angle, was also found to be gold-bearing, and these indications led to a considerable amount of prospecting by driving into the spur in search of a continuous body of stone. These works were conducted on behalf of a company, by Mr. Trent, and finally ended during April last in the cutting of a body of stone which proved non-auriferous, or but feebly auriferous, and in appearance not promising. The works have, consequently, been discontinued.

At Cuttle Cove there are a number of reefs, some of which have been prospected. The most southerly of these shows in a cavern, on the shore-line, outside Cuttle Cove, in the direction of Cavern Head. Three or four feet of stone shows on the southern wall of the cave, but the thickness of the lode is irregular, and the average thickness will not exceed the amount stated. This, or another lode, shows on a rocky bank a few yards to the south, and a small leader appears on the beach about a chain to the east. The two principal bodies of stone are nearly vertical, and are encased in dark graphitic mica-schist. To the north of the landing at Cuttle Cove a number of

claims have been taken up, and on some of these, now amalgamated, a fair amount of prospecting has been done.

A winze of about 20ft. follows a thin vein of highly mineralized stone, dipping at a low angle to the westward. This, at the outcrop, looked like a segregation between different laminæ of the carbon mica-schist and a more quartzose rock. A vertical outcrop running north and south occurred some little distance to the south of the winze, and to the north-east two or three other outcrops of thin flat-lying leaders had been laid bare. One of these outcrops showed a considerable dip of the stone to the southward. These thinner reefs were, according to report circulating among the miners, gold-bearing at the rate of 1oz. to the ton. Samples from the winze, in which was the most promising stone, were taken, and have since been analysed in the Colonial Laboratory at Wellington, and yielded traces only of gold.

At Cavern Head there are a great number of small reefs and leaders forming a "stock-work" in the projecting headland, that, lashed by the sea, is devoid of soil and vegetation. Persistent rumours as to the finding of a very rich auriferous lode at this place circulate amongst the miners in the district. The find as reported was made in 1863, and the stone is said to have yielded at the rate of 37oz. of gold to the ton. In the line of the strike of these lodes and leaders a considerable body of quartz is reported as occurring in the ranges at the back of Te Whara Beach.

V.—Mica Schist.

(*a.*) *Highly Metamorphic Schists north-east of the Granite Belt.*—These rocks extend from the upper valley of the Dawson Burn, some unknown distance to the eastward, and to the north-west they continue throughout the district examined. They were examined at but a few places—viz., in Last Cove, Long Sound, Cunaris Sound, and at the head of Edwardson Sound. Quartz veins are abundant in these rocks at the head of Long Sound. Samples taken did not on analysis show the presence of gold. Prospectors have penetrated the country of this mica-schist belt along Long Burn Valley, and to the eastward, without finding anything more than a trace of gold. In the watershed of the Cunaris Sound the same rocks yield similar results for a greater amount of prospecting; and at the head of Edwardson Sound, in spite of reports to the contrary, those working there informed me that only a colour of gold could be got. In the region around the Lakes Cadman, even Mr. Carrick admits no gold could be found.*

VI.—Granite.

Throughout the district, wherever examined *in situ*, the main body of granite appeared uniform as regards its colour and composition, the whole belt from Wednesday Peak to North Port being a flesh-coloured, or, when long weathered, a grey granite, often markedly but never very strongly, porphyritic. From Gulches Head through Red Head to North Port runs a finer grained, darker variety of syenitic granite. The width of this belt is not great, and it has not towards the north been well explored. In the crystalline material of the glacier drifts there is a considerably greater variety of granitic and syenitic rocks than can be collected from the parts of the granitic belt that came under observation.

In Isthmus Sound a mineral lode in the granite trends east and west, and dips south at high angles. This is rather a remarkable lode, and contains gold, silver, copper, lead, iron, and zinc, free or combined with sulphur or arsenic. The lode varies from 2ft. to 3ft. in thickness, and sometimes there is a lesser sub-parallel lode. Mispickel is the most abundant mineral; zinc-blende is next in bulk in the lodes; galena and yellow copper-ore come last, in the order given. The galena may at times form a tenth to a sixth of the entire lode, and were these proportions constant and to be relied on the lode would probably pay to work for the silver and gold contained in it. Samples of the galena, nearly pure, were analysed by Mr. Skey, and gave 120oz. of silver, and as much as 7dwt. of gold to the ton. On the whole of the lode the returns gave but a few ounces of silver and a trace of gold. The lode appears to be very continuous, and Mr. Bradshaw, the prospector of it, states that he has found an outcrop of the lode half a mile distant from where it was first discovered.

Alexander McKay,
Mining Geologist.

The Under-Secretary of Mines, Wellington.

Appendix B.

Mr. F. W. Linck, my assistant while examining the Wilson River and Preservation Inlet Goldfield, was intrusted with the task of examining the shores of Chalky Inlet and the adjacent coastline as far as Cape Providence. The results, so far as they could be fully apprehended by me, have been embodied in the report on the above-mentioned goldfields; but, as is apt to be in such cases, inferences may be drawn that the facts stated in the original will not bear out the deductions made. Mr. Linck's report is here published as supplementary to my own on the more extended district.

17th July, 1896. Alex. McKay.

Sir,— Cromarty, April, 1896.

Acting under instructions received from you at Seek Cove, Preservation Inlet, on the 27th March, 1896, I left for Chalky Inlet at noon the same day, in company with William and John Robertson, in the cutter "Star of Hope," for North Port.

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* "Mines Reports," 1895, p. 148.

