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## GEOLOGY OF THE SOUTH-WEST PART OF NELSON AND THE NORTHERN PART OF THE WESTLAND DISTRICT

(REPORT ON THE).

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,—

Mines Department, Wellington, 18th August, 1895.

I have the honour to forward my report on parts of the Grey and Buller Valleys and the Paparoa Mountains, in the district of the west coast of the Middle Island, in which I was engaged during September, October, parts of November and December, 1894, and parts of February and March, 1895.

During the latter part of November and the first half of December, 1894, I was engaged with Mr. N. D. Cochrane, Inspector of Mines, in making an examination of a portion of the Mokihinui Coalfield, a joint report on which has already been presented; and during the latter part of January and till the middle of February, 1895, I accompanied Mr. Gordon, Inspecting Engineer, on a trip to the east district of Auckland (the Urewera country), the report on which is also a joint one; and, again, I accompanied Mr. Gordon to the west coast of the Middle Island, and with him made an examination of the different blocks of land reserved for mining purposes in the Westland District, north of the Mikonui River, and in the south-west part of the Provincial District of Nelson. The report on this work is also a joint one.

In compliance with your directions, the examination of the region of the Paparoa Mountains, and parts of the Grey and Buller Valleys, was made principally with the object of studying the nature and source of the gold deposits of that district. To do this involved the necessity of paying some attention to the general geology of the district, and a study of the lithological and petrological characters of the rocks, their mineralogical composition and contents.

In exploring for mineral veins likely to contain metalliferous ores or gold, more especially the latter, I have shown that the chief areas over which auriferous quartz lodes occur, or may be expected to occur, extend—

1. As a narrow belt along the east side of the Inangahua Valley, from near the Buller River to Reefton. This work was first undertaken during January, 1874, when I examined the gold-bearing rocks of the district, distinguishing them from the associated Devonian series, and traced them from Rainy Creek and Merrijigs north to Larry's Creek; and, during the latter part of December, 1875, from Rainy Creek, through Merrijigs, in the direction of Big River to Antonio's Flat; and in 1882 I again examined the same district for the purpose of clearly discriminating between the Carboniferous (auriferous) and the Devonian (non-auriferous) strata of the district, and determining the limits of each. Also at this time I examined and determined the limits of the Lankey's Gully cements, lying between the two branches of the Inangahua River, and the same rocks lying farther to the northward.

2. The auriferous rocks occurring as a wedge-shaped area of limited extent, stretching along the middle or lower slope of the Mount Davy Range, from the Grey River at the upper end of the Brunner Gorge to within the watershed of Ford's Creek. The reefs of Langdon's Creek occur within this area.

3. The rocks of the Paparoa Range, from the northern end of Mount Davy and the source of Ford's Creek to the northern source of Moonlight Creek. This area is of considerable extent, and contains numerous lines of reefs, some of which are of gigantic dimensions, and probably auriferous to a degree that will enable them to be worked for gold. All the creeks draining from this range, with one exception, are gold-bearing, and thus give evidence of the auriferous character of the rocks into which their channels have been cut.

4. An area of semi-metamorphic and unaltered slates and sandstones that occupies part of the Waimangaroa Watershed, and thence extends through Mount William south across the Buller Valley as a narrow belt, the rocks of which are well displayed in these localities, and in the road-cuttings from the east bank of the Little Ohika for a quarter of a mile along the road through the Buller Gorge. A small area of slates invaded by granites, and also containing quartz-reefs, appears on the banks of the Buller River, between the Inangahua Junction and a mile and a half farther down the river.

These rocks occupy but a very limited extent of the total area recently examined within the Grey and Buller Watersheds, as far inland as the east slopes of the Brunner and Victoria Mountains, from the Buller to the Brown Grey, and west of a line from the Bog Saddle (leading from the Upper Grey into the Buller Watershed) to Lake Brunner. Within these limits, excluding the Matakitaki and Mangles Watersheds, all the important gold-workings of the Grey and Lower Buller Valleys are to be found, and no effort has yet proved successful to trace the gold to the schists and unaltered rocks of the Spencer Mountains and the main range to the south-west; and it does appear almost a necessity that the gold found in the low grounds of the westward region has been liberated from rocks confined to the western area.

The rocks of the higher part of the Paparoa Range, from the source of Slaty River and Bullock Creek to the Buller Gorge, are gneissic schists, passing sometimes into granites, and at other times into mica schist. Throughout, the whole of this series of rocks are remarkably barren in metal-liferous ores, and it was in vain that they were searched for auriferous quartz-reefs or other indications of the presence of gold. As the rocks, on examination, are unpromising in appearance, this unfavourable view is confirmed by what has been the experience of the alluvial miner, whose trips into the so-called granite region, as regards gold-getting, have always been without success; and systematic and successful workings have never been carried on within the area covered by these rocks except in localities where it may be clearly shown that the gold has been derived from a distant and a different source.

The auriferous Maitai series of rocks, which are of Carboniferous age, must therefore not only be regarded as supplying gold to the creeks and mountain streams, of which they form the bed and bounding valley slopes, but also they must have largely contributed gold to those alluvial formations that are at some distance from slate areas, and that usually rest on tertiary clays or soft sandstone. Thus the presence of alluvial gold in the gravel deposits of the low grounds may indicate the source of the gold in one case as being in the neighbouring range, and in other cases as being at a considerable distance. For example, at Langdon's, Blackball, and Moonlight, on the north-west side of the Grey Valley, the gold is mostly derived from the slates of the adjoining range, while on the south-east side of the Grey Valley, from the Arnold to the Big Grey, it would be hard to say from what particular area of slate the gold of Nelson Creek, Orwell Creek, or Napoleon Hill has been derived.

These gravels on the south-east side of the Grey Valley extend into and along the same side of the Little Grey Watershed, and thence into the Inangahua Valley, along the east side of which they are found as far as Coal Creek. They form a belt of country varying from two to five miles wide, and the gravel formation is of great thickness—300ft. to 600ft. On these gravels, as a false bottom, rest the alluvial deposits of modern date, which constitute the wash of the many gold-mining localities that lie along this belt of older gravel formation. As to the south-east of the boundary-line of the gravel formation, very little gold-mining has been, and scarcely any is at the present time, carried on; it is a fair, nay, the only inference that may be drawn, that the gold in the superficial modern deposits of the creek valleys has been derived from the older gravels that underlie and form the surrounding hills. This, by those having any knowledge of the facts, will scarcely be denied; and naturally from this follows the inquiry: Are these older gravels likely to afford gold-bearing strata rich enough to pay for working (*in situ*) without the interposition of the natural processes of sluicing and concentration along the water-channels of the district, as has been in the case of the creek gravels already worked? Many miners believe they are auriferous, and would pay to work, but perhaps the greater number contend that no gold is to be got from the "Old-man bottom," the term by which the alluvial gold-miner designates these gravels.

I agree with the minority in this case, and am of the opinion that in many instances the "Old-man bottom" is worked under the belief that, in the particular instance, the gravels do not belong to the same series, but to a younger formation. Such differences of opinion might be maintained with a show of reasoning when the higher beds, or beds that outcrop at a low angle, are concerned; but when it can be shown that the auriferous stratum occupies the middle of the gravel series as developed in a particular locality, or it may be the lowest stratum, then it is hard to see how it could reasonably be contended that these gravels are non-auriferous. But while it may be admitted that the "Old-man bottom" is thus a source of gold to the younger drifts within the area over which it extends, the origin of the "Old-man bottom" itself, and the original source of the gold it contains, is a much more debateable question. This has at some length been discussed in a former report dealing with the northern part of the Westland District,\* and need not be more than adverted to in this place.

Another condition of the occurrence of gold, and another form of mining, is the beach-workings and the mining of auriferous black-sand deposits at higher levels, and often at a considerable distance inland from the coast-line. Such deposits within the district examined are found over the greater part of the coast-line and immediately inland, but are more noteworthy in the northern and southern parts. The northern part, extending from the Buller River to Charleston, has yielded very large quantities of gold, and supported a large mining population for a long series of years, and is still very far from being exhausted. In the southern part of the district, from Grey-mouth to Canoe Creek, the recent black-sand deposits on the sea-shore and the raised beaches further inland have also been very productive, and are still yielding a large return of gold.

\* "Geological Explorations of the Northern Part of Westland," Goldfields and Mining Reports, 1893, p. 132.

Gold-workings in cements of Cretaceous date are also likely to develop into considerable importance, and prove a comparatively permanent form of mining in both the Grey and Buller Valleys. In the Grey Valley, and on the south-west part of the Paparoa Range, the beds in question have been but little prospected with the direct purpose of proving them gold-bearing, but there lacks not indications of their auriferous character, both in the Mount Davy Range and in the Valley of Slaty Creek and Big River. In the first-mentioned part of the district a great development of coarse breccia-conglomerates and pebbly quartz-drifts extends through the range, from the slopes of the Grey Valley to the coast-line between the Nine-mile and the Twelve-mile Creeks, north of Greymouth. The coarser material of this division of the cements resembles the breccia-conglomerates of the Horse Range and Trotter's Creek that form the lower strata of the Shag Point Coal-field, in the Otago Provincial District, where, of somewhat finer grain and not quite so angular in character, it resembles the deposit of the Blue Spur, at Tuapeka. The finer and more quartz material, which is the higher in the series, resembles closely the quartz-drifts of Central Otago, where, over a widely-extended area, they are often very rich in gold.

In the Buller Watershed, along the east side of the Inangahua Valley, both kinds of deposit are developed; the coarser brecciated material within the valley of Boatman's Creek and the quartz drifts from Rainy Creek to the gorge of the Buller River, on the west slope of the Brunner Mountains.

The vast formation of angular brecciated material represented in Hawk's Crag, in the middle part of the Lower Buller Gorge, has not been proved to contain gold, but, so far as has been ascertained, no one has thought of testing any part of this formation with the object of proving it auriferous; nor may it be said does it hold out any great prospects of rewarding efforts to show that it is payably auriferous, but there is quite a possibility of its being so. The arguments in favour of the Hawk's Crag breccias being gold-bearing are, that the material, though angular, has been transported from a distance, and therefore some sort of arrangement favourable to the aggregation in particular horizons of the gold it contains must have taken place. The component rocks of the breccia material, though various, is mainly a subschistose rock, which, when *in situ*, was likely enough to contain gold-bearing reefs. Unfortunately, so far as proved, the gneissic schists of the Paparoa Range do not contain gold.

While dealing with the probability of gold occurring in cements of Cretaceous date, I may close this by remarking that, during a recent visit to the Upper Buller Valley, in which I accompanied Mr. Gordon, Inspecting Engineer, we were both strongly impressed with the evidences that a very large part of the gold found in the valleys of the Maruia, Matakītaki, Mangles, &c., have been directly derived or liberated from conglomerates and pebble-beds under- and over-lying the principal or lower coal seams. The facts constituting the evidence on which our opinion as to the auriferous character of the conglomerates referred to have been known to all during the last twenty years or more, and in a vague way have been speculated upon by Mr. Cox when reporting on the geology of the district.\*

The facts are not more clear now than they have been at any time during the past twenty years; but they are such as lead to the very definite conclusion that the conglomerates referred to are a great storehouse of gold, and are likely to prove of the utmost importance in the near future, now that attention has been pointedly drawn to them.

Of course it remains to be proved whether the gold is widely dispersed throughout a great thickness of gravel or conglomerate cement, or whether it is concentrated so as to occur as rich deposits, allowing of its being mined from particular bands of conglomerate. From the well-rounded character of the bulk of the conglomerates the inference is that the gold will be found as rich deposits in particular horizons, although, at the same time, the cements may be generally gold-bearing to a less degree.

The Under-Secretary of Mines, Wellington.

I have, &c.,

ALEX. MCKAY.

## GEOLOGY OF THE GREY AND BULLER VALLEYS.

### GENERAL SKETCH.

*Grey Valley.*—The principal source of the Grey River is Lake Christabel, which lies towards the south-western end of the Spencer Mountains. Towards the east, these mountains are formed of sandstone and indurated shales of probable Carboniferous age, followed at places by calcareous breccias, and diabasic ash-beds, red or green, that are probably of Triassic age. From beneath these, to the westward, appear mica-schists.

From Lake Christabel the Grey flows west across the schist-belt till it receives the Brown Grey coming from the north, from the junction with which it has a south-west course between schist mountains on the east side of the valley and granite mountains on the west side, till, again altering its course, the river breaks through the chain of granite mountains, and thus forms the first gorge of the Big Grey. Through the granite gorge the river at first runs north, then north-west to the point where it receives the Alexander coming from the north-east. Thence the Big Grey has a generally west-north-west course to its junction with the Little Grey, below which junction the united waters are known as the Grey River. The gorge of the Big Grey and the course of the Alexander River are in granite or gneissic rocks; but around the sources of the Snowy River, a tributary of the Little Grey, the granite gives place to unaltered rocks consisting of sandstones and slates, forming part of the auriferous series of Reefton (Maitai series of Carboniferous age). These rocks, as a belt four to five miles wide, extend north-east to the Inangahua, and from Merrijigs north to the reefing district of Crushington and Murray Creek.

The Little Grey has, from its source to its junction with the Big Grey, a south-west course. Its broad valley is filled with recent alluvial shingle from Squaretown to the junction with the Big Grey. These recent alluvial deposits are mainly confined to the low grounds of the middle part of the valley and its north-western side. On the south-east side the valley is filled with a vast accumulation of gravels of Pliocene age that are cut across by tributaries of the Little Grey, such as Slab-hut Creek, Antonio's Creek, Adamstown Creek, and Blackwater. These and the lesser streams falling into them have so cut down and sculptured the Pliocene gravels (usually known as "Old-man bottom") that they now form broken hilly country, full of deep narrow creek valleys.

On the north side of the lower part of Big River these gravel hills for a time terminate, and high level river-terraces, formed by the action of the Big Grey, take their place. Several streams rising in the Paparoa Range join the Little Grey from the north-west. The largest of these, the Otututu, or "Rough River," falls into the Grey just below the junction of the Little Grey. After debouching from the granite mountains, among which it takes its rise, the Rough River has its course for five or six miles across an alluvial plain built up of material mainly derived from the mountains in which it takes its rise, and which is therefore due to its own action.

Below the junction of the Little Grey with the Big Grey the united waters are denominated the Grey River, and the valley of this part of the watershed from the junction to the sea, the Grey Valley. The lower alluvial grounds of this part are from two to five miles wide. These lower lands are limited on the south-eastern side by a belt of broken hilly country, which, having a breadth of from seven to eight miles, extends from the southern bank of the Big Grey to the Arnold Flat, a distance of nineteen miles, and is continued to the south-west across the valley of Stillwater Creek to the water-divide leading into the New River basin. This belt of hilly country is broken through by the Ahaura and Arnold Rivers, and its whole breadth is traversed by Nelson Creek, the main source of which comes from Lake Hochstetter. Numerous smaller streams take their rise among these hills, and generally follow a north-west course to their junction with the Grey River. These hills are formed of Pliocene gravels ("Old-man bottom"), and are nearly in direct continuation of the same gravels on the south-east side of the Little Grey Valley. All the streams breaking through or taking their rise in them are gold-bearing, and in the beds of many of them the gravels have proved exceedingly rich in gold.

South-east of this line of hills the country is of lower elevation, and broad shingle-terraces (due to action of the larger rivers, the Big Grey, the Arnold, &c.) extend from the south-eastern limits of these hills to the foot of the high mountains forming the outermost of the series of ranges that culminate in the main axis and water-parting between the east and west coasts of the island.

On the northern side of the lower part of the Ahaura River there is an alluvial gravel plain due to the action of that river when running at a higher level. On to this plain Orwell Creek debouches, at a point about one-third of its total length from its source. The Ahaura runs in a deep channel, having on the south-western banks steep cliffs of gravel belonging to the "Old-man bottom." The lower part of its course is through a deep narrow gorge to the lower river plain of the Grey Valley, across which it has a short course to its junction with the main stream.

The Arnold River from Lake Brunner flows along a broad valley, the surface-gravels on its north-eastern side for about a mile back from the stream being due to the modern action of the river, a lesser breadth on the southern side being due to the same action.

Beyond the broad alluvial tract of this part of the Grey Valley, or to the south-east, the granite belt extends from the gorge of the Big Grey to and across the Ahaura River, and thence to the neighbourhood of the Kopara, and beyond this along the south side of Lake Brunner into the watershed of the Teremakau and the Westland district. East of the granite-belt there is a broad rib of mica-schist, the true limits of which have not yet been ascertained, and beyond this the unaltered Palæozoic rocks, forming the main chain and extending eastward into the Amuri district of Nelson. On the north-west side of the Grey Valley, between Slaty River and Blackball Creek, alluvial flats near the level of the river are confined to the lower parts of Slaty River and Moonlight Creek. Along the western bank of Slaty there is a considerable area of such land, now mostly occupied by farmers. In the lower Moonlight the area is less, and the low grounds along this stream, both above and below the junction of the Meg River, form a narrow strip on both banks. Elsewhere from Slaty to Blackball, and south-east of the slate range or coal rocks, "Old-man bottom" appears at the surface, unless it is covered by high-level creek gravels of younger date. In Blackball and Ford's Creeks there are no heavy bodies of gravel-deposit due to other action than that of the streams at present operating in the denudation of the country.

Between Blackball Creek and the Brunner Gorge, on this side of the valley, there is a fringe of shingle of limited breadth deposited by the Grey River, the mountain-creek wash found in the beds of the several streams of this part being derived from a narrow belt of slate on the slopes of the Mount Davy Range, or from the conglomerates and breccia conglomerates at the base of the Cretaceous formation, as developed in this part of the Paparoa Chain.

The Grey Valley below Brunnerton, as far as the Limestone Range running from Point Elizabeth to Marsden on the New River, shows an alluvial triangular flat on each bank of the river. That on the northern side extending some distance up Coal Creek, that on the southern side being bounded by hilly country lying towards the New River Watershed.

*Buller Valley.*—The area of the Buller Valley here coming under consideration, in the upper valley embraces the watersheds of the Matakita and Maruia Rivers, both of which take their rise in the Spencer Mountains, and flow north in nearly parallel courses to their junctions with the Buller. From the Grey Valley a low depression leads by way of the Bog Saddle into the valley of the Maruia, opposite, or nearly opposite, the junction of the Alfred River. The Bog Saddle is a bush-covered plain, formed by the action of the Maruia River when this was an affluent of the Grey, and not, as now, of the Buller River. The diversion of the Maruia to its present course, and the lowering of its bed, has cut away the eastern margin of the old high level river-bed, and the erosion of

the valley of the Brown Grey has, in like manner, circumscribed the former area of the shingle-beds now confined to the higher level of the Bog Saddle. Towards the source of the Maruia River the rocks of the Spencer Mountains consist of sandstones and slates of Carboniferous age. Appearing from beneath these, and forming the mountains between the Alfred and the upper part of the river and stretching north-east towards the sources of the Glenroy and Matakītaki Rivers, there is a continuation of the schist rocks, described as lying to the south-east of the granite belt in the Grey Valley. On the plain opposite the junction of the Alfred there is an isolated mountain of marble, or crystalline limestone, and the same calcareous beds stretch north-east along the right bank of the Alfred River.

