The NEW ZEALAND

MINING HANDBOOK

(With Maps and Illustrations).

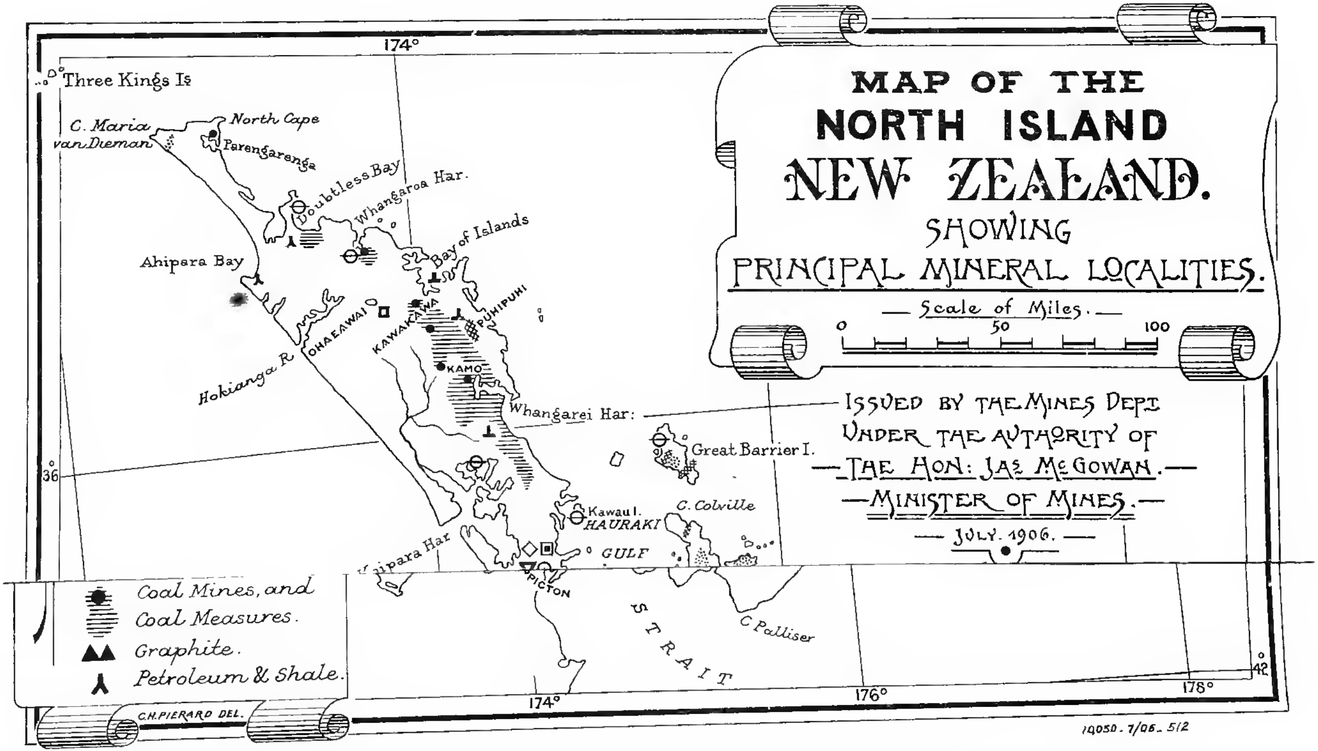
Issued under the Authority of the Hon. JAMES McGOWAN,

Minister of Mines.

WELLINGTON.

BY AUTHORITY: JOHN MACKAY, GOVERNMENT PRINTER.

1906.


MAP OF THE
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SHOWING
PRINCIPAL MINERAL LOCALITIES.
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ISSUED BY THE MINES DEPT
UNDER THE AUTHORITY OF
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MINISTER OF MINES.
JULY. 1906.
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Three Kings Is
C. Maria van Dieman
North Cape
Parengarenga
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HAURAKI
GULF
C. Colville
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Petroleum & Shale.
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Issued under the Authority of the Hon. JAMES McGOWAN,
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EDITED BY P. GALVIN, SECRETARY MINING BUREAU,
Editor of "The Handbook of New Zealand Mines, 1887."

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PREFACE.

Some twenty years having elapsed since the publication of "The Handbook of New Zealand Mines," it has been deemed fitting at the present time, when New Zealand is embarking on the largest Exhibition of her industries in the history of the colony, to give a review of its metalliferous and mineral resources.