Owing to a calm which prevailed it was found necessary to pull round Gulches Head into Chalky, the distance being shortened owing to there being no broken water on Balleny Reef, which permitted of going through Broke-adrift Passage. On getting abreast of Red Head a light wind sprang up from the south-west, carrying us up as far as Garden Islands, which lie at the entrance to South Port. By this time we saw that it was impossible to make North Port that night before dark, and, as some articles had been found in the boat which should have been left with you, we made into South Port, dropping anchor about dusk. On the road round, a landing was made at a point on the coast about three-quarters of a mile south-south-west of the western headland of South Port; the rock being granite. This granite was traced from there to a point about a quarter of a mile inside the boat-passage to South Port, Garden Islands being the same rock. Having crossed the neck to your camp at Seek Cove, and delivered the things carried on, we next day started out of South Port. On reaching the entrance we had a light breeze from about west-south-west. This was taken advantage of to coast along the eastern shore of Chalky towards the Cunaris Sound. Landings were effected at different points, but, owing to a long swell which was running up the Sound, there were very few places that it was safe to land at without endangering the safety of the boat. The rocks from Reef Point in South Port to Rocky Head are granite, similar to that at Garden Islands; while from Rocky Head to a point on the coast about due south of Small-craft Harbour Islands the rocks are highly-indurated sandstones and schistose slates, similar in character to those in Preservation Inlet, between the Neck and Cuttle Cove.

Leaving the southern side of Chalky, a course was shaped for Edwardson Sound, but on reaching the entrance the wind freshened and came whistling down the Sound, and, as it was getting late in the afternoon, a retreat was made for Small-craft Harbour Islands; while coasting round the group the smaller island, towards the head of the Cunaris, appeared to be granite, but the weather would not permit of getting close enough in shore to positively determine them. On reaching the harbour we anchored for the night, the rocks there being highly-indurated sandstones. In the wash at the head of the harbour some holes sunk by prospectors were seen, but from information received the prospects for payable gold were not promising.

As instructed by you, attention was paid to the extent of alluvial terraces referred to by Mr. Carrick in the locality of South Port, with the result that there appeared to be a considerable area of terrace-land between Reef Point and the Neck extending back from the shore-line to the slopes of the mountains, the extent back from the shore-line being about an average distance of a quarter of a mile. On going ashore at the mouth of a small creek cutting through these terraces, and situated about midway between Reef Point and the Neck, the gravels in the bed of the creek were seen to be chiefly slates and sandstones, evidently derived from the mountains at the back. A short distance south of Reef Point a creek discharges itself into what is known as Anchorage Cove. This creek evidently comes from a large valley running in a north-east direction for several miles, and as far as could be seen this valley drained practically all the north-western slopes of Treble Mountain. From Anchorage Cove a continuation of the terraces aforementioned evidently extends as far as Rocky Head, but above this point precipitous country comes right on to the shore-line, and as far as could be observed from the boat very little alluvial terraces would be looked for in that direction.

A start was made next day (Sunday) for Edwardson Sound; there being no wind the oars had to be resorted to, and the first land made was on the North Port side of Chalky, at a small headland at the mouth of Edwardson Sound, lying about due west-north-west from Divide Head; the rock was seen to be granite. The western shore of Edwardson Sound was then followed in a northerly direction for a distance of about three miles, at which point a change in the rocks was noticed, schist taking the place of the granite to the head of the sound. Sunday night was spent in a small cove at the mouth of what is shown on the map illustrating Mr. Carrick's report as the Left-hand River; the rocks in the cove being schists.

Next morning (Monday) we shifted round to the cove into which the river flowing from the Cadman Lakes discharges itself. Going ashore we went to the lakes by way of the track blazed by Mr. Hamer and party, and found the hut at the lake in a very dilapidated state, the flies which had been used for a roof being removed. There being no boat on the lake we did not go further than the foot of the lake. Standing at the foot of the lake the mountains in view to the north and east are all apparently schist. Leaving the lake we returned to the boat, and started down the Sound, with the intention of examining the shore-line from the mouth of Edwardson Sound in the direction of North Port; but on the way down it started to blow hard from the south-west, and with the sea that got up it was found necessary to abandon our original intentions, and we sailed along the northern shore of the Cunaris Sound to Islet Cove, where we arrived after dark, anchoring for the night at the back of some small islands there. While coming up the Cunaris it was dangerous, owing to the sea running, to attempt to land on its northern shore; but from Divide Head to the saddle between the Lump and Tower Hills is undoubtedly granite; the schist belt crossing Edwardson Sound evidently flanking the Lump on its northern slope, and, curving south, passes through the saddle aforementioned, the junction on the southern side of the Cunaris being about the western headland of Cliff Cove.

The following morning we landed at the mouth of the Carrick River. The shingle deposited on the boulder banks at the mouth of this river consists mainly of mica-schist, quartzose schist, and quartzites, with a small percentage of granite, thus pointing to the fact that for the greater portion of its course the river runs through schists. Leaving the head of the Cunaris, we proposed coasting along the shore on the southern side, with a view to determining the position of the junction of the schist at the head of the sound with the granite belt coming through Treble Mountain, as also the junction of the slates and sandstones on the western side of the same granite belt, but the weather would not permit of going anywhere near the shore-line, thus leaving us the option of lying at the head of the Sound or making for North Port, with a view to examining the rocks in that locality, the

latter course being adopted. Entering North Port by the ships' entrance, the islands enclosing the harbour were seen to be granite, and an examination of the rocks along the mainland from Mosquito Point to the Boat Entrance showed them to be similar rock.