This limestone appears to rest upon gneissic granite. Granite rock towards the source of the Glenroy has but a limited development; but, on the left side of the valley, it forms the mountains to and round the sources of the Inangahua River and the Victoria and Brunner Mountains, stretching along the west side of the Maruia Valley to the Buller Gorge above the Lyell Township. From the Alfred junction to the junction of the Warbeck, seven miles below Walker's Homestead, a distance of twenty-one miles the Upper Maruia Plains stretch, principally, at first, on the west bank of the river as far as the Home Station, and finally, for the last seven miles, the greatest breadth of level land is on the east bank of the river. Generally, these plains are open lands, grass-covered, with a species of tussock; but large areas are covered with a stunted manuka scrub, the area covered by which is said during late years to have been greatly increased.

The soil of these plains, that embrace a total of about 22,000 acres, is at some places of fair quality, but the bulk of it is very poor, and all vegetation, owing to the severity of the climate, is at a standstill from the middle of April to the middle or end of October. A little above the junction of the Warbeck, a line of moraine hills stretches across the valley from the east slopes of the Victoria Mountains on the west side, to the hills bounding the opposite side of the valley, which forms the water-parting between this part of the Maruia and the Glenroy Valley. This line of terminal moraine is well marked, and explains the character of the terraces along the upper valley of the river to the Alfred junction. This part of the valley, on the disappearance of the glacier that once filled it, was for a long period a lake, which was gradually filled with shingle to the level of the highest terrace or moraine, and subsequently, by the action of the river, the deposits accumulated in this manner were cut down to form the lower terraces and bottom flats along the margin of the river.

Between Station Creek and the Warbeck the mountains on the east side of the valley are mainly composed of Cretaceous strata, consisting of conglomerates and sandstones, constituting the lower part of the coal-bearing series. Below the Warbeck, gneissic granite appears on both sides of the valley; and, from the Upper Warbeck, this rock constitutes a range of mountains on the right bank of the river to within twelve miles of its junction with the Buller. The lower part of the valley is, for the most part, narrow, deep, and gorgy, the only extent of level land being on the left bank, from twelve to fifteen miles above the confluence with the Buller. About eight miles above the junction, the granite or gneiss gives place to coal-measures belonging to the Cretaceous or Cretaceous-tertiary series. These form the mountains on the right bank, and, crossing the river to the westward, extend some distance in that direction amongst the granite peaks of the Brunner Mountains.

The Matakītaki, like the Maruia, takes its rise in the Spencer Mountains, and for the first fifteen miles flows in a northerly course through or across a succession of sandstone and shale, schist, or granite mountains, as has been shown the Maruia does. Below the point indicated, the Matakītaki has a west course for about twelve miles. This part of its course is across granite and coal-measures, while there are also considerable developments of superficial gravels that are of importance, they being auriferous. Below the junction of the Glenroy, the Matakītaki resumes its north and south course, and flows along the west side of its valley to its junction with the Buller. On both sides of this lower part of the Matakītaki Valley the rocks are of Cretaceous or Cretaceous-tertiary age, and consist of limestones, marly strata, and beds of sandstone or quartz conglomerates and shales, with coal-seams of greater or lesser thickness and value. The lower terrace lands and the bed and immediate banks of the river show the presence of a shingle largely derived from the harder rocks towards the source of the river; but also, in a great measure from beds of conglomerate occurring as part of the Cretaceous formation. This conglomerate, it has been ascertained, is gold-bearing to such an extent that it becomes of great importance in considering the immediate whence of the gold found in the Matakītaki and Mangles Rivers, and also, to some extent, that found in the Maruia and its tributaries.

*Glenroy River.*—This takes its rise between and near the sources of the Maruia and the Matakītaki, and flows north-west and north to its junction with the Matakītaki. Its source is in schist, its middle course in the conglomerates and sandstones of the coal-bearing series, and its lower course for about two miles through granite, and finally for a short distance across coal-measures to its junction with the Matakītaki. All the gold-workings in this part of the Buller Watershed are, with the exception of those on the Alfred, either upon a granite bottom or upon different members of the Cretaceous formation; and it is a remarkable fact that generally, except on the Alfred River, to the eastward of the Cretaceous formation, no payable gold has been found.

*Upper Buller to the Inangahua Junction.*—This part of the district includes the narrow valley of the Buller below the Maruia, including Lyell Creek, and New Creek areas, and the river valley below the latter to the Inangahua Junction. The gorge above the Lyell passes through frequent alternations of granite and comparatively unaltered rocks. Near the junction of the Newton River a rib of Cretaceous-tertiary limestone and associated marly beds are deeply involved as vertical strata between granite. The same thing happens between the bridge over the Buller, one and a half miles below Lyell, and the lower part of New Creek, where a representative development of the Cape Foulwind limestone, underlain by coal-measures, occurs, standing at very high angles between the auriferous slates of New Creek and the granite of the lower part of Lyell Creek. Below the bridge

cretaceous-tertiary and coal-bearing rocks, overlain by terrace gravels, extend along the banks of the river for some two miles, beyond which granite again appears in the hills on the left bank and along the road-line. The granite further down the valley is followed by a narrow rib of slate, then, near Junker's Hotel, by grits, &c., of the lower coal-measures, followed by limestone and dark-coloured marly strata which, dipping west underneath the recent alluvial gravel-beds, reach to the Inangahua Junction. The granitoid rocks on the north side of the Lyell Gorge do not extend more than a few hundred yards up Lyell Creek, and in the New Creek area they appear to be absent altogether.

*Inangahua Valley.*—The Inangahua River and its principal tributary, the Waitahu or North Branch, both take their rise in, and draw most of their waters from, the southern end of the chain of granite mountains that forms the water-parting between the Maruia and Inangahua Valleys. About fourteen miles above Reefton, slate succeeds the granite on the south side of the Inangahua; but no slate appears on the north bank in contact with the crystalline rocks, a development of coal rocks taking place between the Devonian rocks and the granite on this side of the valley. The junction of the two older series is thus obscured. A narrow belt of Devonian rocks extends from the lower part of Lankey's Gully south across the Inangahua to near the source of Rainy Creek. In the direction of Deep Creek the rocks show evidences of having been subjected to metamorphic alteration. They differ indeed from the typical rocks of the auriferous series, but it has not been definitely proved that they are other than the gold-bearing series of Reefton, or of an age greater than that of the Carboniferous period. There are some areas of flat land in the valley of the Inangahua above Reefton, but these do not appear to have at any time been prospected for gold. These alluvial flats are now occupied in part as freehold lands. A very considerable area of the range east of Lankey's Gully, lying between the two branches of the Inangahua, has its higher part formed of grits and conglomerates, constituting part (the lower part) of the coal-bearing series. These are gold-bearing in Murray Creek and in Lankey's Creek, and probably in other parts where they are present. The Devonian rocks form the lower part of the range to the east of Murray Creek and Lankey's Gully, but after a time they sink to lower levels. Along the line of Garvie's Creek the coal rocks fill a deep syncline, and thus it is not seen what Palæozoic rocks underlie the coal-measures, nor in what manner these make junction with the granite.

West of the Devonian rocks these are, overlain by the Maitai series, the auriferous rocks of this district and the neighbouring mining districts of Boatman's to the north and of Merrijigs and Big River to the south. The district to the south, including the Big River area, has already in this connection been dealt with. Boatman's and Larry's to the northward are in the same line of country-rock which, on the disappearance of the Devonian strata, is continued along this side of the valley to the Buller River. The syncline filled with coal rocks, which has been described as extending along Garvie's Creek from the south, to the north branch of the Inangahua, is continued further to the north, and has a remarkable development in the upper part of Boatman's Creek. It does not appear to cross or reach as far as Larry's Creek. The Devonian rocks also are not traceable as far as Boatman's Creek, they in this direction being overlain and surrounded on three sides by the auriferous series. Near the Town of Reefton the auriferous series are succeeded by a considerable development of the coal-bearing rocks, but the junction between the two is often obscured by terraces of river-gravel that are now at a considerable elevation above the lower levels of the opposite plain.

The coal rocks are seen to extend along the lower flanks of the range between the North Branch of the Inangahua and Boatman's Creek, near Caplestone. The coal rocks are well exposed in the valley of Boatman's Creek, at the Township of Caplestone, and along Little Boatman's Creek to the foot of Specimen Hill. They are followed by a massive development of Pliocene gravels ("Old-man bottom") which, forming high terraces or broken hilly country, continue past Boatman's to and beyond Larry's Creek, and in the same direction across Landing and Coal Creeks to within a short distance of the Buller River. Boatman's, Larry's, Landing, and Coal Creeks, of which Larry's Creek carries considerably the greater volume of water, are mountain streams, all of them taking their rise in the granite mountains to the east of the Inangahua Valley, and all of them traverse the low grounds of the valley to reach the Inangahua River, which has its course along the foot of the mountains on the west side of the valley.

A considerable breadth of the low-lying recent alluvial ground is found between the "Old-man" formation on the east side of the valley and the river towards the southern end of the plain. This area of lower and more recent alluvial land gets narrower as the valley is followed to the north, and this for a time terminates at half a mile to the south of the Landing. Terrace flats are developed to a considerable extent on the east side of the lower part of the valley, between the Landing and the Junction. Below Reefton, Devil's Creek makes junction from the south. In the valley of this stream the fundamental rocks are the auriferous series of slates and sandstones, in the rocks of which a considerable number of quartz-mines are being worked. Coal rocks are also developed to a moderate extent on the higher lands towards Merrijigs. Deposits of gravel belonging to "Old-man bottom" also occupy the higher ground between the Sir Francis Drake Mine and Merrijigs, and also along some parts of Maori Creek. Coal rocks are to a limited extent present in the lower part of Devil's Creek, while towards the Midland Railway-line and the saddle leading to Squaretown there is a great development of Pliocene gravels or "Old-man bottom." These Pliocene gravels form high cliffs on the left bank of the river in its passage from the east to the west side of the valley. On reaching the furthest west, the river turns to the north and closely follows the lower spurs of the Paparoa Range to its junction with the Buller.

*Lower Buller Gorge.*—From the Inangahua Junction to the ferry at the foot of the gorge, six miles from Westport, the Buller River, breaking through the Paparoa-Papahua chain of mountains, has, for the greater part of the distance (twenty-two miles), its course through a tortuous and deep mountain gorge, presenting at places scenes of rare magnificence and savage grandeur. One mile

and a half below the Inangahua Junction the river breaks through a formation of cretaceous limestone, and has formed high cliffs on both its banks. The limestone forms on the southern side of the valley a sort of table-land between the Lower Inangahua and the Buller, below the junction. This at one time has received a deposit of river-shingle, probably by the action of the Buller before it had commenced to cut down the limestone part of the gorge. These gravels—what remains of them—are necessarily but a remnant of what they once were, and to some extent their removal has been effected along underground channels in the limestone. Some of these underground channels have been explored, and the concentrated gravels of the surface-wash found to be rich in gold—at least, gold-bearing to such an extent that a rush set in, and for a considerable time sub-alluvial workings were carried on in these underground channels. Below the limestone cliffs the valley opens out, and between the Limestone Range and the river lies the Big Swamp, extending to the junction of Coal Creek and Grainger's Point, where the river is again enclosed between the precipitous cliffs or steep slopes of a gorge. From the north the Mackley River joins the Buller opposite the middle of the Big Swamp. The Mackley flows in a transverse valley, which lies between the Mount Glasgow Range and the Lyell Mountains to the eastward. This transverse valley is continued across the Buller and along the course of Coal Creek on the south side of the main valley, the limestone hills between Coal Creek and the Inangahua forming one side of the transverse valley, the hills between the upper part of Coal Creek and the lower part of the Blackwater the other side of the valley. At Berlin's, for a short distance the hills on the south side of the gorge are low, and a greater breadth of alluvial gravel deposit occurs here than elsewhere in the middle and lower parts of the gorge, and it is here that the chief "diggings" in the Buller Gorge have been ever since the commencement of mining in the district. At Lovell's Point the river is again confined between precipitous rocks or steep banks, although some alluvial banks are formed between the latter point and the mouth of the Blackwater.

Between the Blackwater and Hawk's Crag, immediately beyond the crag and near the Twelve-mile, there are also small areas of gravel-formed alluvial banks on the south side of the river, and there is a like small area on the north bank of the river, opposite Powell's accomodation-house, at the Twelve-mile. These small areas of alluvial deposit, in favourable situations, and the bed of the river when low, are worked for gold. Below the Twelve-mile there is an area of gravel deposit at the junction of the Big Ohika; but the gravels of this have been brought down the Ohika, and, being mostly or wholly granite, they are either non-auriferous or have not been prospected for gold. Below this point the gorge is cut through granite mountains, and so steep are the slopes to the water's edge that few opportunities are afforded for the accumulation of shingle, even between high flood-mark and what the river marks when of medium volume.

From the Inangahua Junction to a few chains west of the Little Ohika, all the rocks on the south side of the Buller Gorge belong to different members of the Cretaceo-tertiary or Cretaceous formation. The higher beds are limestones and dark mudstone marls, often, but not always, underlain by the Cape Foulwind limestone, beneath which, associated with sandstones and shales, is the upper or brown-coal series. These coal-measures rest on the breccias of Grainger's Point, and they so rest with some appearance of unconformity. The breccias of Grainger's Point are amongst the lowest beds of the sequence, and in the lower beds are very obscure in their stratification. Towards the west they alternate with beds of sandstone and sandy shales, which are followed by pebbly conglomerates, which again are followed by sandstones, the whole forming a syncline the east side of which is repeated in Lovell's Bluff, between which and the Blackwater the beds form an anticline exposing as the lowest rocks of the series, light-grey, thin-bedded siliceous shales, much indurated, and having at places the general aspect of the Cobden limestone at Greymouth. These latter rocks are followed by the higher beds described, and they constitute the west wing of the anticline to within 300 yards of Hawk's Crag, where they are followed by the enormous development of breccias that continue without intermission and without material change in their characters till they are terminated along the west side of the Little Ohika Valley. These Hawk's Crag breccias extend six or seven miles up the Blackwater, and constitute, between that stream and the Little Ohika, perhaps, or, rather, without doubt, the most rugged and inaccessible country in the whole of the Paparoa district. The same rocks form exceedingly rough country east of Mount William Ridge to Hawk's Crag, and this part of the country is unexplored, its geology being explained and mapped from what is known of the Buller Gorge and that of the Waimangaroa Watershed.

*Lower Buller and Coast-line north to Waimangaroa.*—From the lower end of the Buller Gorge the outer slopes of the ranges are granite till, passing Mount Rochfort, the steep slope west from the plateau shows coal-measures, tilted to high angles and resting on the granites. The coal-measures here dip to the westward. Along the foot of the range high-level terraces extend from the Buller Gorge to Fairburn, and below these, gradually sloping to the coast-line, are the lower flat lands which may be regarded as partly due to the action of the river and partly as a littoral marine formation. Large areas of these lower plains are swampy, and devoid of forest, and are, hence, called "pakihis." The Waimangaroa crosses this coastal plain where it is about two miles wide, east of which the river-valley gradually narrows till it becomes a deep mountain gorge. Gold is found and worked on the beaches at the mouth of the river, and also along its banks from the point where the narrower part of the valley begins to the source of the river.

*Coastal Track, Lower Buller to the Fox River.*—From Cape Foulwind to the mouth of the Nile the coast (near the Cape) for the first two miles is bold, and formed of gneissic granite, followed inland and to the south by coal-bearing rocks. Towards the mouth of the Okari and Totara Rivers it is low and sandy. East to the Buller River and the slopes of the Paparoa Range the country north of the Totara River rises gradually, and forms a gently-sloping plain to the foot of the high terrace extending between the Buller and Totara Rivers. Along the butt of this terrace, from Bald Hill to the Shamrock Claim, lie the main gold-workings of Addison's Flat, although there are at

least three other lines of gold-workings between the foot of the high terrace and the coast-line. Deposits of black sand are found in considerable areas over many parts of Addison's Flat and the slope thence to the mouth of the Totara River. Generally, however, the superficial rock deposit is a gravity beach-wash. Along the course of the Totara River the marine deposits have been carried away by the river, and a large shingle fan of river material takes their place. On the south side of the Buller the marine sands cap the brink of the highest terrace, and the succession of terraces to the river-level show by how much the land has been raised since the sea washed the foot of the Big Terrace, between Bald Hill and the Shamrock Lead. The high terrace east of Addison's Flat, some 300ft. above the level of the flat, has a width of from one mile and a half to two miles before the foot of the granite range is reached. Black-sand deposits, evidencing the presence of the sea, are also to be met with on the higher terrace, but no important gold-workings have been carried on at this higher level.

South of the Little Totara the country from the western base of the granite mountains is hilly to the sea. The Nile, the Four-mile, and the Fox River drain this area. A range of limestone hills, commencing on the coast-line near the mouth of the Totara, sweeps inland in a semi-circle from this point to St. Kilda and Brighton. The limestone (its western boundary) is furthest from the coast-line between Candle-light and the Four-mile, south of Charleston. A valley depression lies between the limestone hills and the foot of the Paparoa Range. This part is either not gold-bearing, or has not been sufficiently prospected. Coal is found along this line, and outcrops on the banks of the Fox River, and marine tertiary (Miocene) beds are also present. It is between the limestone range and the sea that the greatest interest attaches to this part of the district. Over this are black-sand deposits that have been accumulated at all heights up to fully 500ft. above sea-level. These black-sand deposits have been the mainstay of gold-mining in the Charleston district. The auriferous character is not confined to the purely black-sand beds, but the beds of granite wash (beach-gravels) widely spread over the area between the limestone and the sea are also gold-bearing. It is here that black sand deposited by the action of the sea reaches the highest level along the coast-line between Ross and the Mokihinui River. The Fox River has cut part of its course through the limestone, and in this part the river-channel is through a remarkable gorge, which is only a few feet in width, but 300ft. or more in depth.

*Coast-line, Fox River to Barrytown.*—Gold-mining in the north part of this district is limited to the beaches on the coast-line and one or two patches of high-level gravels in the vicinity of Razorback. South of Razorback and the Punakaiki River continuous beach-workings are to be had as far as the Fourteen-mile Bluff, while inland of the present coast an old high-level terrace-working extends along the foot of the ranges, from Doubtful River to Baker's Creek. There are also creek-workings in some of the various streams draining this part, and taking their rise from the southern continuation of the Paparoa Mountains. Canoe Creek and Fagin's Creek are the most important of these gold-bearing streams.

*Barrytown to the Grey Valley.*—This part of the district has a bold coast-line, and the inland district is mountainous. Gold-workings are chiefly confined to the beach, and the sea-terraces immediately at the back thereof. The conglomerates of the Ten-mile Creek are thought to be stanniferous, and probably also are gold-bearing. From the Seven-mile to the Nine-mile, and, again between the Nine-mile and the Ten-mile, a back lead is at the present time being worked, and at higher levels, 60ft. or 100ft., there is a high-level line of auriferous gravels that corresponds with the higher levels of Darkies' Terrace, between Point Elizabeth and Cobden, and west of the Limestone Range.

#### *Westland District.*

This has been fully described in the Goldfields and Mining Reports for 1893,\* so that a few remarks on the general character of the country will suffice in this place.

*Grey River to Marsden and the Valley of New River.*—The coast-line of this part is formed of a slightly elevated beach, ranging from half a mile to less than a quarter of a mile in width. Behind this, near Greymouth, are hills of tertiary clays, or, further back, and forming a range of higher hills, the southern continuation of the Cobden limestone. The valley of Salt-water Creek and the vicinity of Rutherglen shows clearly that the New River at one time had its course to the sea in this direction, the old high-level beaches being destroyed in the middle parts of the valley, and only attesting their former continuity by appearing as disjointed fragments on the ridges that are between the Salt-water and New River, and the first-mentioned and lesser streams to the north.

The valley of New River, as elsewhere described,† is due to the action of the main stream and its various tributaries on a table-land formed near its surface by gravels of the "Old-man bottom," which are present also in the adjoining hills overlain by glacier *débris* brought on to this region by the action of a branch of the Teremakau Glacier, which, passing through the gap in the mountains at and below Jackson's, filled the Lake Brunner Basin, and thence overflowed the country to the west and south-west. By this means (the action of the New River itself) gold widely dispersed was collected and greatly concentrated along the beds of the several streams within the watersheds of New River and Salt-water Creek, and these accumulations of auriferous material, together with the beach deposits, modern, and of older date at high levels, formed a source of gold that has maintained a large mining population from the early days of the Coast till within very recently.

*Teremakau Valley.*—The Greenstone or Hohonu River is the principal gold-bearing tributary of the Teremakau. The source of the gold is the same as that of the New River, and the physical circumstances under which the river-valley has been excavated differs only in this, that the Greenstone takes its rise among mountains of granite and gneiss, which may have hastened somewhat the rate at which the middle and lower valley was cut down. The granite belt which, from the south of Lake Brunner, extends through the Greenstone Mountains to the south side of the Teremakau Valley, limits, with the exception of the Seven-mile Creek and some other creeks in the

\* Geological Explorations of the Northern Part of Westland, Mining Reports, 1893, C.-3, p. 132.

† See report

already cited above, page 137.



Taipo Watershed, the eastern extension of payable gold in the Teremakau Valley. In the neighbourhood of Kumara the gold has its origin in part from the morainic hills of Dillmanstown, and those that thence extend south-west to the granite belt at the western base of Turiwhate Mountain. The river-plain that extends from Kumara to the sea, and is limited to the south by Aker's Creek, either contains, comparatively intact but covered over, a northern extension of the old high-level marine-drifts of the Houhou, Blue Spur, Ballarat Hill, and Lamplough Lead, or, if destroyed by the action of the river, its gold has gone to enrich the black-sand leads of the present beach-line and Drake's Terrace on the southern bank of the Teremakau. The sequence of the rocks in the Teremakau Valley east of the granite belt is the same as farther to the north, the granite being succeeded by the mica-schist formation, and this by but slightly altered or unaltered formations of Devonian and Carboniferous age. On the boundary-line between the two last-named formations, quartz veins occur, and it is in this horizon that the reef on Jackson's Hill has been found. The same line of reef runs over the range south-west into the valley of the Seven-mile Creek. On the northern bank of the Teremakau, opposite Jackson's, the rocks are mica-schist, and on this side of the river it is not till passing to the eastward of the junction of the Otira that the corresponding rocks to those at Jackson's are met with.

*Arahura Valley and District.*—As formerly the Arahura occupied or wandered over the greater part of the Kapitea Basin, and also at one time had outlet from the same by way of Waimea Creek, the principal features of the Arahura, Kapitea, and Waimea may be described together as one district. As in other parts of Northern Westland the coast-line is backed by a low raised beach. Behind this at most places there is a steep face leading on to a high-level terrace. This is the region of the fine black-sand deposits containing gold equally fine. Next to the south-east rise the Tertiary hills, the valleys between which are filled with wash, either of a granity or a sandstone type, according to its source—namely, of the first, the old moraines of the Arahura, or, of the second, the gravels of the "Old-man bottom," which are present, the first to a large extent in the Kapitea Basin, and the last forming the highest beds of the Tertiary sequence, and is generally found on the top of the rocks which belong to that period.

Between the Teremakau and the Arahura, eastward of the Waimea Hills, there is a very considerable development of glacier drifts that occupy the upper basin of Kapitea Creek and the lower and middle parts of the Kawaka Watershed back to the western boundary of the granite belt. The low grounds of the Arahura Valley, from Humphrey's Gully to the sea, contain some considerable areas of river alluvium, more recent than the glacier deposits mentioned. Between Humphrey's Gully and the junction of the Kawaka these are confined to the southern side of the valley; but from half a mile above the crossing of the river, on the Christchurch-Hokitika Road, the alluvial flats are on both sides of the valley, and towards the mouth of the river the breadth of these increases till they join with those of the Three-mile to the south, and to the north leave but a narrow ridge between them and the lower Waimea Valley. South-east of Island Hill there is another considerable area of river alluvium between the first and second gorges of the Arahura, while on the south side of the river, from the Christchurch-Hokitika Road to nearly abreast of the lower end of Kanieri Lake, there is a large development of gravels of the age of the "Old-man bottom" (Older Pliocene), overlain in parts by glacier deposits. These, with the underlying Tertiary clay, form the Humphrey's Gully Range, interposed between the Arahura Valley and that of the Kanieri River. East of the granite belt, the limits of which are along a line crossing the Arahura at the foot of the second gorge, the rocks consist of a triple series of mica-schists, the middle and upper of which are divided by a band of magnesian rocks, mainly Olivene. The crystalline rocks terminate near the upper end of the second gorge, and thence to the crest of the Southern Alps the rocks are unaltered Palæozoic sediments. Gold is found in the Arahura Valley almost to the source of the river, and has afforded payable results to the foot of the second gorge. At the present time there are no workings above the foot of the first gorge cut through the great moraine between Island Hill and the east end of the Humphrey's Gully Range. Recent developments at the opposite end of this range, on the Arahura slope from the Blue Spur, show that the auriferous deposits of this district are far from being exhausted.

*Hokitika Valley and Valley of the Three-mile Creek.*—The Three-mile Creek drains but a small watershed; but this is important as having yielded a large quantity of gold, and it would appear that its resources are as yet far from being exhausted. Near the sea the stream is sluggish, and on the north side its banks are low and covered by a heavy growth of forest-trees. On the south side the Houhou Terrace lies between it and the lower part of the Hokitika Valley. Below the line of the Houhou Lead, which crosses the creek at the Blue Spur Township, there is a moderately-sized flat bounded by terraces on each side. This—the gravels of it—enriched by the destruction of the upper part of the Houhou Lead, proved very rich in gold. The upper valley has been encroached upon by an off-shoot of the Kanieri Glacier (rather that of the Browning Valley passing through Lake Kanieri), and the result has been the deposit of moraines of considerable magnitude, which, with the creek-gravels, are being worked for gold at the present time.

The Lower Hokitika Valley forms a triangular flat between high terrace-lands to the north and south. These low grounds are partly due to river-action; but near the seaboard the deposits in and west of Craig's freehold must be regarded as formed by the sea. Between Woodstock and the Lower Kanieri, at Kanieri Township, moraines stretch across the valley up the Kanieri River to the Forks, and, with the hilly country between Rimu and Ross, bound thus on the south-western and north-western sides the low alluvial flats of the Hokitika Valley above the Kanieri Junction that include the Kokatahi Plain. The Kokatahi Plain is of considerable extent. It stretches north, south, and east to the limits of the mountains. The Kokatahi Plain proper lies on the north bank of the Hokitika, but here the term is used as applicable to the whole of the low grounds of this part of the valley. The Hokitika, in the middle of the plain, divides into two branches, the eastern of which is called the Kokatahi River, this again dividing into three main streams, all coming from the east or south-east.

On the east side of the Kokatahi Plain granite again forms the outer western slopes of the higher mountains, and this is followed by the same sequence of rocks that have been mentioned in describing the middle and upper parts of the Arahura Valley.

On the south-west side of the Hokitika Valley, below the Gorge, lies Constitution Hill, which is in part composed of slate. Between this and the hilly country, along the road-line from Rimu to Ross, lies the Big Swamp, from which in times of flood a portion of the surplus waters of the Hokitika finds its way into Lake Mahinapua.

The hilly country between Rimu and Ross is densely covered with forest growth, and the details of the surface are for the most part unknown, or known only to a few explorers. Its general character is, however, quite evident from what can be seen along the ordinary route of travel, and it is warrantable to say that the whole is overspread with morainic heaps, that towards the Totara River only have been modified by the action of running water. Old river-gravels underly these morainic heaps, as seen at Back Creek and Seddon's Terrace, and towards the margins they may have been acted on by streams from, or the whole body of the Hokitika, as in the case of the Rimu Flat.

*Totara Watershed—Ross and Mount Greenland.*—The Totara River takes its rise from Mount Fraser and the Cedar Creek Saddle, leading into the Mikonui Watershed. The upper and middle parts of its course are along a mountain-valley between Mount Greenland and Constitution Hill, and the river is so confined till reaching and passing the outer spurs of Mount Greenland. Seaward of this the Totara receives Donnelly's Creek, and flows along the north side of Ross Flat to the Totara Lagoon.

Between the hills and the sea from the Mikonui to the Totara extends a tract of low, level country, having its greatest breadth to the north. From the lower slopes of the spurs of Mount Greenland gold has been traced into this flat, and the portion known as Ross Flat has in past time yielded a great amount of gold, and it is known that considerable areas of very rich ground await working, capital and machinery being required to do this.

East of the alluvial plain the ridge of front hills are composed of Pliocene gravels ("Old-man bottom"), and behind or on top of these, in Mont d'Or, there is a development of what appears to be a glacier deposit. Mount Greenland, like the bulk of Constitution Hill, is formed of sandstone and slates belonging to the Maitai series of the New Zealand Geological Survey classification, and thus corresponds in age with the auriferous rocks of Reefton. The Cedar Creek rocks are of the same age. Quartz reefs occur on both the east and west slopes of Mount Greenland, but, though a considerable amount of prospecting has been done on the Cedar Creek line, the prospects have not been such as were anticipated, and "reefing," as a form of gold-mining, is developing but slowly in this part of the district.

#### DETAILED DESCRIPTION.

##### TABLE OF FORMATIONS.

###### *Sedimentary.*

- I. Recent.  
Glacier, river alluvia, littoral.
- IA. Pleistocene.  
High-level old river-channels and terraces.
- II. Pleistocene and Younger Pliocene.  
Extended glacier deposits outside the limits of the mountains. River-deposits formed prior to the advance of the glaciers. Marine gravels, &c., containing black-sand leads.
- III. Older Pliocene and Upper Miocene.  
Humphrey's Gully Beds, "Old-man bottom," Brown sands.
- IV. Lower Miocene (Marine Tertiary-beds).  
Blue fossiliferous sands and marly clays.
- VI. Cretaceo-tertiary and Cretaceous.  
Upper, Middle, and Lower series.
- X. Triassic (?).  
Beds in the Upper Teremakau Valley, resembling the jasperoid and diabasic beds of the Selwyn Gorge, Canterbury.
- XII. Carboniferous.  
Maitai series—Westland formation of Haast.
- XIII. Devonian.  
(a.) Reefton series.  
(b.) Slightly altered sub-metamorphic rocks.

###### *Metamorphic.*

- Mica Schists.  
Upper, middle, and lower mica-schists.
- Gneissic schists.  
Crystalline schists and metamorphic granite.

###### *Plutonic.*

- Massive and intrusive granites, &c.

## I.—RECENT.

*Northern part of Westland.*

(a.) *Glacier Deposits.*—Glacier deposits in course of formation are found only around the sources of the Hokitika River, and, as a factor in the liberation of gold liable to be carried to the coast-line, are of little importance. Neither are they of much consequence as affording gold directly from the morainic heaps, as these accumulate. The rocks concerned in the production of these morainic accumulations are, it would appear, not highly impregnated with auriferous quartz reefs, and, besides, the moraines themselves are accumulated in such distant and inaccessible parts of the country that they would require to be very rich in gold to tempt the miner to explore and work them.

(b.) *River Alluvia.*—In the Mikonui and the upper part of the Totara Rivers gold-workings have been carried on in the beds and immediate banks of these streams; but in this southern part of the district it is Donnelly's Creek, Jones's Creek, and a number of small streams draining from the western part of the Mount Greenland block of mountains, that yielded gold in such quantities as made the Ross district famous in the early days of gold-mining on the West Coast. Some part of this gold was undoubtedly directly derived from the auriferous Maitai rocks of Mount Greenland, but there can be no question that the greater part, found in the recent wash of the beds and banks of the various streams draining from the western slopes of the range, was derived from gravels of older date present in the creek-valleys or resting on or forming the lower slopes of the outer hills.

In the *Hokitika Valley*, above Kanieri, there have been but few, and these unimportant, workings along the bed and banks of the main stream, or of its largest tributary, the Kokatahi River, and its various affluents. Recently it has been reported that payable gold has been got on the banks of the Hokitika, at or just below the junction of the Kokatahi. But if the Hokitika is to be regarded as an at-present-gold-bearing river, the gold-workings at Woodstock and the Kanieri Townships must be regarded as recent deposits due to the action of the Hokitika, and the geological evidence does not bear this assumption out. At Woodstock the gold-workings are in gravels that underlie glacier accumulations, and consequently are to be excluded from deposits coming under this head. On the opposite side of the river, at the Kanieri Township and Commissioners' Flat, the relation of the auriferous wash to the moraine-heaps is, in certain cases, that it passes under them, and in others that the gold of the superficial deposits should properly be considered as having been brought down the Kanieri River. Yet it is true that at the Kanieri Township the gold-bearing gravels on the immediate banks of the river and on the seaward side of the morainic hills may, without doing violence to the truth, be considered as being due to the action of the Hokitika.

Along the *Kanieri River* a considerable amount of gold-working has been carried on in beds of this age at, above, and below the Forks, and in several tributary streams, such as Coal Creek, Butcher's Creek, &c., but all of these streams derive their gold not from the rock matrices direct, but from older alluvial or glacier deposits that are to be found in that neighbourhood.

In the *Three-mile Creek* the recent alluvial auriferous deposits are wholly derived from alluvial or glacier detritus brought from a distance and deposited prior to the action of the present stream upon them. These older gravels being auriferous, and in certain cases very richly so, the result has been that the gravels of the bed of the Three-mile Creek and lower flats along the banks have yielded large quantities of gold, the Blue Spur Flat having maintained a large population for many years.

In the *Arahura Valley* gold has been worked along the bed of the stream and over parts of the low flats on its banks from below the Christchurch-Hokitika Road to the foot of the second gorge, and for a long time maintained a considerable population. Tributary streams joining the Arahura from the south have also yielded gold to a considerable extent from their modern alluvia. These are the several creeks between the Christchurch Road and Humphrey's Gully, Humphrey's Gully itself and MacDonald's and German Gullies, and others of lesser consequence farther up the valley as far as Caledonian Creek; all of these being auriferous, but indicate a prior existence of alluvial auriferous deposits, from which the gold in their beds and on their banks has been derived, and this since none of these creeks contain within their watersheds any solid rocks of a character likely to carry auriferous reefs or afford other than alluvial gold. On the north side of the Arahura Valley there is a considerable extent of alluvial land, stretching from the river bank to the foot of the southern Waimea Hills, over which gold may be found. The higher part of this terrace-plain may, however, be more properly treated of under another heading.

Along the *Kawaka River*, and in the flatter low grounds of *Fox's Creek*, beds and deposits of this age are known to be auriferous, but along the Kawaka River they have never to any extent paid for working, and in Fox's Flat the ground is too wet and deep to be readily worked, or worked for sufficient returns—at least, so says report in general. It is, however, an opinion strongly expressed by miners whose opinions are entitled to respect that Fox's Flat must contain rich deposits, seeing the Creek, where workable, and Fox's Hill were very rich diggings.

In the *Waimea Valley* the great bulk of the gold-workings are to be regarded as being in gravel-deposits of this age, for though it is quite true that the present stream passing along the valley could not and did not bring the auriferous wash into the watershed of the Waimea, after the Arahura abandoned this valley as its course to the sea, without question a considerable re-arrangement of the alluvia it left were effected by the waters of the present Waimea and its different tributaries. Yet such heavy deposits as are found in Tunnel Terrace and at other places in the valley must be referred to the action of the Arahura, and not to that of the Waimea, which is an inconsiderable and wholly modern river. Liverpool Bill's Gully and the right- and left-hand branches of the Waimea not having at any time been former channels of the Arahura, their alluvial gravels must be regarded as derived from glacier deposits or from the gravels of the "Old-man bottom," rearranged and concentrated by the action of the present streams in immediately modern times.

In *Greek's* and *Duffer's Creeks* the auriferous wash being worked is, for the most part, such as might be considered under this head; but not wholly so, for there are workings at high levels on the side of the range towards Stony Creek and Fox's that show the "Old-man bottom" is being worked in that direction.

In the *Kapitea Watershed* the upper portions towards the Loop-line Road on the one hand, and the track from Whiskey Creek, on the Kawaka, to Greek's on the other, have been but little explored, and certainly not sufficiently prospected, and it is not till nearing the Greenstone-Hokitika Road that distinct alluvia, due to the present action of the stream, begin to be met with in the main stream or in Little Kapitea Creek. At Italian Gully and Callaghan Hill, the gold-workings, whatever they may have been, are not now in modern creek-gravels. Following down Kapitea Creek, considerable areas of worked ground are met with, showing the former importance of mining in the modern gravels and bed of this stream.