In a small cove to the north-east of Mosquito Point schistose slates and highly-indurated sandstones are met with overlying the granite, the schists and sandstones being ramified by granite veins, thus showing the granite along the junction at this point to be intrusive. On the map accompanying this report I have shown the schists and sandstones referred to as passing on to the shores of Chalky Inlet to the northward of the Boat Entrance to North Port; and, with a view to verify this theory, an attempt was made next day to go along the shore with the boat in that direction, but it had to be given up as the wind was blowing stiff from the north-east, and a nasty sea along the shore prohibited any attempt to get ashore at that point. Turning back, we re-entered North Port and went ashore at Ransom Head, which is composed of granite. Leaving North Port by the Blind Entrance, the coast-line was followed as far as Breaker Point, the rocks being granite up to that point. Beyond this, in the direction of Cape Providence, we had to give the coast-line a wide berth owing to a heavy south-west swell and the rocky nature of the coast; this, together with a haze along the land, made it rather difficult to determine the nature of the rocks, and at the time I considered the rocks from Breaker Point to Cape Providence to be coal-rocks, similar to those flanking the slates to the southward of Chalky Island; but as Messrs. Colin and Clark, miners on Coal Island, Preservation Inlet, who have been ashore on that part of the coast-line, state that the rocks are similar to the slates in Preservation Inlet I have mapped that part of the coast accordingly.

Leaving the northern side of Chalky Inlet, we made for the Passage Islands, and ascertained them to be granite. As we were not close enough up to determine the nature of the rock underlying the limestones on the north-eastern end of Chalky Island I have mapped them as granite, as determined by Sir James Hector. There being only two more days left of the time suggested for the trip, and the wind favourable, we made straight that night for South Port. Next morning, having reported to you at the Neck, a departure was made from South Port for Seek Cove, Preservation Inlet, but owing to contrary winds we would not have been able to reach Seek Cove before dark, so we made for Cuttle Cove where we spent the night, arriving next day, Friday, the 3rd April, at Seek Cove.

I have, &c.,

A. McKay, Esq., Mining Geologist. F. W. Linck.

List of Specimens collected in Chalky Inlet by Mr. F. W. Linck.

Nos. 1 and 2.—Sandstones; locality, Small-craft Harbour Islands.

No. 3.—Schist from cove, &c., north-east of Mosquito Point (North Port). One specimen.

No. 4.—Sandstone (highly indurated) from cove, &c., north-east of Mosquito Point (North Port).

No. 5.—Granite from North Port.

No. 6.—Dioritic granite from cove, &c., north-east of Mosquito Point (North Port).

No. 7.—Granite taken from point on beach about three-quarters of a mile to southward of western entrance to South Port.

No. 8.—Granite from North Port Harbour, between Mosquito Point and Deep Point.

McKENNA BROTHERS CLAIM, GULCHES HEAD, PRESERVATION INLET.

Report on, by Alexander McKay, F.G.S., Mining Geologist.

Mr. A. McKay to the Under-Secretary of Mines.

Sir,— 4th May, 1896.

In the matter of Mr. McKenna's letter of the 17th April, 1896, I have the honour to report that I examined the claim at Gulches Head, known as Block I., held in the name of Messrs. Hall, Cullen, and Clark, on the 30th and 31st March last, and to submit the following notes descriptive of the same:—

Extent and Position of the Claim.

Block I. consists of 100 acres, situated about a mile north-east of Gulches Head, on the northern side of the main entrance to Preservation Inlet. It occupies the foreshore at Price's Beach inside the entrance to the Sound from the rocky headland, formed of coal-bearing sandstone, that lies immediately inside Gulches Head to a little beyond the eastern end of Price's Beach, where the shore-line is again bold and rocky. Forming roughly a square, the claim extends back to the north-west in the direction of Red Head to the valley of Back Creek, and thus constitutes part of a larger area, surrounded on three sides by hills of considerable elevation; while on the fourth, from the more moderate elevations of the alluvial lands, a steep terrace-face descends to Price's Beach and the shore of the inlet. The average height of the terrace-lands within the claim may be estimated at from 130ft. to 140ft. They are lowest toward the south-west, and also slope gradually to the north-west to the sea at the mouth of Back Creek and for some distance along the lower course of the creek. Further-north Back Creek drains the eastern slopes of the granite hills along the coast-line, and the western slopes of Round Hill and part of the coal-bearing strata to the north.

Nature of the Rocks.

On the western coast-line the rocks from Gulches Head are granite to and beyond Red Head. To the eastward the granite is overlain by coarse or finer conglomerates forming the basement-beds of the coal-bearing series. (Slates occur within the area of Gulches Head Peninsula, but these lie further to the north, along the western shore of South Port.) The conglomerates at the base of the coal-bearing series are succeeded by sandstones, and sandstones and shales with small seams of coal, one seam varying from 2ft. 7in. to 4ft., and the series is again closed by conglomerates of coarse pebble-beds, as seen at the inner point of Gulches Head. On these granite and coal-bearing rocks there rests indifferently a considerable deposit of tough clayey gravel, evidently of glacier origin, which has clearly yielded under the action of denuding and reassorting agents the bulk of the material forming the younger and more auriferous series of gravels. These morainic deposits are not naturally exposed at many places, and, for the most part, are seen in the working-faces which have been opened out in different parts of the claim. They contain a considerable proportion of well-rounded stones, besides the angular material characteristic of such deposits. The clay and finer parts of the deposit contains scarcely any gold, so far as yet ascertained, nor is black sand present to any extent, but iron-pyrites are abundantly distributed throughout the mass.