On the south side of the Teremakau Valley, regard must be had to the workings in the *Seven-mile Creek*, *Scot's Creek*, and some other creeks within the Taipo Valley, a tributary of the Teremakau. Neither the Little nor the Big Wahinuini proved gold-bearing—at least, not sufficiently so as to attract a mining population—and this may be said also of all the recent alluvial deposits in the Teremakau Valley above the Taipo Junction.

In *Donegal Creek*, a quarter of a mile on the Kumara side of the junction of the road thence with the Christchurch-Hokitika Road, gold-workings were for a considerable time carried on in creek-wash derived from glacier *débris*, and "Old-man bottom," showing in the banks of the stream. These workings were not in gravels brought down by the Teremakau itself, the gravels of which apparently remain barren of gold till passing opposite Dillmanstown, and at the junction of the Greenstone.

On the south-western bank of the Teremakau, between Kumara and the mouth of the river, there is a considerable extent of bush-clad plain, gradually sloping towards the sea. As the Teremakau has cut its way to the sea at a considerably lower level than this plain, though the surface of it may be recent gravels, the high level prevents them being considered under this head, except it be some reconstructions of the gravels along the banks of the lower part of Hughie's Creek. On the northern side of the Teremakau Valley there are no gold-workings east of the west margin of the granite mountains at the source of the Big Hohonu or Greenstone River. In the Greenstone Valley, a quarter to half a mile wide, the low banks have been worked for gold from the junction with the Teremakau to Maori Point and Harrison's Terrace, and in some of its tributaries like workings have been, as, for instance, Little Fuchsia Creek. Workings are now carried on for the most part at higher levels.

In the *New River Watershed* the recent alluvia of almost every creek have been worked for gold, and of the Rutherglen district, within the watershed of Saltwater Creek, the same thing may be said. The various lesser streams and gully-creeks need not, therefore, be here more closely described.

In the *Grey Valley*, below Brunnerton, there are no gold-workings in the low grounds along the river-banks. At the upper end of the Brunner Gorge there are workings on the banks of the river, and again at intervals gold has been obtained up to the junction of Ford's Creek and the Blackball Creek with the Grey River. At one place a considerable amount of plant has been erected for the working of the low-level river-gravels close under the terrace. In Langdon's, Ruby, and Nugget Creeks, and the beds of several other streams draining from the eastern slopes of the Mount Davy Range, the modern alluvia have been worked for gold since the earlier discoveries made in the Grey Valley, and, by a limited population of miners, are still being worked. In all of these creeks the wash and gold is in part derived from cements at the base of the coal-measures, but in greater part from the denudation of a narrow belt of gold-bearing slate and sandstone country, which, in a wedge-shaped area, is prolonged along the middle lower slope of the Mount Davy Range nearly to the right-hand branch of Ford's Creek.

In *Ford's Creek* gold-workings have been carried on in both branches, and a large area on the south-west bank of the left branch has been worked, chiefly by Chinamen. No part of Ford's Creek drains from slate country, and none of its gravels are due to the action of the Grey River. Its gold is of such a quality that it cannot have had the same source as that found in the Blackball, and it remains, therefore, but to infer that the gold of Ford's Creek has been derived from the conglomerates at the base of the coal-bearing series, which, as a coarse breccia-conglomerate, has a large development within the watershed, and of which much detritus is mixed up with the slaty portion of the gold-bearing wash.

In *Blackball Creek* all the wash of the valley may be considered recent. It is wholly derived from the slates and sandstones of the Maitai series, that form the neighbouring part of the Paparoa Range, and which within this watershed are impregnated with quartz reefs, some of which are of considerable dimensions. The inference usually made, that the gold comes from this reef, is thus evidently correct, as there are no other than auriferous Maitai rocks in that part of the valley where the chief workings are carried on.

In the valley of the *Roaring Meg* there is an alluvial flat near the source of the stream which is known to be gold-bearing; but in this very little work has been done up to the present time, it being thought necessary to bottom the alluvial deposits in the flat, where the ground is likely to be deep and wet. From a study of this during the past year, it appears that this upper basin of the Roaring Meg has at one time been a lake, which filled in to the level of the outlet, had then laid over the lacustrine deposit an overlaying stratum of river-shingle, which, resting on the false bottom of the lacustrine series, are the only gravels that are likely to be worth prospecting. As this area of unworked ground lies directly in the line of the Upper Blackball and Moonlight Diggings, and has derived its gravels from the same rocks (the Maitai series, impregnated with quartz reefs), it is fairly reasonable to expect within this workable deposits of gold. After the Meg leaves the ranges it

flows over an alluvial flat to its junction with the lower Moonlight. Healy's Gully owes its modern auriferous deposits probably to the action of the Meg before the stream assumed its present course to join the Moonlight.

In the *Moonlight Valley* the auriferous gravels are mainly derived from the destruction of the surrounding Maitai slates and sandstones. To a small extent gold may have been derived from a development of breccia-conglomerate at the base of the coal-bearing series that, from the north-east, reaches into the bed of the creek opposite the township. The valley of this stream, including also the valleys of some lesser creeks, has been famous for the coarse and nuggety character of the gold found in the alluvial deposits. But in the mode of its occurrence the gold is very patchy, and for long periods the miners work without any return or sufficient reward for their labour. On the whole, however, they are well satisfied with the results, and most of the miners have worked in the near vicinity of where they now are since the first of the rush, or since their arrival at Moonlight.

In *Garden Gully* a great collection of small nuggets and coarse pieces of gold was found at the junction of a small creek coming from the west and joining the main stream near its source. This tributary creek scoured out its upper course and projected the detritus over a precipice, where, over a coal-seam, a waterfall was formed; and, at the foot of the cliff, a shingle-fan, or talus, accumulated. In this modern deposit—a mixture of gravel, tree-roots, and vegetable mud—a very large quantity of gold was found. This happened some years ago. More recently, a systematic working of the same area has been undertaken, but, up to the present time, without any satisfactory result. Gold-workings are carried on in the valley of Moonlight Creek to and below B.A. Creek; but further down, though there are considerable areas of comparatively promising river-flats, that so far seem to have been very little prospected. Next to Moonlight, following the Grey Valley upwards, is Barker's and Caledonian Creeks. In the first of these the recent alluvial auriferous deposits are derived mainly from high-level terraces and from a development of "Old-man bottom," which from Blackball Creek extends along this side of the Grey Valley as far as the eastern side of Caledonian Creek. The gold-workings in Barker's Creek are not at the present time of great importance. In Caledonian Creek and its tributary, Shellback Creek, a large area of recent alluvium has been turned over, and there is still a considerable population, chiefly Chinamen, engaged in gold-mining within the watershed. The gold in the modern wash is partly derived from "Old-man bottom" forming hills in the middle part of the valley, partly from Maitai slates crossing Shellback Creek near its source, and partly from the breccia-conglomerate at the base of the coal-bearing series, which, having a great development farther to the eastward, reaches west, as has been said, into the Moonlight Creek at the township.

In *Slaty Creek* the recent alluvial gold obtained from the bed of the stream has mainly been derived from the conglomerates under the coal, which within this watershed has a very great development.

In *Black-sand Creek*, a tributary branch of Big River, the recent alluvia are confined to a narrow and deep valley among mountains of breccia-conglomerate; and, as the creek does not reach through or beyond these breccia-conglomerates, it is evident that the gold in the modern creek-wash has its source in these.

Beyond the watershed of Slaty or Big River the recent alluvial deposits of the Grey Valley and the valley of the Little Grey are not auriferous, or not sufficiently so as to have induced the working of them. The surface-shingle of this part is mainly derived from granite and gneiss forming the greater part of the adjoining Paparoa Range; and it is owing, apparently, to the non-auriferous character of these rocks that on this side of the valley no gold-workings extend beyond the valley of Slaty Creek or Big River.

On the south-east side of the Grey Valley the recent gold-bearing deposits in the valley of Stillwater Creek and Maori Gully are partly derived from "Old-man bottom" or from glacier deposits, of which ample evidence is furnished by the large erratic boulders found in the gold-workings.

Over the *Arnold Flat*, from Lake Brunner to the Grey River, there is a broad extent of modern river-shingle, but gold-working over this is confined to a limited distance along the banks of the Arnold. The northern side of the Arnold Flat, towards the No Town Hills, is supposed to be gold-bearing in the deep ground, and the several creeks draining from the hills on to the flat, by the denudation of the gravels of the "Old-man bottom" must have carried forward auriferous material now lodged in the beds and lower valleys of those streams, or it carried forward to the north-eastern margin of the Arnold Flat. From the southern slopes of the No Town Hills to the Big Grey the recent alluvial deposits of every stream, large or small, are gold-bearing, and for the most part have been worked, yielding a rich return to the miner. By far the greater amount of such gold has been derived from the gravels of Pliocene date, which are here spoken of as "Old-man bottom." A portion of the gold found on the banks of the Ahaura River may, indeed, have been brought from the back-country beyond the area covered by the "Old-man bottom," or washed out of old high-level river-gravels, or directly from auriferous reefs in the schists or unaltered rocks of that part of the district. The amount so carried forward from the back-country can, however, be but small, as the gold-workings along the Ahaura almost cease on passing the south-east boundary of the deposits of "Old-man gravels." The many creeks which owe their gold to deposits of auriferous strata in the Pliocene-gravel formation will be mentioned and described in detail in another part of this report.

In the *Valley of the Big Grey* the gravels of the river-bed and the lower river-flats are at the present time being worked for gold, and would be to a greater extent than they are were it not that there are difficulties in bringing water on to the ground where the richer deposits are known to be. This is due to objections raised by owners of freehold sections to the passing of water-races through their lands. Higher up the river valley—that is, above the junction of the Alexander River, and

thence through the granite gorge to and along some parts of the Brown Grey, gold has been obtained from the modern gravels of the river-bed, but no continuous workings of consequence have taken place. This is imputed to the difficulty of prospecting, and the distance of the auriferous localities from settlement; but this may be doubted, as in many other parts of the Coast far greater difficulties in the way of getting forward provisions have been overcome, and the failure to prove the Upper Grey Valley a rich goldfield has rather been the lack of payable gold in the alluvial deposits than the impossibility of working these, or the transport of provisions to where the gold is said to occur. The above remarks apply also to the Upper Ahaura, and in this latter case even with greater force, since the Upper Ahaura has been from the early days of settlement on the Coast a route of travel to the East Coast, whence sheep and cattle were driven from the pastoral districts of south-east Nelson and Northern Canterbury.

*Little Grey Valley.*

In *Snowy Creek* there is a large extent of ground, chiefly on the south side of the stream, that comes under this head, and has been worked for gold. The gold-workings extend nearly three miles up from the junction of the creek with the Blackwater. The gold has wholly been derived from the high-level terraces of the Big Grey, formed at a time when this ran at a high-level, and when its junction with the Little Grey was where the junction of the Blackwater with the latter stream now is.

In the *Blackwater* the recently-formed and low-lying flats are auriferous for about seven miles above the Greymouth-Reefton Road. The principal workings are confined within the distance to which the "Old-man bottom" extends up the valley, and these beds are therefore the great source of the gold found in the Blackwater Valley. Above where the gravels of the "Old-man bottom" cease and slate-rock makes its appearance there is a sudden and marked decrease in the area of the gold-workings, though these yet continue along the banks of the creek to the distance stated.

In the *Big River*, a tributary of the Blackwater, the alluvial workings have been carried almost to the source of the stream, at and near the Big River Quartz-mine. The source of the gold in these up-stream workings is evidently the Maitai slates, which appear at the surface over this part of the country.

In *Adamstown Creek* the alluvial wash along the bottom of the valley has been almost wholly derived from the gravels of the "Old-man bottom," which form the hills bounding the valley as far as this has yielded payable gold.

In the *Valley of Antonio's Creek* the recent alluvial deposits of the low grounds along the main stream have been derived principally from the gravels of the "Old-man bottom," but also to a considerable extent from the slate country towards the source of the creek. The Pliocene gravels do not reach further up the main stream than four miles from the Little Grey Valley, but above this point there have been extensive gold-workings on the slate bottom, where also the hills bounding this upper part of the valley are composed of Maitai slate and sandstone. In the smaller tributary streams, more especially those draining from the south, the narrow gully-bottoms have been worked for gold a mile or more distant from the main valley, and in some cases almost to the watershed leading into Adamstown Creek.

In *Slab Hut Creek* there has been a large amount of ground turned over, both above and below the gorge. Above the gorge some of the lesser creeks have been worked to their very sources. The beds of these show the presence of Maitai slates, but on the tops of the hills towards Antonio's Flat the "Old-man bottom" is present, so that both these formations may be a source of gold to the recent alluvial gravels along the course of Slab-hut Creek.

*East side of Inangahua Valley.*

In *Devil's Creek and Maori Gully* the alluvial gold of the recent gravel deposits is derived partly from the Maitai slates and partly from the "Old-man bottom," also partly from a series of high-level gravels that cap the hills in the vicinity of Merrijigs, and thence extend along the plateau-like ranges towards the source of Big River. Extensive mining in these beds has taken place in the creeks mentioned and their various tributaries.

In *Soldier's Gully* also the recent auriferous gravels of the creek-bed have had their source partly from the Maitai slates and partly from a development of "Old-man bottom" lying at the source of the creek, on the water divide between this, Liverpool Bill's Creek, and a tributary of the Devil's Creek.

In *Rainy Creek*, in *Lankey's Gully*, and along *Murray Creek* the recent alluvial auriferous deposits have derived their gold partly from the auriferous Maitai slates that occur within the watersheds of these creeks, or, and this to a considerable extent, from quartzose cements lying at the base of the coal-bearing series.

In *Painkiller Creek* the source of the gold is the same as in the case of Rainy Creek, &c.

In *Burke's Creek* the tailings swept down by the stream from the battery-sites near the source of the creek are being treated for gold.

In the *Inangahua Valley*, below the junction of the two main branches, the gold found in the bed of the river necessarily may have been derived from all or any of the older auriferous rocks occurring in the valley. A few men from time to time work on the beaches above the junction of Boatman's Creek, but no important digging has ever been done on the immediate banks of the Inangahua River.

*North Branch of the Inangahua to Boatman's Creek.*—There are two or three creeks that, taking their rise on the front range between the Waitahu or north branch of the Inangahua and Boatman's Creek, below Capleston, have along their courses alluvial deposits that have been worked for gold. The high terraces, downs, and hill-slopes drained by these lesser creeks, of which Fryingpan Creek is perhaps the most important, are formed of old high-level deposits, "Old-man bottom,"

quartz drifts, and conglomerates under the coal formation or auriferous Maitai slates, and each and all of these different gold-bearing formations probably have yielded auriferous material to the modern gravels along the different creek-beds of this part.

In *Boatman's Creek*, where the area of recent alluvial deposit is even more considerable, all the sources immediately above mentioned have contributed to the auriferous character of the gravels in the creek-bed below Capleston. Unfortunately, below the point where the valley widens, the low grounds along the banks of the creek are likely to prove wet, and the sinking to bottom on the "Old-man" gravels on which the recent deposits rest will be, as a consequence, difficult. In the upper part of Boatman's the gold is derived from Cretaceo-tertiary conglomerates and gneissic rocks.

In *Little Boatman's Creek* the gold is derived from Matai slates in Specimen Hill, from conglomerates at the base of the coal-bearing series, and from gravels of the "Old-man bottom," all these sources contributing material towards the formation of the recent gravels in the bed of the creek.

In *Italian Gully* and its different branches the main source of the auriferous wash is the slate belt extending along the front ranges between Boatman's and Larry's Creeks. In the lower part of the creek, however, the gravels of the "Old-man bottom" are also a source of supply.

In *Larry's Creek* the main source of the recent gravels in and along the river-bed is the gneissic and mica-schist rocks of the Brunner Mountains, but to a considerable extent gold must have been supplied from hills and plateau table-lands formed of Pliocene gravels that are present on both sides of the lower valley before the creek enters upon the lower plain formed by the Inangahua River. In the upper part of Larry's Creek, gold and gold-workings are found right into the heart of the mountain chain, in which the several sources of the creek take their rise.

In *Landing Creek* and its several tributaries in the lower part, where gold-workings are first met with, the recent deposits are a mixture of the gravels of the "Old-man bottom" and slate rubble from the western slopes of the Brunner Mountains. Further up Little Landing Creek the bottom is "Old-man" gravels, and the wash largely composed of the same material. This stream also reaches back to the slopes of the mountain-range, where the auriferous slates are found.

Between *Landing Creek* and *Coal Creek* there are high grounds covered with auriferous wash, which will have to be considered under another head; but there are also numerous creeks in this direction the beds of which have been worked for gold. These and the several creeks that take their rise beyond Coal Creek, and fall into the Buller River, have not been particularly examined, but it is well known that the more important of them have been worked for gold.

#### *West Side of the Inangahua Valley.*

At the mouth of *Stony Creek*, which joins the Inangahua opposite the mouth of Boatman's Creek, there are heavy terraces of gravel, in which a little gold has been found. To make this ground pay, hydraulic sluicing must be the means employed.

In *Fletcher's Creek* and some other creeks on this side of the valley gold is found in the recent wash along the beds of the streams, but it does not appear that systematic and remunerative workings have at any time been carried on on this side of the valley of the Inangahua.

From what has been stated it will be apparent that, in most instances, the source of the gold in the beds and alluvial banks of all but the great rivers has been the gravels of the "Old-man bottom," which, it has been shown, is either present in or never far distant from the localities where important workings have been carried on.

#### *Coast-line between Greymouth and Westport.*

Neither in the Seven-mile nor in the Nine-mile Creek can there be said to be any gold-workings in gravels that rightly have to be considered under this head.

In the valley of the *Ten-mile Creek* there have been gold-workings up to the first branch going to the south, while in the north or main branch of the stream prospecting has been carried almost to the source of the creek. The gold found in the Ten-mile Creek is of a coarse description. Part of it is undoubtedly derived from the slates and sandstones in which the upper part of the valley is excavated. Part of it also is undoubtedly derived from the conglomerates at the base of the coal-bearing series, of which more in the proper place.

In *Baker's Creek*, at the southern end of the Seventeen-mile Beach, gold is found, and workings, though to a limited extent, have been carried on near the lower part of the creek. The gold in this stream has, as in the case of the Upper Ten-mile Creek, been derived solely from reefs occurring in the Maitai-slate formation.

In *Fagin's Creek* gold is got along the bed of the stream to the foot of the high range in which the creek takes its rise, nearly opposite the source of the Ten-mile Creek. A considerable amount of work has been done along the bed of this creek, but more in the way of prospecting than of systematic working. The gold appears to be patchy, as in Moonlight, and is of such character as indicates the near presence of reefs. Near the point where the creek leaves the hills it has broken through the Barrytown lead, and here the greater part of the gold must be considered to have been derived from that part of the lead which the action of the creek has carried away.

In *Gravity Creek* no gold has yet been found above the point where it is crossed by the Barrytown lead, and a number of smaller creeks crossed before reaching Canoe Creek are auriferous only because they also have broken through and carried away part of the lead.

In *Canoe Creek* a very considerable amount of gold-workings have been carried on, and most of the gold was obtained from the recent low-level terraces and gravels of the creek-bed. Like the other streams flowing from this part of the Paparoa Range west to the seaboard, it has cut through, and in part destroyed, the Barrytown lead.

*Lawson's and Scott's Creeks*, rising on the slopes of Hawera Mountain in like manner, after eroding gold-bearing slates, break through the northern continuation of the Barrytown lead, and, thus enriched, have no doubt carried a portion of the finer gold to the lower ground and the sea-beach of the present day.

*Talus formed by Partial Destruction of Barrytown Lead*.—The Barrytown lead, between Fagin's Creek and Canoe Creek, partly by the action of the creeks breaking through it and partly by the formation of a talus at the foot of the terrace cliff, has yielded up a considerable percentage of its gold, and this now lies buried in or under the more recent accumulations formed as just described, or that have been brought down by the different creeks that intersect the lead.

*Canoe Creek to Buller River*.—It is somewhat remarkable that scarcely any of the small rivers between Canoe Creek and the Buller River have yielded payable gold from the recent gravels of their present beds, and this in the face of the fact that many of the high-level terraces have yielded handsomely.

*Lower Buller Valley*.—In the Lower Buller itself little or no gold has been obtained till its sands came within the action of the tide.

In the *Waimangaroa River*, above the township, most of the gold-workings are being carried on in the recent gravels of the bed and banks of the streams. The gold is of a coarse description, and, probably, has been derived from the auriferous Maitai slates that, east of the granite belt, are developed throughout the watershed as the fundamental rock, on which rest the Cretaceous coal-measures.

In the *Buller Valley from the foot of the Gorge to the Inangahua Junction*.—Below the junction of the Little Ohika the shingle of the river-bed and of the terrace-banks, where any such are formed, are mainly granite detritus brought down by the Big Ohika or by lesser streams, or mere falls of granite rock from the precipitous mountains on each side of this part of the gorge. There are no gold-workings on the beaches of this part of the gorge. At and opposite the Twelve-mile, gold-workings have been and still to some extent are carried on. Above this point, to the "Old Diggings" at Berlin's, a few miners are scattered along the banks of the river working portions of the banks, but preferably washing on the beaches when the river is low. At and near Berlin's a number of claims are still being worked, all of them situated on what must be regarded as recent deposits by the river.

Above Berlin's to the Inangahua Junction there are, at the present time, no workings on the bed or in the immediate banks of the river; but at Grainger's Point, near Coal Creek, one or two claims are being worked on the point, at an elevation considerably above the river, so that properly this has to be considered under a following heading.

*Buller River from the Inangahua Junction to the Lyell*.—Within the past twelve months beach-workings were in operation on the river-beaches opposite the Inangahua Junction. Further up the river a number of river-claims are being worked, and here also is situated the Cock Sparrow Dredge. Alluvial flats of moderate width continue up the river to the bridge, a mile and a half from the Lyell Township, and on the northern bank of the river there are also bush-clad terraces reported to be gold-bearing that must be considered as coming under this head.

In *New Creek*, making junction with the Buller, below Lyell Bridge, the alluvial deposits of the bed of the creek are mainly derived from the auriferous slates that form the neighbouring ranges and hills, but they do not seem to carry much gold.

#### *Upper Buller Valley.*

*Buller Gorge from Lyell Creek to Fern Flat*.—From the bridge below the Lyell to the mouth of Lyell Creek there are a number of claims working on the east bank of the river, but the water-supply being limited, the present workings are less extensive than the ground available might warrant, though this at best is but a narrow strip along the brow of the deeper part of the gorge through which the river flows. Above the junction of Lyell Creek the same character of deposit prevails—namely, a ledge on the slope of the range on one or other side of the gorge (usually on the north side), below which, in a narrow channel, the river makes its way. These deposits are mostly worked for gold, but with appliances, and such a water-supply as makes it evident that with improved means far greater returns might be obtained. These deposits, though generally above high-flood mark, are, nevertheless, to be regarded as having been deposited by the river during the modern period.

In *Lyell Creek* the recent alluvial deposits are mostly confined to the bed and immediate banks of the creek, where small flats lie upon one or other side of it. Lyell Creek and some of its tributaries were rich in gold, the greater part of which has been directly liberated to the shingle of the creek from the auriferous slate ranges, along which it finds its way to its junction with the Buller. Part of its gold, however, and certainly that of some of its tributaries, has been derived from older gravel deposits, a remnant of which is preserved on Manuka Flat, a high-level deposit situated between Lyell Creek, the Eight-mile Creek, and the Buller River.

In the *Maruia Valley* all the narrow flats that lie along each or either bank of the river must be considered as belonging to the series of deposits under consideration. That at and above Castleana's is the largest in extent, and also the highest above the present channel of the river; but, having regard to the volume and power of the stream, these river-flats are as much due to recent action as are others along the valleys of lesser streams that, holding the same proportionate relationship, are undoubtedly regarded as due to the action of the stream, in such times and manner that they are correctly treated of under this head. To the junction of the Warbeck all the deposits along each bank of the Maruia come under this head. Wherever along the banks of the river there are gravels, they are gold-bearing. In the Middle Valley, extending from the junction of the Warbeck to the junction of the Alfred River, at the foot of the Cannibal Gorge, the recent deposits of the valley lie along the lower grounds as narrow river-flats as far as Walker's Homestead. Above the junction of Station Creek the low river-flats expand, and at places have a width of two miles. Gold is found on the banks of the river in the lower part of this division of the Maruia Valley, but it does not appear to be present in paying quantities above the junction of Station Creek.



In the *Warbeck*, and a tributary of the *Warbeck* (the *Rappahanock*), there is some extent of alluvial lands, and notably in the *Rappahanock* these are gold-bearing, the gold present being derived from conglomerates belonging to the lower division of the Cretaceo-tertiary rocks, which have a very considerable development in this part of the district.

In *Station Creek* the auriferous alluvia have been worked for gold to a considerable extent, these are in great part derived from gravels of older date, brought down the *Maruia Valley* by the agency of ice, or by rivers, when this part of the valley formed the basin of an extensive lake; but the gold, it would appear, has been for the most part derived from the conglomerates at the base of the coal-bearing series.

In the *Alfred River* the recent alluvial deposits are the results of the degradation of the schist ranges to the eastward surrounding the sources of the river; the gold is therefore most probably derived from reefs in these rocks.

*Buller from Fern Flat to Junction of the Mataira.*—At *Fern Flat* the banks of the river have been worked for gold, and the *Buller Dredge* is at present placed on a portion of the river-bed immediately opposite the accommodation-house. Higher up the river valley the chief extent of alluvial flat land lies on the opposite or south side of the river, on both sides of the lower *Matakitaki*, and constitutes the farming district of *Hampden*.

In *Doughboy Creek* the outer and lower alluvial area is a part of that already described as due to the action of the *Buller* above and below the junction of the *Matakitaki*, but in the upper valley, leading to the *Glencairn Saddle*, by which the *Maruia Valley* is reached, the auriferous alluvial gravels are of local origin, probably derived from the conglomerates of coal-bearing series.

In the *Matakitaki Valley*, up to the junction of the *Glenroy River*, all the gold-workings are situated in the low grounds along the banks of the river, and are consequently in river alluvia of recent date. The river keeps close under the range of hills on the western side of the valley, and the high level terraces are all on the eastern side, but whether these should, in the lower part of the valley, be separated from the recent deposits may be doubted. All the gold of this part of the *Matakitaki Valley* must be considered as having been derived from either older gravels above the *Glenroy* junction, or from the conglomerates of the coal-bearing series.

In the *Upper Matakitaki* the river has cut through very heavy deposits of shingle, that now form high banks on each side of the river. Narrow flats lie along the river banks at a lower level, and, these alone have to be considered at the present time. In the deeper terraces the bottom gravels appear to have been deposited in a lake, the outlet of which has been cut away by the action of the river. In this respect, therefore, the *Upper Matakitaki* deposits resemble those of the *Maruia Valley* above the junction of the *Warbeck*.

In the *Glenroy Valley* there are a number of terrace flats which may be considered under this head, while along other parts of its course the stream has cut its way through the conglomerates of the coal-bearing series, forming thus a narrow channel not favourable for the retention of gravels. Further towards the source of the stream the valley widens, and the alluvial flats along the river are of considerable extent. There are a variety of rocks present in the upper part of the *Glenroy Watershed*, and from the *Maitai* slates and the schist rocks present some part of the gold found in the valley has without doubt been derived; but from the great development of the conglomerates at the base of the Cretaceo-tertiary series it is presumed that these have yielded the greatest proportion of the gold obtained and yet to be obtained from the alluvial deposits of the valley.

(c.) *Littoral.*—These deposits consist of the moving sands and shingle of the tideway between high- and low-water mark, and the series of but slightly raised beaches that generally lie at the foot of a higher terrace or bold rocky land, and which do not exceed 25ft. above sea-level. Such deposits are found along the coast-line from the mouth of the *Mikonui* to the *Hokitika River*, and along this part the gold is generally obtained from within, at, or near, high-water mark; but towards the mouth of the *Hokitika* black-sand deposits, rich in gold, lie at a considerable distance inland from the coast-line; these on *Craig's* freehold, on the south side of the river, have yielded during the past three years a large amount of gold. On the north beach, and thence to the mouth of the *Arahura*, the same character of deposit generally prevails—viz., layers of black sand, containing gold, overlain or underlain by grey sand, the overlying grey sands being often drifted on to the black-sand layer by the action of the winds, which drives inland from the tide-way the lighter sand grains. Of such character are the deposits along the coast-line between the *Three-mile*, north of *Hokitika*, and the mouth of the *Arahura*. North of the *Arahura* the back leads usually rest on or are contained in shingle, as may be seen in the ground worked along the foot of the higher terrace between the *Kumara Railway-station* and the beach opposite that place.

North of the *Teremakau* to the mouth of the *Grey River* this is also the general character of the deposits immediately inland of the tideway. South of *Greymouth*, as far as the mouth of the *New River*, these workings are very extensive, and sometimes the amount of gravel removed to reach the gold-bearing stratum has been considerable. Like conditions prevail north of the *Grey River* to *Point Elizabeth*, and on the *Seven-mile* and *Nine-mile Beaches*. Away from the vicinity of the mouths of the larger river and from an abrupt coast-line, the shingle passes into sands on the low sloping beaches, and the black sand auriferous deposit under the action of the tide separates into distinct beds. This is the condition of the auriferous deposits on the *Seventeen-mile Beach*, abreast of *Barrytown*, and of all the beaches up to the *Fox River*. Nor is it greatly different between the *Fox River* and *Cape Foulwind*. North of the *Buller* the shingly type of beach again makes its appearance, and continues to the *Waimangaroa*, beyond which for the present it is not necessary to trace this series of deposits.

The amount of gold raised from these littoral deposits has been very great, and although "beach combing" must gradually become less and less remunerative, and the black-sand leads not so easy to work, and possibly also, what are left of them, not so rich in gold; yet from these deposits there has yet to be won, perhaps, more gold than has hitherto been obtained from them.

Dredging of the back leads, between the beach and the high ground at the back thereof, has not been attended hitherto with a very marked degree of success; but it is not to be thought of that the ground will remain unworked when the proper machinery for, and the correct methods of, working the ground has been ascertained. At some places these back leads should prove very rich, generally where the accumulation has taken place on the side of a bluff or projecting point of land.

#### IA.—PLEISTOCENE.

(a.) *High-level Old River Channels and Terraces.*—In the southern part of the district, between Ross and Rimu, it is doubtful whether gravel appearing on and near the road-line between Limestone Creek and the Half-way House, should be regarded as above or below the moraines that form the hilly country between the Totara and Rimu. Rimu Flat is, however, clearly an old channel of the Hokitika River, as has already been stated in another report.\* Tunnel Terrace, in the Waimea, possibly also Quin's Terrace opposite Staffordtown, and part of Kelly's Terrace, should be referred to the action of the Arahura within the Waimea Valley. These, at most places, are possibly rearranged glacier deposits. Along the edge of the Upper Kapitea Basin, near Italian Gully and Callaghan's, there are auriferous deposits that should be referred to this period. A large part of the plain, from Kumara to the beach, has been due to the action of the Teremakau, though immediately under the Dillmanstown hills the surface may be due to more recent action.

In the Greenstone Valley, the old channel of the Teremakau, starting from abreast of the special settlement in the Teremakau Valley and running north to the Duke of Edinburgh Terrace, opposite the Greenstone township, thence passes again to the east side of the Greenstone Valley, and continues on this side to near the present junction of the Greenstone with the Teremakau, has left along this line a considerable area of high-level river-gravels that, at the present time, are being largely worked for gold. Before the Teremakau River channel or the Greenstone Valley had been cut down to their present levels the Teremakau must have wandered over the plains between Kumara and the sea, and at the same time deposited the high-level gravels on its northern bank, which are now being worked for gold from the mouth of the Greenstone and Cape Terrace to and beyond Westbrook, in the direction of Candlelight. A large area of high-level river-gravels extends from the foot of the granite mountains to the eastern foot of the high lands surrounding the sources of New River, between the Greenstone Valley and the Big Hohonu River (falling into Lake Brunner). These, however, do not appear to be gold-bearing, being for the most part reassorted glacier moraines, the material of which has been brought here by the Upper Teremakau Glacier, which, passing through the gap in the granite mountains, filled the basin of Lake Brunner, and formed a series of moraines on its west and south-west sides.

In the Grey Valley, old high-level river-terraces occur on the right bank of the river near to the Brunner Mine and Taylorville, and are at the present time being worked for gold in Sulky Gully. West of Taylorville these grounds reach a height of 440ft. above sea-level.

Above the Brunner Gorge, on the right bank of the river and west side of the valley, gravels of this description occur only as patches, till reaching the valley of Blackball Creek. In Blackball Creek the principal deposit of this description lies between the lower parts of Blackball and Ford's Creeks, and extends over the area on which the township is built and south-east of Kinsella's, near the point where each stream enters upon the Grey River bed.

To the right of the track, from Blackball to Moonlight, the Meg Stream has deposited high-level gravels between the upper end of German Gully and Healy's Gully, near the point where the Meg leaves the ranges.

In the valley of Moonlight Creek, high-level gravels are present from the terraces at the back of the township, across the head of Garden Gully, and thence extend along the foot of the range in the direction of the mouth of the Meg Gorge. Between the lower part of Slaty Creek and the Grey, below the junction of the Little Grey, it may be inferred that a considerable area of high-terrace country should be considered under this head; but the country has not been explored for the reason that there are no tracks through it except along the banks of Slaty Creek to Black-sand Creek and the bare country on the Paparoa Range. The same may be said of a good deal of country lying between the Little Grey and the Paparoa Range.

On the opposite south-east side of the Little Grey Valley there are no deposits that may be referred to under this head, till passing the Blackwater; the eastern side of the low grounds of the Little Grey Valley is bounded by high terraces formed by the action of the Big Grey. These terraces are of great area and altitude. They stretch back from the banks of the present river channel—a distance of between four and five miles. The first formed and highest terrace lies to the north-east of the Snowy River, and between Snowy River and the Blackwater; the terrace-gravels rest on "Old-man bottom." They show their distinctness in comparison with the "Old-man bottom" in that they have not yet been denuded and sculptured into sharp ridges and deep gullies, as almost everywhere is the case with the "Old-man" gravels. It is true that the Snowy River Valley has been excavated along the line between the fourth and third terrace, and that its tributaries form shingle gulches and gullies extending a short distance into the terrace on each hand; and on the end of the terraces, fronting the Little Grey Valley, gullies have also been cut into the third terrace. The second and first terraces are much as when first formed. Gold is generally distributed through the material of these terraces, and, as already stated, all the gold obtained from Snowy River has undoubtedly been derived from the third and fourth terraces.

On the opposite side of the Big Grey, from Mackley's station and Noble's Township to the Clark River and the foot of the Granite Ranges, gravels of like age and mode of formation stretch between the Big Grey and the Ahaura Rivers. On the south-east side of the Grey Valley a high-level terrace stretches along the foot of the hills formed of "Old-man bottom." This fringing high terrace extends up the main gullies running into the hills formed of "Old-man bottom"—as for instance,

\* Goldfields and Mining Reports, 1893, p. 162.

along the gully of Duffer's Creek; further to the south-west these terraces fuse with the broader expanse of the Ahaura Plain that lies between Orwell Creek and the Ahaura River, and which extends some eight miles back from the Grey River.

Between Lake Hochstetter and Bell Hill there is a considerable extent of alluvial ground, which is of younger date than the Pliocene gravels of the "Old-man bottom," yet scarcely due to the action of rivers following their present direction; these, therefore, must be considered as high-level gravels. The greater part of the Arnold Flat must be considered recent, but on the ridge between Maori Gully and the low grounds along the Arnold there are terraces of gravel that, clearly of river origin, have to be dealt with at this time and under this head.

Along the coast, from the mouth of the Grey to Cape Foulwind, there are no deposits that can be rightly considered or described as "Old high-level river-gravels." On its western side the Buller has cut a series of terraces from the level of Addison's Flat to that of the river at the present time. These are terraces of erosion, not of deposit. Higher up the river, on the same side and on the opposite east side, massive high-level terraces stretch north along the foot of the Granite Ranges. These high-level terraces extend north along the range to Fairdown.

In the Inangahua Valley such terraces are to be met with on the right bank of the Inangahua, near Reefton, and again between the Waitahu River and Boatman's Creek; and in the lower valley they form a high terrace between the lower Inangahua and the Buller, below the junction of the Inangahua. It is from the gravels of this high terrace that the gold came that was obtained from the caves and fissures of the limestone.

In the Upper Buller high-level gravels are present on Manuka Flat, between Lyell Creek and the Buller, between the Lyell Township and the Eight-mile. These gravels are at a considerable elevation above the present drainage channels. They appear to be river-gravels, though it has been suggested that they are deposits in the bed of a lake, and this on account of the presence of beds of fine granite sand interbedded with the coarser bouldery wash. The gravels are gold-bearing, but have not proved payable. They should be prospected. Between the Newton and the mouth of the Maruia there are high terraces on the right bank of the Buller which, if water was brought on to them, are likely to develop into profitable workings of considerable extent.