Resting on these glacier deposits, and next in sequence, comes the auriferous gravel. This is a comparatively free, gravelly, or sandy wash, which, under a moderate head of water, should pull down and be removed with ease as rapidly as prudent to put it through the tail-race. What the average thickness of this wash is it might be difficult correctly to say, since the faces opened out are not sufficient to determine the point. Professor B. Hooker estimates their thickness at an average of 30ft. I think this a fair and not too high an estimate for some parts of the area. The manner of the formation of these gravels was by the action of the sea breaking up and reassorting the morainic gravels that underlie, which operation was continued during a sinking and subsequent elevation of the land, the effects of the latter movement being the more apparent. Without doubt the glacier deposits, from which the auriferous gravel has been derived, were at one time continuous with like deposits on and over the greater part of Coal Island; but this connection was broken during the periods of depression and upheaval and while reconstruction of the glacier-drifts was being carried on. On what is now the land area bounding the channels of entrance to the inlet the material has been swept seaward to form deposits at lower levels, or in different parts has been thrown back upon the coast-line.

The middle and south-western end of Coal Island shows sandstone cliffs rising to a considerable height above sea-level, but at Price's Beach the glacier deposits yet pass under the sea-level, and this, wasting away more rapidly than the hard grit and sandstone rocks at each end of the beach, accounts for the indentation that here takes place, and also for the abrupt character of the terrace-face. As the eastern abrupt slope from the terrace at the back of Price's Beach has been moulded and formed subsequent to the laying-down of the gravels at higher levels, down the steep slope facing the shore, the reassorted gravels probably do rest on a series of flat ledges carved out of the glacier-deposit, the upward movement probably being intermittent in character; and even if the land rose gradually and regularly a tendency to cut ledges in the morainic gravels would display itself, as the size or compactness of the material affected might vary at different levels.

The top of the terrace at the southern end of Price's Beach is exactly 100ft. above sea-level, at the northern end of the beach it is considerably more, say, 140ft. From the southern end there is a gradual slope westward to the sea at the mouth of Back Creek, where the terrace-lands terminate at about 25ft. above tide-mark. Between the northern end of Price's Beach and a point from the sea in the valley of Back Creek corresponding or slightly exceeding the length of the eastern terrace-face the slope is also to the westward, but, owing to the lower level of the southern end of the sloping tableland, the direction of the maximum fall is to the south-west. North of the south-west slopes of Round Hill the valley of Back Creek is bounded by ranges of hills to the east and west. It is reported as being in the upper part of moderate width and so flat as to afford exceptionally favourable sites for the construction of dams, more especially at one place where, as reported by Professor Hooker, a dam of very considerable capacity might be constructed at a comparatively trifling cost.

Younger than the reconstructed gravels, yet at a higher level and older than the beach-sands of the present day, are deposits of black sand which contain gold. These form a narrow terrace towards the southern end of Price's Beach; but towards the north the black-sand deposit clings to the steep slope descending from the break of the high terrace to the north-west. These sands are auriferous and cover a pavement of large boulders or one or two feet of finer wash; the whole at the northern end of the beach rests on morainic matter, or on coal-rocks.

Auriferous Character of the Gravels within Block I.

The highest and most northerly working-place which has been opened out in these gravels is not now being worked. Professor B. Hooker tested the ground at various places, and reported the finding of such prospects as might well lead to sanguine hopes of a rich return, even with the limited water-supply that was at that time available. Water was brought on to the ground, and enough of this north part of the high level washed away to show that the gravels here would scarcely pay, and did not, as regards the quantity of gold, correspond with the prospects obtained at the surface. At a lower level, on the slope of the same ridge, another opening was made, but was left, and another face was partly opened in the next gully to the south. At this place gold is distributed through the gravels over a vertical height of 25ft. from the bottom. Some prospects taken here showed a number—five to twenty—of colours of fine gold; and in this face, also, I am satisfied that coarse gold is to be found, though I saw none in the prospects washed from the face.

In the next little gully, cut into the face of the terrace, the same gravels are well seen, and here forty to fifty fine colours of gold to the dish were obtained, but no coarse gold. Further along the terrace-face—*i.e.*, to the south—I was told the prospects were not so good, but, so far as I could see, very little prospecting has been done in this direction. Along the foot of the terrace gold drifting from higher to lower levels has accumulated so as to form a deposit that can be worked to profit with even the present means and appliances, and it was this terrace-foot that was being worked when the ground was visited by me. Although no one was working in Back Creek at the time of my visit, in the past it was worked to some extent, and good-sized gold found along its banks. It is said that the frequency of large boulders in the wash is the reason why workings there are discontinued.

The slope-deposit accumulated at the foot of the steep slope of the terrace-face immediately inland of Price's Beach, as a concentrate of the terrace-face overlooking this part of the inlet, is likely to be richer in gold than most other parts of the claim, but it must be borne in mind that this gold is directly derived from the reassorted terrace-wash and in the first instance from the glacier-drifts. The black-sand deposits near beach-level, in a general estimate of the value of the claim, are comparatively unimportant.

Means of Working the Claim.

The gravels on the eastern face towards Preservation Inlet are favourably situated for being disposed of through tail-races on to the beach; and at small cost, except to the very highest levels, water under sufficient pressure can be brought on to the ground. The higher terrace-levels towards the north will require a greater length of head-water enclosed in pipes, but this will probably have to be considered in connection with the bringing-in of the water from Lee's Creek from the east side of South Port Harbour. The present water-supply is intermittent, and at all times, except during very heavy rains, insufficient to effectually open out and work the ground. The dam in Back Creek recommended by Professor B. Hooker should be constructed; and, if this conserves as much water as is said may be collected by it, the eastern faces of the claim may be thoroughly opened out, and a reliable estimate of the value of a considerable area in this part of the claim arrived at. When this is done, and the owners are satisfied with the results, the water-supply might then, but not till then, be supplemented by the greater and more permanent supply that can be obtained from Lee's Creek.

Remarks.

So far as my examinations were carried, they led me to the conclusion that, with a sufficient water-supply under skilful and careful management, at least a portion of the area of claim Block I. may be made to pay for working. However, a better water-supply than that at present on the ground must, to do this, be available. I should therefore advocate the building of the dam at the spot in the valley of Back Creek pointed out by Professor B. Hooker; but until the claim is thoroughly proved I could not recommend the costly scheme of bringing on to the ground water from Lee's Creek, which would involve half a mile of heavy piping across the Neck between South Port and Preservation Inlet, with a distance of closed pipe-line on each side of at least an equal length to the width of the flat. This would involve a heavy expenditure, which the prospects of the claim at the present time do not warrant.

I have, &c.,

ALEXANDER MCKAY,
Mining Geologist.

The Under-Secretary of Mines, Wellington.

DEPOSIT OF JET COAL AT MAHARAHARA, NEAR WOODVILLE.

REPORT on, by ALEXANDER MCKAY, F.G.S., Mining Geologist.

Mr. A. MCKAY to the UNDER-SECRETARY of MINES.

SIR,— 18th May, 1896.

I have the honour to report that, as instructed, I went from Wellington to Woodville on the 1st May, and the following day examined the deposit of jet-like coal, samples of which had been forwarded to the Mines Department, and on the evening of the same day met at Woodville a number of settlers and others interested in the development of the mineral resources of the district, to whom I explained the nature of the deposits, its geological position, and the probability of its occurring in quantity sufficient to make the working of it a commercial success. The original sample forwarded to the Under-Secretary of Mines, by analysis made by Mr. Skey, yielded the following result:—

Fixed carbon	35·91
Hydro-carbon	22·83
Water	11·14
Ash (ferruginous)	30·12
	100·00

The ash, as determined by Mr. Skey, yields sesqui-oxide of iron fully half the total, or 17·99 per cent. of the mineral. This, or closely-related varieties of the same mineral, occurs in many parts of New Zealand, both in Tertiary strata, and in the older coal-bearing series of Cretaceo-

tertiary and Cretaceous date. The New Zealand jet usually contains a percentage of water, and, so far, no samples of a bituminous character have as yet been found.

There is some uncertainty as to the true nature and origin of jet, as the following article, taken from the "Encyclopædia Britannica," will indicate:—

"Jet, a mineral substance belonging to the Carbonaceous group, and generally regarded as a compact variety of lignite or wood-coal, impregnated with bitumen. The word 'jet' (German *Gagat*) is a corrupted form of 'Gagates,' the name applied to it, or a similar substance, by Greek and Roman writers, and derived, according to Pliny (H.N. xxxvi., 34), from the River Gagas in Lycia, where the mineral was originally found. Its occurrence in Britain is mentioned by Solinus, but it was certainly used there in pre-Roman times. Barrows of the bronze age have yielded beads, buttons, rings, and armlets, and other personal ornaments of jet. The early supply was probably obtained from the Yorkshire coast, near Whitby — a locality which still yields the finest varieties. The Whitby jet occurs in isolated masses, of irregular shape, but frequently more or less lenticular, imbedded in bituminous shales near the base of the Upper Lias. The particular horizon of the jet-rock is known to geologists as the zone of *Ammonites serpentinus*. Opinion is divided as to the exact nature and origin of jet, some regard it as a variety of lignite, others as a kind of cannel coal, and others, again, as a hardened form of bitumen. There is little doubt that the jet has in all cases resulted from the decay of organic matter. Microscopic sections of jet frequently reveal a ligneous structure, in most cases of coniferous type. It has been suggested that masses of wood brought down by a river have been drifted out to sea, where, becoming waterlogged, they have sunk, and have gradually been covered with a deposit of fine black mud, beneath which the decay has slowly proceeded. Possibly bituminous matter may have been distilled from the decaying vegetation and deposited between the layers of shale in its neighbourhood. Drops of liquid bitumen are frequently found in the fossils of the jet-rock, and inflammable gas, derived from bituminous shales, is not uncommon in the jet-mines. Moreover, scales of fish and other fossils of the jet-rock are frequently converted into jet, the bituminous matter having replaced the original tissues. When jet is heated it betrays its bituminous character by burning with a dense pungent smoke, which was formerly reputed to possess powerful medicinal virtues. At present the material is used only for trivial ornaments, principally for mourning jewellery. To obtain jet, the shale is systematically mined not only at its outcrop in the cliffs, but in the inland dales of the Cleveland district. It is now rare to find washed jet upon the sea-shore, but formerly a considerable amount was thus obtained. The best hard jet is exceedingly tough, and may be readily carved or turned on the lathe, while its compact texture allows it to receive a high polish. The final polish is given by means of rouge, which produces a beautiful velvety surface. The softer kinds not capable of being freely worked are known as bastard jet. From the estuarine beds of the Lower Oolite of Yorkshire a soft jet is obtained, but, though occasionally used for ornamental purposes, it is far inferior to the true Whitby jet. Spanish jet has been largely imported into Whitby, but it is deficient in hardness and lustre. Cannel coal from Scotland is occasionally used in the place of jet; and it is not uncommon for brooches to be made of a carving of Whitby jet set in a plain polished rim of either Spanish jet or cannel.

"For descriptions of jet and jet-working, see "The Yorkshire Lias," by Ralph Tate and J. F. Blake, 1876; and a paper on Whitby jet, by J. A. Bower, in the *Journal of the Society of Arts*, 19th December, 1873."*

From the above extract it does appear that jet may originate in a variety of ways, and a variety of substances may eventually be converted to jet. Jet appears at the present time to be regarded as a non-hydrous bituminous substance, under which definition the Maharahara mineral would have to be excluded; but originally, and as known to Greek and Roman writers, it would seem to have been a Tertiary or Cretaceous mineral, and probably non-bituminous.