In the Upper Maruia Valley the high-level terraces south of the moraine stretching across the valley, above the junction of the Warbeck, as lake deposits are in some sense to be regarded, as river-gravels, and have to be dealt with in this place. They stretch up the valley to the mouth of Station Creek. The gravels of the Bog Saddle have also to be considered. These have been deposited by the Maruia when it was an affluent, rather the true source, of the Grey River. In the Matakaitaki Valley heavy deposits of auriferous gravel, on both sides of the river above the Glenroy junction, may be dealt with under this head, though for the matter of that they might be regarded as recent, seeing that under a considerable thickness of these gravels an underlying and evidently unconformable series is seen, which are yet younger than the gravels of the "Old-man bottom."

## II. PLEISTOCENE AND YOUNGER PLIOCENE.

(a.) *Extended Glacier Deposits outside the Limits of the Mountains.*—The hilly country between the lower course of the Hokitika River and the Totara River, west of the Big Swamp and Constitution Hill, forms the most extensive, continuous, and connected area of these deposits. Here and generally they consist mainly of angular morainic material, mostly brought from the unaltered Palaeozoic rocks of the higher part of the Southern Alps, but schist, to a limited extent and a fair proportion of granite rocks, are also present, and at some places predominate. Although the general character of these deposits is angular and subangular pieces of rock of all sizes, rolled gravels do also occur in association with the less rounded material. In this area they have been encroached on by the action of the Totara River, and reduced, over a considerable breadth of flat country on the north side of the river, to the condition of well-rolled gravels. At other places, along the road from Ross to Rimu, gravels appear, but it cannot always be said whether such gravels overlie, are associated with, or underlie the more angular glacier material. Gold-prospecting has been carried on in these beds to a limited extent only, and it must be said that they have been prospected less than they should have been. The great difficulty in developing the field is the lack of an abundant high-pressure water-supply, such as is available for the Kumara field, and there are almost insuperable difficulties in the way of bringing such a supply from any proposed source on to the ground. At Woodstock, on the west side of the Hokitika River, opposite Kanieri Township, at the Kanieri Township, and along the foot of the Mount Misery Range, glacier moraines lie in the low grounds, and near the Kanieri Township these have been worked to some extent after the manner followed at Kumara. At the Kanieri, however, the deposit occurs at too low a level for the successful working and treating of the auriferous material by the processes hitherto in vogue in the district.

Below the Kanieri Forks the glacier deposits bend to the eastward, and run along the lower southern slopes of the hills between Kanieri Lake and the Kokatahi Plain. Between the left or main branch of the Kanieri River and the Humphrey's Gully Range glacier moraines are found at a considerable altitude, and thence pass across a saddle in the range into the watershed of the Three-mile Creek. These deposits are worked for gold at the Kanieri Forks and in the upper part of the Three-mile Creek.

In the Arahura Valley great accumulations of glacier matter lie along the east side of the valley in the second gorge; and between Island Hill and the eastern end of the Humphrey's Gully Range a vast moraine has accumulated that at one time stretched across the valley, but now this is cut through to a depth of 500ft. Along the northern side of the Humphrey's Gully Range moraine deposits extend, at a high level, to Humphrey's Gully Claim, and similar deposits can be traced along the range yet further to the north-west.

On the north-eastern side of the Arahura, glacier deposits can be traced over almost the whole

of the Kawaka Watershed, and round the eastern slopes of the Waimea South Hills, by way of Stony Hill, Duffer's, and Greek's, to Callaghan's, all within the Kapitea Watershed.

In the upper basin of the Kapitea and Little Kapitea Creeks almost the entire area of drainage by these streams is occupied by morainic matter, slightly modified over particular areas, or by beds of silt deposited in lakes fed by glacier-streams. These moraines and other glacier deposits were, within the Kawaka and Kapitea Watersheds, mainly, if not wholly, due to the Arahura Glacier, which, finding little or no relief to the south and south-west, pressed with great force to the north-west and north, and in the latter direction came in collision with a portion of the Teremakau Glacier. These phenomena of the action of ice in the northern part of Westland, during the glacier period, have been fully described elsewhere;\* and more than a rapid sketch of the areas covered by these deposits need not be given in this place. The Arahura Glacier, driven to the north, was met by one great branch of the Teremakau Glacier, and thus the Loop-line Hills are on one side formed of materials brought forward by the Arahura Glacier, while on the other, the northern side, the material is due to the action of the Teremakau Glacier. Yet the Arahura Glacier reached forward into the watershed of the Teremakau River, a little to the seaward of where was the terminal moraine of the Teremakau Glacier. As regards the gold-bearing character of the Arahura moraines there can be little doubt, as otherwise it would be required in some other way to explain the presence of the gold over the entire watersheds of the Arahura River and Kapitea Creek, and part of the Teremakau Watershed near Dillmanstown. Perhaps such alternative explanation would be the more reasonable if it assumed this as being due to the denudation of the Pliocene gravels where they occur in this part of the district, since if gold be denied to the glacier-drifts, it must also be considered absent from the river-gravels that, having the same source, simply by a little time preceded the deposit of the moraines, such river-gravels being in great part merely glacier matter rounded and carried forward from terminal moraines that in course of time were overridden by the further advance of the glaciers.

On the northern side of the Teremakau Valley no moraines appear to have reached further to the westward than within the limits of a line drawn from the mouth of the Greenstone Valley across Fuchsia Creek, where that is crossed by the Greymouth-Greenstone Road, and thence by way of Maori Creek (in the New River Watershed) to Stillwater and Maori Gully, within the Grey Watershed. At all of the places mentioned there is unmistakable evidence of the presence of morainic matter, but slightly if at all modified by the action of running water. How far glaciers reached down the Arnold Valley is not easily determined, but probably to abreast of, or even further west than, the points reached in Stillwater Creek and Maori Gully.

No clear evidences of the presence of ice has been detected on the No Town Hills, and it is only to be inferred that the line of furthest ice extension crosses Nelson Creek somewhere above Hatter's Terrace; nor has the line of limit been clearly made out further to the north till reaching Orwell Creek. Here the presence of ice is unmistakably made clear by the occurrence of vast angular blocks of rock scattered over the tops of the hills between Napoleon Hill and the saddle leading from the left branch of Noble's into the head of Duffer's Creek. More to the north every trace of moraine in the low ground has been destroyed by the action of the Big Grey in the formation of the succession of terraces described under the previous heading. Yet, in the different gullies cut into the "Old-man bottom," in Adamstown and Antonio's Flat Creeks, large boulders are found suggestive of the agency of ice as a means of transport from their original matrices and localities to the hill tops, whence they have rolled into the gully bottoms.

No modern ice-action appears ever to have taken place in any part of the Paparoa Range, otherwise the morainic material has been carried completely forward into the Grey Valley, so as to come under a reconstructive process by means of running water, or, on the west coast side, bodily into the sea. As far as this latter assumption is concerned, as older deposits of a loose or incoherent character are preserved in many places that must have been passed over by ice in its passage to the coast-line, we may assume that no such ice-sheet ever existed. In the Upper Buller Valley the only evidence of glacier action is the moraine stretched across the Maruia, seven miles below Walker's Home Station. This is unmistakable in its character—the general character of the material, the hummocky outline of the surface, and the large far-transported blocks of rock, still perfectly angular, amply testify to the fact.

(b.) *River Deposits formed prior to the Advance of the Glaciers.*—At Ross the deposits in the flat are partly reconstructed glacier material, and partly river-gravels that were deposited prior to the advance of the glaciers. The various alternations of these beds are well seen in the workings of the Ross United Company's claim, and there can be no doubt that the greater area of the Ross Flat towards the sea contains the like deposits.

In the country between the Totara and Rimu it is uncertain if any of the gravels seen along the road-line do underlie the glacier deposits, but along Back Creek and in the face of the terrace overlooking the low grounds of the Hokitika, it is abundantly demonstrated that river-gravels underlie the glacier deposits. These old river-gravels are auriferous, and form what is now the principal source of gold in the immediate district.

River-gravels under the morainic hills are probably present at the western margin of Commissioner's Flat, Kanieri. In the glacier deposits of the Kanieri Forks there are considerable developments of gravel at places; in other places almost none. In the Arahura, Kawaka, and Kapitea Valleys very little has been done to prove the existence of gravels under the glacier-drifts, or, where gravels have been observed, to prove them gold-bearing. It is at Kumara where the river-gravels under the morainic deposits of the Dillmanstown Hills occur fully displayed, and where they have most extensively been worked. It would appear that these gravels on the Kumara field are the great source of the gold. They in the various workings pass under the morainic hills of Dillmanstown. Over Kumara and Larrikins Flats these gravels were overlain by others of a similar nature, derived from the denudation of the adjoining glacier deposits, and it was a matter

\* Mines Reports 1893, pp. 163, 164.

of difficulty to distinguish between the two in vertical section. The distinction was only made clear when it was seen that on the western edge of the morainic hills the glacier material wedged in between the two gravel deposits.

The same deposits should be present under the morainic heaps of Hayes Terrace; and in the Greenstone Valley they appear to be present at Maori Point. Elsewhere, in the Greenstone Valley, and over the district south of the Arnold, these gravels have not been noticed.

(b.) *Marine Gravels containing Black-sand Leads.*—Like the littoral deposits already described, these beds are developed parallel, or approximately parallel, to the coast-line. They are not clearly indicated as present in the district south-west of the Hokitika River. They are first distinctly met with at the eastern edge of the Big Paddock in the Houhou Lead, at the bottom of the series of gravels forming the terrace-flat to the westward.

The Houhou Lead yielded a very great amount of gold, but was lost at the southern edge of the Blue Spur Flat, being, in fact, cut away by the action of the Three-mile Creek, as has already been indicated.

On the opposite side of the valley it was traced in Scottie's Terrace, but not by the miners recognised as a continuation of the Houhou Lead, from the fact that the original deposit was much disturbed, or destroyed altogether; and the gold in and under a thin deposit of gravel was left clinging to the steep slope of Tertiary clays that form Blue Spur. A little further west, where the blue-reef bottom dips rapidly to the seaward, the line of lead remains intact; and in Simpson's claim, opposite the Blue Spur Township, the nature of the material forming the wash can be studied to advantage, there being here heavy beds of black sand mixed with flat beach-stones, and overlain by gravels evidently of marine origin. In Simpson's claim the golden bands were not remarkably rich; and, for this cause again, it was not generally supposed that this was a continuation of the Houhou Lead, which, nevertheless, undoubtedly it is. The lead was therefore, despite these evidences, considered to stop short on the southern side of the Blue Spur Flat; but within the past few years it has been traced to the Arahura slope of the Blue Spur, and recent developments in that quarter show that it is here very rich in gold, probably richer than at any other point of the line to the southward.

The history of what has been done, leading up to and ending in the discoveries recently made, and which have lately been the cause of not a little excitement in mining circles on the West Coast, is as follows:—

On the north-east side of the Humphrey's Gully Range, south-east of the road from the Arahura crossing to Blue Spur, rich diggings were found on the lower slope of the range, which, east and west of the road-line, were traced into and under the level terrace-lands at the foot of the range. In the extreme west of this line the slope of the ridge does not appear to have been as rich as to the east of the road, and in explanation of this it has been noted that the Houhou Lead was comparatively poor on the point of the Blue Spur in Simpson's claim. Be this as it may, the gold was found rich along the edge of the terrace flat, up to what is now known as Dwyer's freehold, but the auriferous wash dipped rapidly into deep and wet ground, and it was found impossible to follow it further than a vertical depth of 30ft. from the surface of the flat. For a number of years the ground was abandoned, and no mining was carried on on the north-east side of the Blue Spur, or along the south-west extremity of the Humphrey's Gully Range. East of the road-line some areas of freehold were acquired between the Blue Spur and what is known as the "Black Bridge," and latterly Mr Dwyer acquired a residence area of one acre at the extreme western end of the gold workings on the flat, and subsequently negotiated with the Midland Railway Company for the purchase of forty acres adjoining, on the west and north-west sides of his residence area. In the meantime Mr. Boys, of Blue Spur, from a conviction that rich deposits of gold were still to be found on the terrace flat, commenced putting in an adit from the foot of the lower terrace, near the level of the Arahura, and one mile distant from the ground he intended to prove. Through successive years this work was continued, and in 1892 the face of the drive was still fully 300ft. from the point where it was hoped to catch the lead, that could not be followed into the flat on account of water. This adit, which for the greater part of the distance driven was through river gravels, it was hoped would strike gold, other than that to reach which it was started; but throughout 4,000ft. of driving the gravels were barren of gold, and at one time it seemed that the work must be abandoned. However, in 1893 the Mines Department granted Mr. Boys a subsidy, which enabled him to continue the work.

The same year the writer, who examined the district with reference to its geology, and more particularly with regard to the distribution of the different alluvial gold deposits, expressed the opinion that the ground sought to be proved by Mr. Boys would turn out to be the northern continuation of the Houhou Lead. Meanwhile, throughout the time of its being driven, the adit put in by Mr. Boys gradually drained the ground, and, shortly after the time the tunnel was driven into the lease held by Mr. Boys, shafts could be sunk over the flat to a much greater depth than formerly, and in some cases bottomed, without meeting with water.

Mr. William Harcourt, when living at the Arahura Crossing, at times prospected in the small creek crossing the Christchurch-Hokitika Road at Black Bridge, and obtained a fine sample of gold, corresponding with that from the lead on the north-east side of the Blue Spur. This clearly had been washed out of an eastern continuation of the lead, probably by the cutting action of the creek at or near the foot of the hill. As soon, therefore, as Mr. Boys cut in his tunnel through the ridge of Tertiary clay, and reached the auriferous gravels to the south-east of that, the Harcourt Brothers applied for, and were granted, extended claims, and at a distance of about 10 chains to the east of Boys's shaft sank and bottomed on gold. A rush then took place, and several shafts were put down, and, due to the water being drained away by Boys's tunnel, the ground was now comparatively dry. Most of the trial shafts, however, did not find gold to pay, and, for a time, things again became quiet. Finally, Boys struck very rich gold-bearing wash, and R. A. Harcourt negotiated for the privilege of mining under Dwyer's residence area, which right he acquired, and sank a shaft

just outside the area, within Boys's claim. This bottomed through washdirt very rich in gold, Mr. Harcourt estimating that the area of the shaft alone yielded 8oz. of gold. There was now considerable excitement with respect to the 40 acres held by Mr. Dwyer, and the whole of the ground was pegged off under the belief that the land had not been alienated, and was still open for mining purposes. It is understood that the land is to be resumed by the Government shortly.

There is little doubt that the lead extends east to or beyond the Black Bridge, and thence dips to the westward, and in this direction is covered up by the more modern gravels of the Arahura Valley. Over the low grounds of the Arahura Valley the lead has been carried away by the river, and it is not likely to be again met with till passing to the north-east of Flowery Creek, where it should again be present in, and for some distance into, the flat west of Ballarat Hill, which is the line of its continuation to the north-east, at or near the level of the Houhou and Blue Spur portions of the lead.

On Ballarat Hill the lead was fully developed, but the richer part of this area has now been worked. North-east of this the Waimea has broken through and destroyed the lead, and it is not met with till Scandanavian Hill is reached, although the terraces at the back of Staffordtown should afford some indication of it, as being formed of the same marine gravels, which are gold-bearing on the south-west side of the Waimea. As far back as workings have been carried to the eastward, on Ballarat Hill, beds of black sand, partly oxidized and cemented, are found interbedded with the coarser gravels, thus indicating the marine character of the beds.

On the continuation north-east of the line of this old raised beach, between German Gully and Sandy Creek, there are a series of terraces, denominated second, third, fourth, and fifth terrace. These appear to be the line of lead, cut down to various levels by the action of the different streams that are tributaries of German Gully Creek or Sandy Creek.

The Lamplough Lead, within the Kapitea Watershed, lies on the same line, and is distinctly on a continuation of the Houhou lead thus far.

Further to the north-east, between the Kapitea Creek and the Teremakau River, the line of black-sand old beach deposit has at one time been continuous, but in times more recent the action of the Teremakau has either destroyed or covered up the marine beds. Workings along the high terrace banks of the river, and in Drake's Terrace and Hughes's Creek, indicate that here portions of the lead yet remain.

Between the Teremakau and Rutherglen, in the watershed of Saltwater Creek, there seems to be two lines of black-sand leads, either of which may be considered as the direct continuation of the Houhou Lead. Practically, both are continuations of the same lead, which may be said to be of greater breadth here than farther to the south. New River and Saltwater Creek have broken through and almost destroyed the lead, scattering its gold in the more recent gravels, now occupying the low grounds of their valleys.

Towards Greymouth this line of black-sand deposits is not so well marked, possibly through the action of the Grey River; but towards Point Elizabeth it is again distinctly and characteristically present on Darkies' Terrace.

On the northern side of Point Elizabeth the action of the Seven-mile Creek has destroyed the continuity of the lead, but between the Seven- and Nine-mile Creeks it is present as a high terrace of marine gravels, which are known to be gold-bearing, and which would ere this have been extensively worked had there been facilities for bringing water on to the ground at a moderate cost.

The coast-line is now abrupt and high; consequently, the 200ft. to 300ft. line is much nearer the tideway than farther to the south, hence this lead approaches the coast as it is followed towards the north. Between the Ten-mile and the Twelve-mile Creeks (north of Greymouth) it simply rests on the brow of the cliffs overlooking the sea, or stretches as a narrow terrace at the foot of the steeply rising hills.

Between the Twelve-mile Creek and the Fourteen-mile Bluff, since its deposit, this line of black-sand leads has been completely destroyed by the action of the sea in cutting back the coast-line.

At Barrytown the lead runs along the lower slopes of the slate-ranges, between the coast-line and the Grey Valley, and from Baker's Creek to the northern slopes of Hawera it has been cut through by numerous small streams, so that the auriferous gravels are found only on the points of the spurs intermediate between the different creeks and larger gullies. The average height of the lead at Barrytown is a little over 200ft. above the sea. It appears to be thoroughly broken, in fact, destroyed altogether, between the Punakaiki River and the mouth of the Fox River. This has been owing to the action of the numerous small streams that find their way from the higher part of the Paparoa Range to the coast-line. Where the rivers are larger, as in the case of the Fox, Nile, and Totara, a greater distance lies between the streams, and thus there is a greater chance of the marine-beds being preserved on the bluffs and high lands intervening. There is, even thus, a probability of areas being between the Punakaiki and the Fox Rivers where these deposits are preserved. One such is said to be on the high ground near Razorback.

North of Brighton and St. Kilda the elevation above the sea of the black-sand leads rapidly increases, till before reaching the Four-mile (from Charleston) Creek these deposits reach to between 500ft. and 600ft. above the sea. Between the Four-mile and Candlelight the highest reached by the black-sand deposits is somewhat less, some 450ft., and this height is practically maintained to Bald Hill, overlooking the Lower Buller Valley.