The formation at Maharahara, ten miles north of Woodville, is of Tertiary-Miocene age, and consists of gravels and sandy clays dipping south-east at high angles, and followed by sandy clays about 100ft. thick, which are overlain by shelly limestone, constituting a feeble development of the limestones at the upper end of the Manawatu Gorge, and which, as massive beds of shelly limestone, are largely developed to the south-east and east within the Upper Manawatu basin. At Maharahara sandy beds and gravels succeed the limestones, and these in this part of the district close the series of Miocene rocks.

The jet-like mineral occurs in connection with the gravels, clays, and sands that underlie the limestone at the distance above stated. The principal masses show a woody structure, and are evidently the trunks and branches of trees that have been covered up by the sandy clays succeeding the gravel-beds. At the same place there is also a thin seam of jet-like coal, which is evidently not buried wood. This, however, is not more than 1in. thick, and is of no consequence. The principal mass of jet-coal has been followed about 3ft. into the bank on the south-west side of the road, and on the opposite side of the road a short drive has been put in at a lower level without, however, bringing to light a continuous deposit of the mineral sought for. Pieces of the jet-like coal are found in the bed of the stream next to the south-west, but in this direction it has not been found *in situ*.

To the north-east of Maharahara a similar substance is reported as occurring in a seam about 2ft. thick, but this has merely been observed, and no excavation of the mineral made. Lignite and brown coal are found on the same horizon of the Miocene sequence at several places within the basin of the Upper Manawatu River and also in the Ruamahunga watershed, near Mauriceville, but it is only at Maharahara, and for some distance south-west and north-east, that it assumes the appearance of jet.

* "Encyclopedia Britannica," ninth edition, 1881, Jet.

Since the first samples were sent to the Mines Department and analysed by Mr. Skey they have been subjected to various tests, in order to prove how the substance stands the elimination of its accidental and in part of its constitutional water without rending or crumbling to pieces during the dessicatory process. So far as these tests have gone, they show that unless very slowly dried the substance does crack to some extent, and this, together with the fact that, compared with Whitby jet, it is somewhat brittle, unfits it for the purposes to which jet is usually applied. Appended is a copy of Mr. Skey's original analysis of the specimen, and his remarks thereon.

ALEX. MCKAY,
Mining Geologist.

The Under-Secretary of Mines, Wellington.

RESULTS of ANALYSIS of SPECIMEN No. 7252, CARBONACEOUS MINERAL. (Locality: Vicinity of Woodville).

THIS mineral has all the appearance of a first-class jet. It is very hard, and gives a greenish-brown powder. It cracks somewhat when rapidly dried, but, as Mr. McKay suggests, it may not crack at all if dried slowly at common temperature. Its quality as a jet is being further tested.

Approximate Analysis.

Fixed carbon	35·91
Hydro-carbon	22·83
Water	11·14
Ash (ferruginous)	30·12
	100·00

Evaporative-power low, only 4·6lb. Ash contains 17·99 per cent. of sesqui-oxide of iron.

WILLIAM SKEY, Analyst to Mines Department.

PROSPECT OF FINDING COAL ON THE TIRAUMEA ESTATE, UPPER TIRAUMEA VALLEY.

REPORT on, by ALEXANDER MCKAY, Mining Geologist.

Mr. A. McKAY to the UNDER-SECRETARY of MINES.

SIR,— 25th May, 1896.

Between the 5th and 8th of May, as directed, I examined portions of the Tiraumea Estate, with the object of determining whether or not coal-seams of workable thickness occur there, and have the honour to report as follows:—

REPORT.

While the road from Alfredton to the East Coast by way of the Upper Tiraumea was being constructed indications of a seam of coal were exposed at the base of Cook's Tooth, about half a mile from the Home Station on the Tiraumea Estate, thirteen miles east of Alfredton.* A sample of the coal found, on analysis, proved to be a brown coal of good quality. Subsequently a further sample gave a high return, and had an evaporative-power of 7lb., indicating in some degree an altered coal, implying the presence in the district of the Cretaceo-tertiary formation—the true coal-measures of New Zealand.

During last December I was instructed to visit this and some other localities where coal occurs in the Wairarapa North district, but was recalled to Wellington before being able to examine this particular deposit, but, opportunity offering, the locality of the outcrop and the surrounding districts were examined between the dates above mentioned.

Locality of the Coal-measures.

The Tiraumea Estate, about thirteen miles north-east of Alfredton, lies east of the Tiraumea River, and, containing 10,360 acres, extends north and south five miles, and has an average breadth east and west of three miles. The surface is generally hilly, with comparatively narrow valleys between. The most extensive areas of flat land lie along the valley of Ngarangakopo Creek, intersecting east and west the middle part of the estate. In the south-east, hills of papa and limestone rise to 1,200ft. or 1,500ft. above sea-level.

General Geological Features.

In the south-west portion, sandy clays and soft brown sandstone are developed over a small area, east of which there is a considerable development of Triassic (?) or Carboniferous rock, having

* Of this coal Mr. Skey says, "This is a useful coal of its kind, comparing very well with the Shag Point coal and others of the less hydrous brown coals. It is a fairly-coherent homogeneous coal, burning freely, with a good flame."

strata highly-inclined and much-disturbed, consisting of shaly mudstones, sandstone, and ferruginous rocks, either hæmatite more or less pure, or flinty jasperoid rocks. Throughout this formation there is a small percentage of lime, affording pasture-land of good quality. To the east, resting on these older rocks, with an east or south-east dip, the coal-rocks extend from [illegible] to north a distance of four miles, with an average breadth of one mile. The coal-measures lie at the base of this formation, the middle and upper beds being fossiliferous strata of marine origin, consisting mainly of arenaceous sandstones, with here and there beds of shelly limestone, or sandy beds full of shells. The whole eastern part is formed of papa-rock—a calcareous sandy clay—capped on the higher hills with isolated masses (often not *in situ*) of shelly limestone. A shelly limestone, *in situ*, appears in connection with the papa on the banks of the Tiraumea, near the northern limits of the area under description. The whole forms a denuded anticline of older rocks, flanked on the west by papa-rock, which at some distance is followed by the limestones of the Puketoi Range, and to the east by the coal-measures and overlying sandstones, followed by papa and limestone, as on the west side. The old rocks to the north disappear under the younger series, but to the south and south-west the old slates and sandstones are continuous for a considerable distance, and, as an unbroken line of outcrop, probably continue as far as the vicinity of Eketahuna.

TABLE OF FORMATIONS REPRESENTED.

III. Upper Miocene.
- (*a.*) Shelly limestones.
- (*b.*) Papa-clays and soft, fossiliferous sandstones.

IV. Lower Miocene.
- (*a.*) Brown sandstones.
- (*b.*) Sandstones, conglomerates, and shales with coal-seams.

X.–XII. Trias (?) or Carboniferous.
- (*a.*) Sandstones, mudstones, and indurated shales, with nests of hæmatite and bands of jasperoid rock.

III.—Upper Miocene Rocks.

These cover an extensive area in this and the adjoining districts to the north, north-east, and south. The upper division—(*a.*) Shelly limestones—appear as rocks *in situ* near the northern limit of the estate, and as isolated masses on the higher hills of the eastward part; but at any point their development and importance is not great.

(*b.*) *Papa-clays and Soft, Fossiliferous Sandstone.*—These rocks appear on both sides of the estate (east and west sides). On the west side they have within its boundaries but a limited extent between the Palæozoic rocks and Tiraumea River. Towards the base the beds are soft brown sandstones, alternating with or followed by shelly beds. Above these lie sandy or marly clays containing fossils and cement concretions. On the central part of the estate the lower beds of this formation extend throughout, but lie nearer the central part towards the western end. These beds are sufficiently fossiliferous to afford clear and distinct evidences of their age. The stray shells and shelly beds in these rocks afford lime to the soils which they produce, and hence the papa-country is superior in its soils to those resulting from the degradation of the sandstones of the coal-bearing series.

IV.—Lower Miocene.

(*a.*) *Brown Sandstones.*—These strike north and south through the middle part of the estate, and form strata dipping to the eastward, and are of little further interest than the indication they afford of the continuity of the coal-bearing series, the outcrop of which lies between them and the the old Secondary or Palæozoic rocks.

(*b.*) *Sandstones, Conglomerates, and Shales with Coal-seams.*—These underlie the brown sandstones with apparent conformity. The conglomerates can be traced from the Tiraumea on the north to the southern end of the estate, and to the west of these lies the line of coal. Coal has been discovered at only one place—at Cook's Tooth—and there, so far as explored, the seam is not of workable thickness. To the northward there is evidence of the outcropping of coal-shales and possible seams of coal in the various overgrown slips that occur on the side of the ranges, and an intelligent prospector would have no difficulty in following the line of coal in that direction. To the southward, as far as the saddle leading into the next watershed, the line of outcrop runs along a gully, where either by driving or sinking the coal should be reached.

So far, it is the existence of coal and the probability only of its occurring in seams of workable thickness that has been proved. The seam, as exposed in the pit put down alongside the road at Cook's Tooth, is crushed, and forms part of a slip which has affected one-half of the hill, on the north-western side of which the outcrop takes place. The measures exposed indicate the conditions under which thick and workable seams of coal are deposited, and it is from such premises that the opinion is expressed that a seam of coal of workable thickness may be found. The quality of the coal is indicated by the following analysis of it made in the Colonial Laboratory at Wellington :—