In the neighbourhood of Charleston these deposits are of great extent, and occur at all levels up to that stated, and from them an enormous quantity of gold has been obtained. The "Back Lead" at Charleston lies along the foot of the limestone range between the Nile River and the Four-mile Creek. Along this line the ironsands have oxidized to some extent, and cements have thus formed, necessitating the use of crushing machinery to again liberate the gold. But the gold is not thus completely set free, and a considerable percentage finds its way with the tailings into the

creeks, where, as it progresses along the different tail-channels, it is gradually liberated from contact with the ironsands, and, as free gold, is caught on tables called "fly-catchers," placed in the channel to intercept the gold.

There are large areas of black-sand and gravel deposits in the Charleston district that are as yet untouched, but all of them lie to the west of the limestone range.

East of the limestone range, between that and the foot of the Paparoa Mountains, lies a depression lower than the country to the west, yet over this there are no black-sand deposits. This fact may be explained by supposing that the marine sands have been removed by the more energetic denudation of the eastern low-lying lands, or by the inequality of elevation affecting the areas east and west of the limestone. The first of these suggestions, from the evidence met with north of the Totara River, would seem to be the correct one, since on the high terrace at the back (east) of Addison's Flat the black-sand deposits are yet preserved. To the north of the Buller the higher level of the terraces between the granite range and the coastal plain is also to be considered a continuation of the high-level black-sand lead. This series of old raised beach deposits in the beginning has been spoken of as the Houhou Lead; but it will now be evident that such local designation fails entirely to indicate the true character and the great importance of the deposit; and in future it will be best to speak of this as "Marine beds of Pliocene age," the different auriferous parts of which might still retain their local designation, as "Houhou Lead," "Lanplough Lead," "Darkies' Terrace," &c.

So far as this report is concerned, the deposits under consideration may be said to terminate at Fairdown, on the lower slopes of Mount Rochfort, where extensive works are at present being carried on for the proper development of their deposits, the success of which will probably lead to future and even more extensive undertakings.

#### IV. LOWER PLIOCENE AND UPPER MIOCENE.

Formerly the higher and lower parts of these beds were considered as distinct from each other; but it must be confessed that it is not always easy to distinguish between the gravels referred to under one or other heads. In some localities there appears evidence that the conditions under which the higher beds were deposited approached those of a glacier period, there being in some localities large erratic boulders, and sometimes heavy deposits of what appears as angular morainic material of large size; and at places such evidences of glacier action appear at the top of a local development of the beds, at others in the lowest member of such local development. The lower part of this great series of gravels does not exhibit brecciated or angular material of great size. Angular material of any size is present to a very limited extent only. With these differences it has to be considered how far the upper and lower parts of these gravels are unconformable to each other. The evidence of unconformity is strongest in the district between the Big Grey and the Ahaura, and especially in the neighbourhood of Napoleon Hill. In Napoleon Hill the unconformity is by many miners declared to be very marked, and the upper gravels are said to lie in what resembles an old river-bed, excavated in the underlying "Old-man bottom." Some facts thus favouring the division of the beds, and it being the opinion of many that there is a distinct and very marked separation between the higher and lower parts, they will be here described accordingly—that is, as a double series.

(a.) *Humphrey's Gully Beds.*—In the higher part of Mont d'Or, at Ross, there is, at the head of Sailor's Gully, clear evidence of glacier drift occurring in the higher part of the "Old-man bottom," as developed at that place; the same thing is seen on the north-west and south-west faces of the hill, which has been cut into on three sides by gold-workings. These glacier drifts are thought not to be gold-bearing, but this has yet to be definitely ascertained.

In Humphrey's Gully Range, near the Humphrey's sluicing claim, angular brecciated material lies at the bottom of the gravel series, and to some extent is interbedded with the underlying sandy clays. The same glacier-looking deposit is largely developed beyond German Gully in the steep bluff that there overlooks the Arahura River. At this point the whole bluff is composed of a species of "till" or less clayey brecciated material. There may also in Humphrey's Gully Range be the presence of the lower beds of this series; but, as the upper series is very thick, and the lower not discriminated, it has been considered that only the upper or Humphrey's Gully beds are present. In Donegal Creek, six miles from Kumara, on the road to Christchurch, there is a considerable thickness of coarse well-washed gravels that have been referred to this upper part of the series, and the same gravels again appear one mile and a half nearer Kumara, there showing in the road cuttings. North of the Tereunakau this higher part of the series has not, apart from the lower beds, been discriminated.

Within the northern part of Westland these beds, at Ross, are important as gold-bearing gravels both in Mont d'Or and in the Ross United Claim, because it can hardly be doubted that some of the many gold-bearing strata in the latter claim represent this upper series of Older Pliocene or Upper Miocene gravels, seeing that gold-bearing layers rest directly on the "Old-man bottom" in the company's ground, and probably throughout the greater extent of Ross Flat. In the Humphrey's Gully Company's claim, and probably throughout the extent of the same gravels in the Humphrey's Gully Range, these gravels are gold-bearing, and, on account of the facilities for getting away large quantities of the wash, are likely to reward enterprise for a long series of years to come.

In the Grey Valley the higher beds of these, the higher beds of the series, are developed on the tops of the hills, on the northern side of Nelson Creek opposite Hatter's Terrace, and thence it is likely that a line of the same gravels will be found to have extended, with a breadth of from one to one and a half miles, across the various creeks and larger streams flowing north-west to the Grey, for the whole length of this particular block of hilly country formed of Older Pliocene or Upper Miocene gravels. The younger and richly auriferous part of the series is found on the ridge of hills on the left or south-west side of Orwell Creek, and, crossing this, occurs to the north-east, forming the

whole area of the higher part of Napoleon Hill. North of Napoleon Hill, the main or south branch of Noble's Creek, has cut these gravels away, and laid bare, along its valley and lower slopes of the adjoining hills, the underlying and less auriferous series. Also, the hill-tops to the north-west and north of Napoleon Hill retain areas of the same rich gravels; but the beds since deposit have been more elevated towards the north-east than in the south-west part, and thus towards the Big Grey the areas of the remaining patches of the higher beds are less.

In the Little Grey and Inangahua Valleys these higher beds of the Older Pliocene or Upper Miocene gravels appear to be absent—at least have not been discriminated. Possibly the gravels capping the higher part of Merrijigs Hill may be properly regarded as belonging to this part of the series.

(b.) "*Old-man Bottom.*"—These beds have a wider area of distribution than the Humphrey's Gully gravels. They extend from the Township of Ross along the front hills, forming the lower western slopes of the mass of Mount Greenland, and, at the same time, cap the auriferous slates forming the higher part of that mountain. They are not elsewhere seen on the southern side of the Hokitika Valley, but appear in the eastern tributaries of the Kanieri River, and form the lower or south-eastern part of the gravel portion of the Humphrey's Gully Range. They appear at Fox's and Stony Hill, at Duffer's and Greek's Creeks, and generally over the higher parts of the Waimea Hills to the head of German Gully, Maori Gully, and the right-hand branches of the Waimea, south-west of Callaghan's Hill. The lower beds appear along both banks of the Greenstone below the township; and at Maori Point they form an isolated conical hill, that on account of its greater elevation has never been overspread by glacier detritus or river-gravels of more modern date. They are largely developed from Cameron's Terrace across Fuchsia Creek, and along the range of which Marsden Hill forms the western part. They are or have been spread over almost the whole of the New River area, and between the south continuation of the Cobden limestone and the sea they have, between Saltwater Creek and Greymouth, a very considerable development.

These gravels constitute the fundamental rocks that underlie the younger and more superficial deposits in the No Town Hills, and the broad belt of country thence stretching to the Big Grey shows these gravels bounded by younger rocks to the north-west and the south-east.

Along the south-east side of the Little Grey Valley they form a strip of country from three to four miles wide, that, commencing within the Blackwater and Big River Watershed, thence extends to Slab-hut Creek. Beyond this, the same beds are largely developed on the watershed between the source of the Little Grey and the Inangahua, below Reefton, and in the valley of Devil's Creek, and along the east side of the Inangahua Valley, from the upper part of Fryingpan Creek to and beyond Landing Creek and Coal Creek, on the same line extended in the direction of the Buller above the Inangahua Junction.

At one or two places in the Inangahua Valley, gold-workings are carried on in these rocks, but though their auriferous character cannot be denied, they are not rich enough to have afforded hitherto payable workings at many places. The concentrates of these gravels have made a great number of creek and valley bottoms famous for the amount of gold found in them, and there are hopes that when large supplies of water can be brought to operate upon these gravels they will pay to work at many places, and at some places pay well.

(c.) *Brown Sands.*—These beds are seen on the southern banks of the Hokitika, below the bridge at Kanieri township, and in the Greenstone Valley, in the Twelve-mile Creek (No Town Creek), and in the banks of the Ahaura, at and above the township. Elsewhere they appear to be absent. These sands sometimes contain scattered pebbles and bands of pebbly conglomerates, and in the Greenstone Valley thick beds of rather coarse granite conglomerate. Near Maori Point they have a considerable thickness.

#### IV.—LOWER MIOCENE.

(a.) *Blue Fossiliferous Sands and Marly Clays.*—These beds are found in the southern part of the district, along the western slopes of Mount Greenland, from the Mikonui to the Totara Rivers, and between Donnelly's Creek and the Totara form a range about 1,600ft. above sea-level. They are to a considerable extent developed along the northern side of the Kanieri Valley, and the south-eastern slopes of the Humphrey's Gully Range and Mount McKay. Throughout the Waimea district they are developed from Fox's to Staffortown, and from Ballarat Hill to Kapitea Creek. They, at Kumara, show as the bottom on which rests the lower gravels that underlie the river-gravels under the glacier deposits. And they appear in Donegal Creek, six miles to the eastward, and generally on the southern bank of the Teremakau, between the Greenstone Bridge and the sea. From the mouth of the Teremakau to the sources of New River, and from Maori Point on the Greenstone to Stillwater Creek in the Grey Valley, these beds form the floor on which rests the various gravels and glacier deposits that appear on the surface.

Between the limestone ranges and the coast-line they stretch north to the mouth of the Grey River, and in the Grey Valley are met with under the "Old-man" gravels of the No Town hills. Further to the north-east, in the Grey and Inangahua Valleys, they are not known. On the coast between the Grey and the Buller they lie as a long narrow strip between the limestone range or plateau and the foot of the Paparoa Mountains, till passing to the northwards of Charleston and the Nile River they reach close to the coast-line, and at the mouth of the Totara River they underlie the black-sand beds and other gravel deposits to the foot of the granite mountains seven miles distant.

Between Cape Foulwind and the end of the cliffs towards Westport they show in section, and exhibit strata in some places abounding in fossils. North of the Buller the same beds are not clearly displayed, except it may be in one particular creek on the Buller Road, between the foot of the gorge and Westport.



## VI. CRETACEO-TERTIARY AND CRETACEOUS.

(a.) *Upper Beds*.—Usually the upper beds of the Cretaceo-tertiary series have been described as embracing the Grey marls, Weka Pass limestone, and Amuri limestone, including also the marly strata that underlies the horizon of the Amuri limestone, and rest upon the Concretionary Green-sands or the saurian beds. On the West Coast the uppermost member of the series is absent, and the Weka Pass stone also is not characteristically represented, the Cobden limestone showing more of the lithological character of the Amuri limestone, while at the same time its more abundant fossil fauna may indicate more the period of the Weka Pass stone. The dark foraminiferous marly clays that underlie the Cobden limestone must, with the limestone, be regarded as representing on the West Coast the upper part of the series. Limestones of this age and character are said to occur on the left bank of Donnelly's Creek, at Ross. Limestone also is present at Camel-back Hill, on the Kokatahi Plain, and the line of limestone south of Greymouth is continued across the New River below Marsden, almost to the banks of the Teremakau. North of the Grey River the Cobden limestone, underlain by the black marls, extends to Point Elizabeth and the Seven-mile Creek. Beyond this no limestone or underlying marls are present till reaching the north end of the Seventeen-mile Beach, where, in the Hills of Razorback, the limestone begins and is continuous along the coast, with a depth of a few miles inland, to the Fox and Nile Rivers, and the Little Totara River. In the Buller and Inangahua Valleys this limestone is developed to a large extent along the west side of the Inangahua Valley, from one mile and a half below the junction to a point between Fletcher's and Stony Creek, opposite the junction of Boatman's with the Inangahua. On the opposite eastern side of the Inangahua a small area of limestone of the same character and age is met with between Little Boatman's Creek and Italian Gully. Limestone of the same age and character is found in the Upper Buller Valley as deeply involved strata, between the Newton River and Fern Flat, and an extensive area of limestone occupies the higher part of the range between the Maruia and the Matakita Rivers.

(b.) *Middle Beds*.—These consist of green-sands, soft yellow or brown sandstones, limestones, sandstones, &c., grit with shales and coal-seams, and constitute the more important part of the formation. In the southern part of the district there is a small area of these rocks in Camel-back Hill, near the banks of the Hokitika River, and again in the Valley of Coal Creek, a tributary of the Kanieri River. On the southern side of the Lower Grey Valley the axis of the range between the Brunner Gorge and the northern sources of New River has on each side of it a development of coal-bearing rocks, but these as yet have been but imperfectly explored for coal-seams. The coalfield north of the Grey is an important development of these rocks. The higher part and west slopes of the Mount Davy Range is the most important coal-bearing district in the region of the Grey Valley. The workable seams vary from 5ft. to 16ft. in thickness on the Mount Davy Range, and dip west at moderate angles. In the Seven-mile Creek the dips in the more important outcrops is inward toward the mountain range. Towards the sources of the Nine-mile, and of the south branch of the Ten-mile, the coal and beds associated are very much disturbed, and often are seen standing at high angles. Between the northern end of Mount Davy and the conical peak at the sources of the south branch of the Ten-mile, and of the right-hand branch of Ford's Creek, the coal-measures form the mountain range, and are continuous from the coast-line to the Grey Valley, at the mouth of Blackball Creek. In the Grey Valley, above the Brunner Gorge, a narrow strip of coal-bearing rocks runs along the north-west side of the valley and the lower slopes of the Mount Davy Range to the right-hand branch of Ford's Creek. This is separated from the coal rocks on the higher part of Mount Davy Range by a belt of slate, that gradually gets narrower as it is followed to the north-east, till in the watershed of Ford's Creek it wedges out altogether. The Blackball Coalfield embraces in part the watersheds of Ford's Creek, and of Coal Creek, a tributary of the Blackball, and, as stated above, is connected with the coal-bearing area on the coast, through the saddle between Mount Davy and Ford's Peak.

There is in the Moonlight Valley, in Garden Gully, a thick deposit of brown coal, which rests upon auriferous slates, while the section does not show what the overlying rocks are. At the crossing of Moonlight Creek, on the way to the township, the associated rocks are seen, and consist of soft grey sandstones dipping at a considerable angle up-stream, or to the north-east. The same rocks are also well developed further down the Moonlight Valley. They are quite unconformable to the gravels on the high terraces and the "Old-Man bottom," with which these soft sandstones come in contact; but at the same time neither the strata associated nor the coal itself agrees well with the rocks and coal-seams of the other parts of the coal-field. Brown coal is found as thin seams in Slaty Creek, and again in the upper part of the Little Grey Valley, on the lower slopes of the Paparoa Range.

Along the sides of the Inangahua Valley coal-seams are found, and are worked at many places on the east side of the valley from Boatman's to Merrijigs. The coal-measures in the Inangahua Valley are shales and quartz grits, passing upwards into sandstone. In the Upper Buller Valley coal-seams of considerable thickness are worked in the vicinity of Longford and in the Upper Maruia. Above and opposite Station Creek there is a 30ft. seam of brown coal.

South of the Buller River a narrow coal-field runs along the foot of the Paparoa Mountains, from the Nile Valley to Bullock Creek, and on the coast-line in the same district are largely developed the brown coals of Charleston and of Brighton, at the mouth of the Fox River. In the valley of the Fox River, between the limestone range and the foot of the higher mountains, anthracite of most excellent quality is found.

(c.) *Lower Beds*.—These consist mainly of conglomerates, or more angular and larger-sized breccia-conglomerates, which are of interest and importance mainly on account of their being auriferous at many places, and at some places stanniferous or tin-bearing. The tin found at the Ten-Mile, north of Greymouth, probably is derived from waste of the conglomerates at the base of the coal-bearing series. Conglomerates and breccia-conglomerates stretch along the lower slope of Mount Davy, and quartz-conglomerates, present on the higher part of the range more towards the north, have apparently yielded to the watershed of Ford's Creek the greater amount of the gold found in it. The lower of these beds, as developed between Moonlight

and the left-hand branch of Slaty Creek (Big River), are of great thickness, and formed of exceedingly coarse material. They extend over a very considerable area, and constitute strata reaching in places from 1,500ft. to 2,000ft. in thickness. From Slaty they stretch across the water-divide into the head-waters of the Punakakaki River. In Black-sand Creek the concentrates from these breccia-conglomerates yield gold, and the bed and banks of the stream have been worked for about one mile. The gold thus obtained does not appear to have paid wages to the men engaged in the work, and at the present time no one is working in Black-sand Creek. In Slaty Creek proper, a considerable amount of gold-washing in the recent alluvial of the creek-bed has been done. The source of the gold in this is either gneissic-granite or the breccia-conglomerates at the base of the coal-bearing series.

Between the gorge of Slaty Creek and three miles farther up Big River, a number of small creeks rise on the eastern slopes of the conglomerate range, and in one or two gullies patches of rich gold-bearing alluvial wash were found. Mr. Johnstone, of Slaty Creek, obtained gold to a considerable amount from one of the smaller gullies indicated.

It is doubtful how far these breccia-conglomerates extend up the Little Grey Valley, as beyond Rough River the recent and Pleistocene deposits derived from the higher and central parts of the Paparoa Mountains overlie and obscure them should they be present.

On the coast-line south of the Buller River they are met with at Charleston and Brighton, and at the first mentioned place are seen exposed along the shore-cliff in Constance Bay. Here the material of which they are composed is largely of local origin. At Brighton they form a remarkable pyramidal rock at the mouth of the Fox River, but do not appear to be developed further inland, where the base of the coal-bearing series rests against the granites forming the lower slopes of the Paparoa Range.

In the Buller Valley, between the Ohika-iti (Little Ohika) and Grainger's Point, near Coal Creek, they have a great development, and form lofty ranges of mountains on each side of the valley. They extend for six or seven miles up the Blackwater, and also a considerable distance back on the northern side of the gorge. In Hawk's Crag they form a high vertical cliff, along the face of which the Westport-Reefton coach road has been cut. In this part they do not appear to be generally gold-bearing, though what little gold has been obtained from the Blackwater appears to have been derived from them. Thin seams of bituminous coal appear in these rocks near Hawk's Crag. On the west side of the Inangahua Valley a patch of such conglomerate appears at the source of Fletcher's Creek.