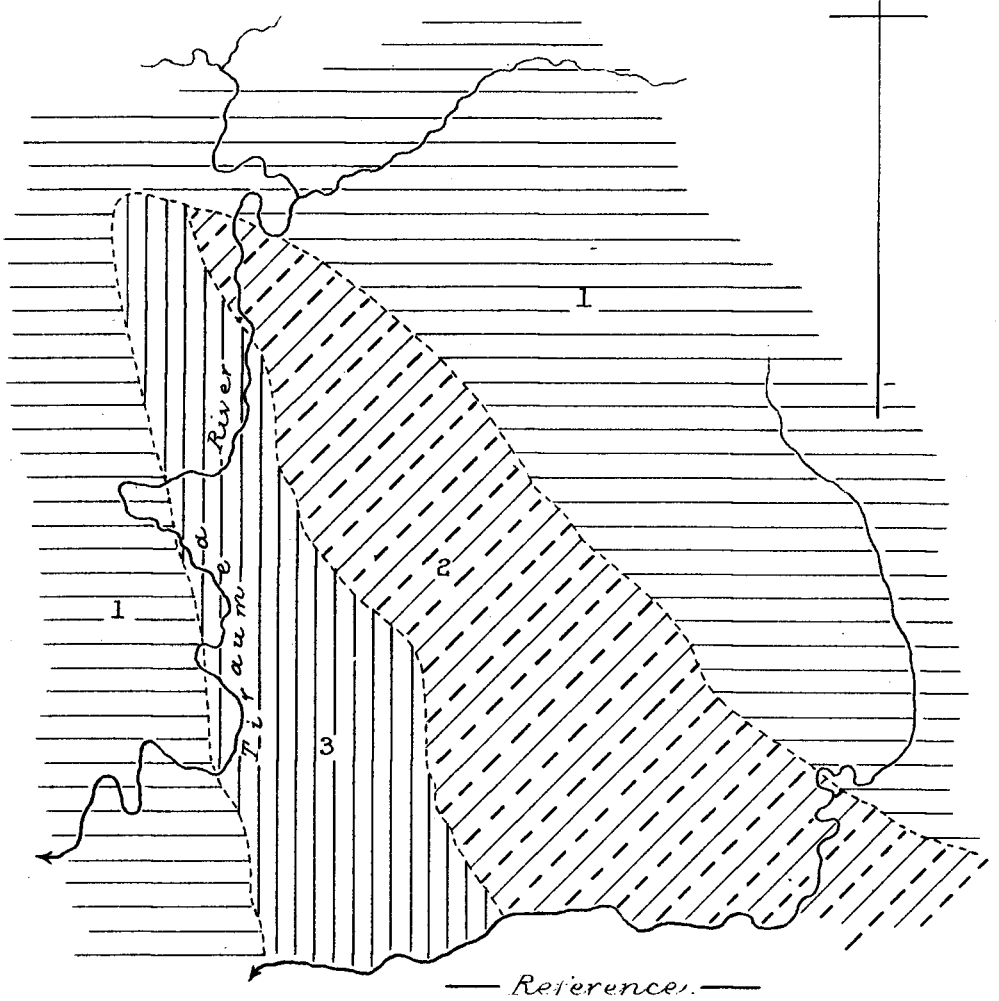
"*Analysis* of No. 7271, brown coal, from Tiraumea Estate, Wairarapa North,—

Fixed carbon	39·13
Hydro-carbon	22·82
Water	20·41
Ash	17·64
	100·00

Evaporative-power, 5·1lb."

GEOLOGICAL SKETCH MAP
— OF THE —
TIRAUMEA ESTATE.
(Waiararapa North.)

By A. McKay. F.G.S. Mining Geologist.



— Reference. —

1 — *Papa & Limestone.*

2 — *Coal-bearing Rocks.*

3 — *Old Rocks. (possibly Gold-bearing).*

— Scale. —
One mile to an Inch.

C.H.P. del.

The earlier samples forwarded by Mr. Warren returned a higher evaporative-power than this, but the samples taken in the latter case, though possibly to some extent waterlogged, were otherwise fair examples of the coal as it appears at and near the surface.

X.–XII.—Trias (?) or Carboniferous.

(*a.*) *Sandstones, Mudstones, and Indurated Shales, with nests of Hæmatite and Bands of Jasperoid Rock.*—These rocks, lying to the westward of the coal-outcrop and the same line, have a maximum breadth of exposure towards the southern end of the estate of about one mile. The features over this part are that of somewhat steep hills, with valleys of moderate breadth between. Owing to the presence of lime in these rocks the soils produced are good. The ferruginous rocks are, of those belonging to this formation, of the chiefest interest. Some of them might possibly be gold-bearing; and it is in rocks of the same age and character that copper occurs at Maharahara, in the Ruahine Range, some twelve miles to the north of Woodville.

Alex. McKay,
Mining Geologist.

The Under-Secretary of Mines, Wellington.

DEPOSIT OF LIGNITE AT MAURICEVILLE, WAIRARAPA NORTH.

Report on, by Alexander McKay, F.G.S., Mining Geologist.

Mr. A. McKay to the Under-Secretary of Mines.

Sir,— 14th May, 1896.

I have the honour to inform you that I visited, on the 11th May, the outcrops of coal on Mr. Kummer's farm, near Mauriceville, and submit the following report on the same:—

Report.

A little above the railway-station at Mauriceville, and on the western bank of the Kopuaranga, an outcrop of old rock (whether of Trias or Carboniferous age could not be determined) takes place, and forms, for a distance of nearly a mile, the hills and spurs immediately overlooking the low grounds of the valley. On three sides—north, south, and west—the old rocks are followed by sandy clays, in which and resting on the old rock are at least three seams of lignite. That on Mr. Kummer's land, being the lowest in the sequence, rests directly on the old sandstone of Trias or Carboniferous age. The strike of the seam is nearly N.–S. and the dip west at an angle of about 25°. The thickness of the seam is from 2ft. to 2ft. 6in., but only portions of this are of a quality better than a Carbonaceous shale.

No higher seams have been laid bare on Mr. Kummer's land. Within the section next to the south, belonging to A. Larsen, three small seams are exposed in the bed of a creek passing through the section. None of these are thick enough to be of any value, but they are superior to the lower seam where that was examined by me on Mr. Kummer's section. In every case the lignite seams are followed by sandy papa-clays, of a thickness approaching 200ft., next to which are, in places, loose arenaceous sands that in turn are followed by impure shelly limestones, passing upwards into shelly limestones of better quality. The seams of lignite are too thin and too poor in quality to be of any value now or in the near future.

Alex. McKay,
Mining Geologist.

The Under-Secretary of Mines, Wellington.

Analysis of Lignite from near Mauriceville.

Fixed carbon	45·01
Hydro-carbon	24·75
Water	25·12
Ash	5·12
	100·00

William Skey,
Analyst, Mines Department.

Approximate Cost of Paper.—Preparation, not given; printing (2,950 copies), £45 10s.

By Authority: John Mackay, Government Printer, Wellington.—1896.

Price, 1s. 3d.