On the east side of the Inangahua Valley these conglomerates and breccia-conglomerates are found nearly continuous from the Buller River to the Inangahua River, opposite the junction of the Rainy Creek.

In Boatman's Creek, at Capleston, well-rounded rather coarse quartz gravels represent these beds, and of the same character, like deposits extend along the front range to the north branch of the Inangahua River.

At Painkiller, and in the upper part of Murray Creek, and thence covering the older rocks, and forming the higher part of the range between the north and south branches of the Inangahua, these beds extend back eastwards to the foot of the granite mountains. In the upper part of Boatman's Creek there is a remarkable development of these rocks, mainly consisting of granite, though other rocks also are present. Here the material seems to be of glacier origin, a large proportion of the granite masses exceeding 6ft. in diameter, and many reaching to 10ft. and 12ft. through. The general bulk of the deposit at this place is completely angular, and, though transported for some distance, not in the least water-worn.

In the upper part of Murray Creek, and in Lankey's Gully, these beds are auriferous, so much so that, with the application of skill and proper appliances, they should be made to pay for working. Some attempts to work these cements, where they are known to be gold-bearing, have, it is true, been discontinued, mainly owing to the great hardness of the material to be dealt with; and, in the case of the Lankey's Gully cement claim, on account of the gold being, for the most part confined to the first foot of cement resting on the underlying rock.

In the Upper Buller Valley, there is a great development of gravels in connection with the lower division of the Cretaceo-tertiary series. These gravels are found in the valley of the Mangles, up which they extend to the Blue Duck Creek, to which point very coarse gold is got in the alluvial deposits of the river-bed, and in those of Blue Duck Creek itself. Beyond this point, *i.e.*, higher up the Mangles Valley, the gold is much finer in grain, and it is also much less in quantity.

In the Matakita Valley, there can be little doubt that the bulk of the gold found in the bed of the river, and along its banks has been derived from the denudation of the gravel cements occurring towards the base of the Cretaceo-tertiary series, or resting directly on the gneissic granites. In the Glenroy and in the Upper Maruia, between Thompson's and Station Creek, there is a great development of these beds. They are known to be auriferous in Station Creek; on the Rapanoch Stream, and along the Glenroy River. There is a probability of these beds being largely worked at no distant date.

#### X. TRIASSIC.

(a.) *Beds in the Upper Teremakau Valley, resembling the jasperoid and diabasic beds of the Selwyn Gorge, Canterbury.*—These beds lie outside the district mapped to illustrate this report, and they have already been sufficiently noticed in a previous report.\*

#### XII. CARBONIFEROUS.

(a.) *Maitai Series.—Westland Formation of Haast.*—In the southern part of the district this formation is found in Mount Greenland, between the Mikonui and Totara Rivers, and in Constitution Hill, between the Totara and Hokitika Rivers. A small area of the same rocks also is said to occur in the Kanieri watershed. They form also a broad belt of country, and all the higher mountains along the main water-parting, between the east and west coasts of the island; and in the report immediately above referred to they have been described with sufficient detail as far as the source

\* Goldfields and Mining Reports, 1893, p. 171.

of the Teremakau River. Further to the north-east they have not yet been closely examined along the higher mountains of the main range. These rocks form the central axis of the range, extending from Mount Buckley, on the south side of the Brunner Gorge, to the western sources of New River. In this part they have not been explored, although liable to contain auriferous quartz-reefs and other metallic minerals, as do the continuation of the same line of rocks on the opposite side of the Grey Valley, along the middle slopes of the Mount Davy Range.

This latter, or the Langdon's area of Maitai slates, extends from the southern slopes of Bald Hill as a gradually narrowing exposure to the watershed of the right-hand branch of Ford's Creek, where it is terminated. Within the watershed of Langdon's Creek an antimony lode and a line of quartz-reef, with several parallel leaders of quartz, have been discovered, and have been prospected more or less continuously for the past twenty years. Recently fresh developments have taken place, and rich discoveries have been made in the Victory Claim, owned by Messrs. Curtis, they having touched upon a small reef containing some very rich stone.

In the Lower Blackball, slate makes its appearance near the township, and the boundary-line between this and the coal-rocks follows the right bank of the stream closely to Smoke-Ho Hill, and thence, disregarding a broken area of coal country, is projected more to the north-east. Beyond this the boundary-line of the slates goes west to the top of the range in Ford's Peak, and thence follows a sinuous yet general direction to the coast-line near the Twelve-mile.

From Ford's Peak to the source of the Moonlight, the Paparoa Range is composed of Maitai slates and sandstones, if a small granite area at Barrytown be excepted.

Throughout, the rocks are generally similar in the different localities, though at places sandstones predominate, as for instance between the Twelve-mile Creek and the Fourteen-mile Bluff. In this southern part of the Paparoa Range there are six or seven distinct lines of quartz-reefs, with accompanying leaders or veins. All of them have an east and west direction and, as a rule, dip to the north. One massive outcrop runs along the north-east side of the right-hand upper branch of Blackball Creek, and passes thence into the watershed of the Ten-mile Creek, but, though the rocks are clearly exposed, this massive reef, 30ft. to 40ft. in width, does not, in this direction, appear to "live down" to any great depth. In the contrary direction it can be traced across the different gullies a distance of from one mile and three-quarters to two miles. North-east of this, another line of reef crosses the range between the Meg and southern branch of the Moonlight, another in the line of Canoe Creek and the middle branch of the Moonlight, and yet another in the left-hand branch of the Moonlight, at the extremity of the slate area. The Minerva Reef lies in the outer eastern range, that runs from the lower gorge of the Blackball to the Moonlight Township.

Another, and considerably the largest, of the isolated areas of the Maitai auriferous rocks, begins on the south side of the upper part of the Snowy River, and constitutes a very considerable area of outer-cropping slates along the south-east side of the Little Grey Valley to the Upper Inangahua. Towards the southern end of this area the Big River Mine is situated, while more to the north clusters of quartz-reefs and mines surround Merrijigs, and occur in the upper part of the valley of Devil's Creek.

North of the Inangahua, between Reefton and the mouth of Lankey's Gully, the breadth of the auriferous formation is considerably lessened, and does not in this part exceed three miles, while north of Larry's Creek the slate belt flanking the granite range is inconsiderable in breadth, and on the banks of the Buller is less than half a mile.

East of Reefton, and between the two branches of the Inangahua River, a comparatively small area of these rocks contains a great number of auriferous quartz-reefs, and lodes containing antimony and other minerals. Second only to the Reefton area is that of Boatman's Creek, while a third, that of Larry's, is in a less developed condition.

North of the Buller River a small area of slates outcrops along the gorge of the Waimangaroa River, the surface rocks immediately to the south being coal-measures, but beneath the coal-measures the Waimangaroa slates are evidently connected with the area forming the bulk of Mount William, and thence extending south-west across the Buller at the Little Ohika.

More to the eastward an extensive area of these rocks lies along the north side of the Buller Valley, between the Inangahua Junction and Lyell Creek. This extends north to and beyond the Mokihinui, but in this direction the northern part of this slate area has not been much explored. The Red Queen and other reefs further down the Mokihinui occur in rocks of a schistose character, and are, therefore, not to be considered in this connection.

In the south-eastern part of the area quartz-reefs occur in Mackley's, or the Orikaka Creek, but these have as yet only been noted by explorers, and no attempt has been made to ascertain if they are auriferous, or to develop them. More to the east, in the valley of New Creek, gold-bearing reefs occur in these beds, and are being worked; while within the watershed of Lyell Creek there has been considerable mining on several reefs for many years.

A small area of these Maitai rocks appears on the south side of the Buller, at and below the junction of the Inangahua, and here also the rocks are impregnated with quartz-veins. At the very junction, dykes of granite have been intruded into the slates, and in the same manner, but on a much larger scale, granite intrusions are seen in the lower part of Lyell Creek, and along the Buller Gorge above the Lyell to the Eight-mile Creek.

Between the Glenroy and the Upper Matakita a small area of rocks is referred by Mr. Cox to the Maitai series, but recently these beds have not been examined.

### XIII. DEVONIAN.

(a.) *Reefton Series.*—These rocks occur between Boatman's, at Capleston, and the source of Rainy Creek, and, generally speaking, lie to the east of the auriferous belt in this part of the Inangahua Valley. The formation consists of blue slates, limestones, and cherts, and has its best and most characteristic exposures and sections in Lankey's Gully, and along the south branch of the Inangahua to Garvie's Creek. The limestones are also particularly finely displayed along the right bank of the Waitahu, or north branch of the Inangahua. No quartz-reefs have yet been discovered in these rocks, and they appear to be devoid of useful minerals, except limestone.

(b.) *Te Anau Series*.—These rocks are confined to the Upper Matakitaki and Glenroy Valleys. The rocks consist of coarsely agglomerated red and green breccias, masses of which are to be met with in the coarse alluvial gravels of the Horse Terrace, and elsewhere in the Matakitaki Valley. Mr. Cox describes these beds as being in the Upper Glenroy associated with serpentine.

#### METAMORPHIC.

##### *Mica Schists.*

*Upper Middle and Lower Schists*.—From the Mikonui to the northern slopes of Mount Alexander and Bell Hill, the triple series of schists have been distinguished, traced, and described.\* North-east of the Ahaura the same rocks form a series of ranges, flanking the higher mountains of the main ranges more to the east. They are continued across the sources of the Big Grey into the Upper Buller, and to the north-east they terminate within the Matakitaki Watershed. Associated with the lower beds there is an extensive development of crystalline limestone, which forms an isolated mountain on the left bank of the Maruia, at the junction of the Alfred, and nearly opposite the Bog Saddle leading into the valley of the Brown Grey. These are overlain by dark mica schists, which by Cox are called “Carbon schists,” these being followed by “black calcareous slates, passing upwards into foliated quartzose schists, talc- and chlorite-schists, and fine-grained mica-schist.” In the southern part of the district these beds pass upwards into a dark-coloured semi-metamorphic slate, probably of Devonian age.

Bands and belts of mica schist occur amongst the gneissic and granitic rocks of the Victoria and Brunner Mountains on the east side of the Inangahua Valley, and of the Paparoa Mountains on the west side of the valley. These, however, will be described as part of the gneissic series with which they occur interbedded. Quartz reefs occur in these beds, but none are being worked for gold within the area dealt with in this report.

##### *Gneissic Schists.*

(a.) *Crystalline Schists and Metamorphic Granite*.—This formation, as developed and displayed within the northern district of Westland, has already been described.† What are practically the same rocks are continued to the north-east throughout the length of the district presently under consideration. At the source of the Inangahua the continuation of the larger connected area of these rocks turns in direction to the north, and continues in a broad belt along the Victoria and Brunner Mountains to the Gorge of the Buller at the Lyell. The great bulk of the rocks in these mountains is gneissic and granitic, but mica schists are at places largely developed, as, for instance, at the upper forks of Larry’s Creek, and at some places on the Maruia slope of the mountains, where it is reported there are considerable areas of slate rock; from which it is to be inferred that mica schist is the rock meant, though not indicated.

In the Paparoa Mountains these rocks, especially in the southern part, are mostly gneissic—even granitic gneiss being of rare occurrence. In the valley of Rough River there are some rather important bands of mica schist. Towards the central northern higher part of the range the rocks are more granitic; but north of the Nile Valley to the Buller Gorge the western slopes of the range are, to a large extent, schistose, a large percentage of these rocks in the Totara Valley being of a schistose character and often characteristic mica-schist. The isolated areas that appear on the coast-line from Cape Foulwind to Razorback have their chief developments at Cape Foulwind, between the Nile and Fox Rivers in the Charleston District; and there are one or two outcrops of less extent farther to the south. At Cape Foulwind the bulk of the rock is porphyritic granitoid gneiss, often a simple gneiss. At Charleston, the rocks are gneiss and mica schist; and further south of the same general character. Although an extensive examination of these rocks was made during the past season in the region of the Paparoa Mountains, they do not appear to yield minerals of a valuable description, and, in fact, appeared to be remarkably barren of metallic minerals, or of vein stuff generally.

In the Victoria and Brunner Mountains there is possibly a greater hope of finding metallic or mineral riches of some kind; but, even amongst these mountains, prospecting from Larry’s, from Boatman’s, and from Reefton has not resulted in the discovery of anything particularly noteworthy.

#### PLUTONIC.

*Massive and Intrusive Granites*.—In northern Westland such rocks are found along the western margin of the granite crystalline rocks, while in the Paparoa Mountains they are confined to an isolated patch at Barrytown, and a number of veins of coarse-grained granite exposed in the Buller (Lower) Gorge. In the Victoria and Brunner Mountains, especially on their eastern slopes, intrusive granites extend along the range, and cross the Buller River between the Lyell and Fern Flat. These are well shown in many sections between the Lyell Township and the junction of the Maruia with the Buller.

The granite rocks in the Upper Matakitaki were not closely studied, nor those that lie on the east side of the Maruia Valley, and from the basement-rocks of the range between the middle part of that valley and that of the Matakitaki.

No minerals of value have been discovered in these rocks. Massive quartz-reefs are said to occur in the Greenstone Mountains, and one is noted on the map of Westland as occurring on the higher part of Turiwhate. This outcrop of quartz is said to be of great size.

The geological map accompanying includes the area of Northern Westland examined during 1893, the map being designed to illustrate another report dealing with the entire area.

The Under-Secretary for Mines.

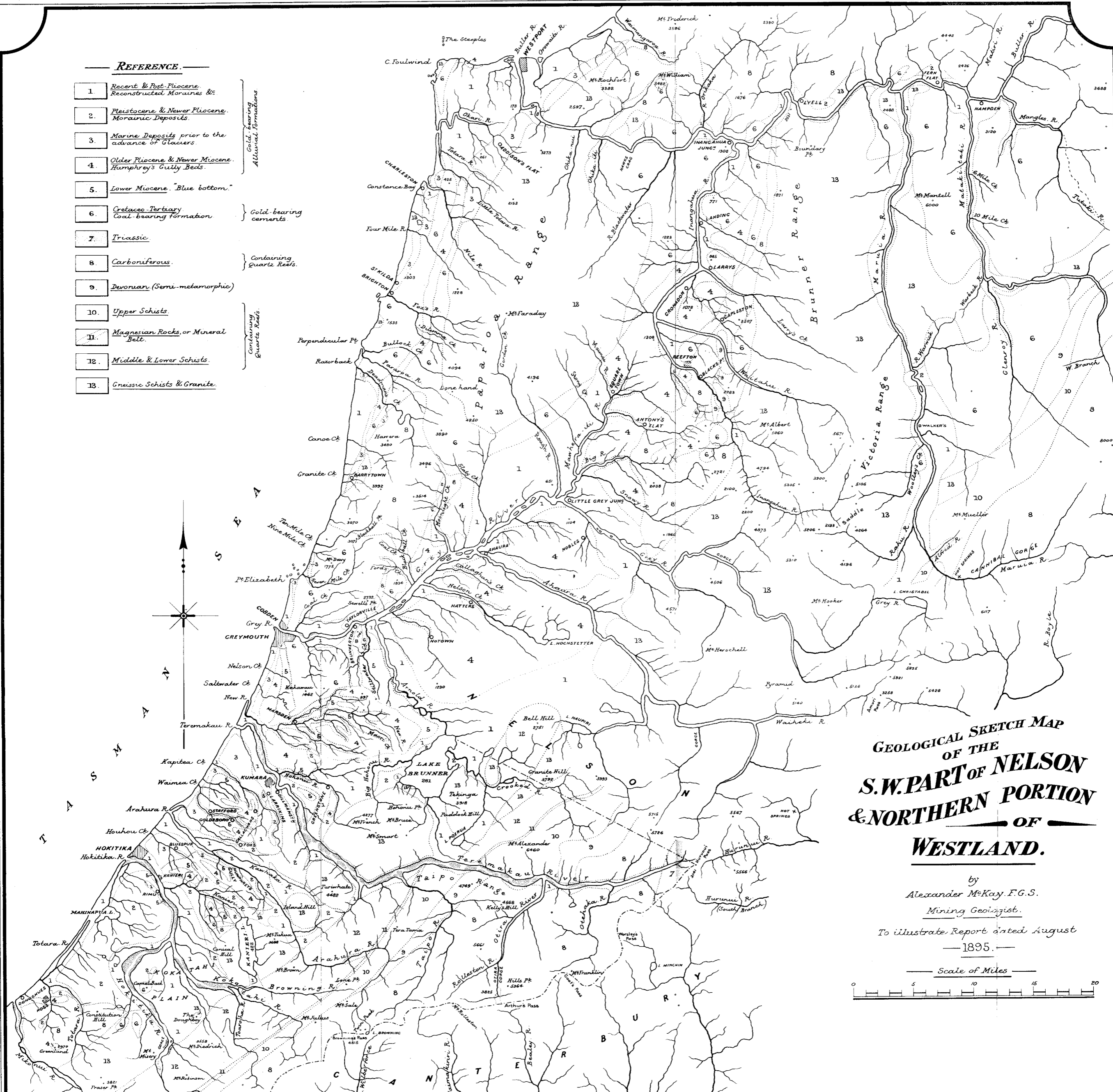
ALEX. MCKAY.

\* Goldfields and Mining Reports, 1893, p. 172.

† Goldfields and Mining Reports, 1893, p. 173.

REFERENCE.

- |     |  |                                       |
|-----|--|---------------------------------------|
| 1.  | Recent & Post-Pliocene<br>Reconstructed Moraines &c      | } Gold-bearing<br>Alluvial Formations |
| 2.  | Pleistocene & Newer Pliocene<br>Moranic Deposits.        |                                       |
| 3.  | Marine Deposits prior to the<br>advance of Glaciers.     |                                       |
| 4.  | Older Pliocene & Newer Miocene<br>Humphrey's Gully Beds. |                                       |
| 5.  | Lower Miocene. "Blue bottom."                            | } Gold-bearing<br>cements             |
| 6.  | Cretaceous-Tertiary<br>Coal-bearing formation            |                                       |
| 7.  | Triassic   | } Containing<br>Quartz Reef's.        |
| 8.  | Carboniferous  |                                       |
| 9.  | Devonian (Semi-metamorphic)                              |                                       |
| 10. | Upper Schists  | } Containing<br>Quartz Reef's.        |
| 11. | Magnesian Rocks, or Mineral<br>Belt.                     |                                       |
| 12. | Middle & Lower Schists.                                  |                                       |
| 13. | Gneissic Schists & Granite                               |                                       |



**GEOLOGICAL SKETCH MAP  
OF THE  
S.W. PART OF NELSON  
& NORTHERN PORTION  
OF  
WESTLAND.**

by  
**Alexander McKay, F.G.S.**  
Mining Geologist.

To illustrate Report dated August  
—1895.—