The writers who have contributed to this Handbook are principally men who have had a long and intimate association with the mining industry, and whose sole aim is to present a truthful picture of what has been accomplished in the past, and to denote where combinations of capital, labour, professional skill, and business capacity may secure the rewards of enterprise in the future.

There is no desire to create what is generally termed a "mining boom," for nothing has been more disastrous to mining as an industrial undertaking than the undue inflation of shares in limited and no-liability companies on the Stock Exchanges. But as long as gold-mining is carried out on the same lines as coal or iron mining, woollen or cotton manufacturing, it is just as legitimate an enterprise, and far more likely than most other undertakings to give an adequate return on the capital expended.

It is often asserted that every ounce of gold extracted from alluvial or river workings, or quartz-mines, while intrinsically worth about £4, costs at least double that amount. That, however, is a very superficial way of looking at the matter, and is far from being borne out by actual facts. It is the manipulation of the share-market, at periods of undue excitement and inflation, that adds to the cost of the ounce of gold; the extra cost, where it does occur, is due to "mining" on the kerbstone or on an office-stool, not to the miner who works underground, or to the millman or cyanide-worker on the surface.

A perusal of this work will, I feel assured, tend to dissipate the idea that the extraction of gold means a loss, instead of a gain, to the colony. Four companies in the Hauraki Mining District paid upwards of £400,000 in dividends during the past year, and one company (the Waihi) has disbursed upwards of £2,000,000 in dividends. The group of mines worked under the management of the Consolidated Goldfields of New Zealand, at Reefton, have paid £125,487 in dividends, as against a subscribed capital of £242,378; while the Progress Mines of New Zealand—an offshoot of the Consolidated Goldfields—has disbursed in dividends £226,875, against a working-capital of £50,000. The Keep-it-Dark Mine, Reefton, has paid £145,666 in dividends, or at the rate of £7 5s. 8d. per share, while only £6,208, or at the rate of 6s. 2½d. per share, has been called up. These results have been attained by skilful mining, combined with the highest metallurgical and mechanical skill in the treatment of the ore and tailings.

Gold-dredging has suffered much in public estimation owing to the undue inflation of shares; yet during the past year the companies listed on the Dunedin Stock Exchange paid £102,446 in dividends, and some of the companies have returned to their shareholders phenomenal dividends as compared with the capital invested. The Electric Company paid £116,350, against a paid-up capital of £26,000; the Hartley and Riley Company, £79,625, against £6,300 in calls; the Manuherikia, £26,700, against £6,000; the Golden Gate, £23,250, against £2,500; the Moa, £22,700, against £6,000; the Pactolus, £20,937, against £8,125; the Matau, £15,225, against £6,200; the Perseverance, £13,500, against £1,500; the Otago, £11,875, against £2,000. Altogether, sixty-eight gold-dredging companies and parties which furnished information for the Mining Handbook paid in dividends £528,322, against a called-up capital of £332,490. But many of the most prosperous dredges are privately owned, and the proprietors in some instances preferred not to supply the desired information as to dividends, whilst not generally objecting to state the amount of capital expended on dredging plant and claim.

Turning to the early days of gold-mining, it reads more like a romance than an actual statement of facts. The Thames was the first field on which limited-liability companies operated, and therefore some of the dividends paid are available. Hunt's Shotover Claim gave £40,000 apiece to the four original discoverers, and afterwards paid £15,120 to the shareholders in the company that purchased it; the Long Drive Company disbursed £82,000 in a few years; the Golden Crown Company paid £141,904, irrespective of a large amount divided by the original shareholders; the Caledonian Company paid £553,440 during the first year of its existence; the Cambria Company paid in one year £48,825; the Moanataiari Company disbursed £117,993; the Nonpareil Company, £14,670; the Kuranui Company, £41,277; the All Nations Company, £41,445; the Cure Company, £17,000; the Manukau Company, £15,750; the Old Whau Company, £11,650. In later years the New Prince Imperial Company paid £60,750 in dividends in three years from a mine that was sold for £800. Even as late as last year the Waiotahi Company, which has been a consistent dividend-paying company during the past thirty years, disbursed £51,000 in dividends.

In Otago it is currently stated that the Bendigo Mine, near Cromwell, paid £70,000 apiece to the five original owners; and a perusal of the papers devoted to quartz-mining in that portion of the colony tends to show that this branch of mining is deserving of more attention than has been bestowed upon it of late years.

In the Inangahua District, the records of which have been admirably kept at the Warden's Office, the dividends paid by quartz-mining companies from 1881 to 1905, inclusive, amounted to £734,200, as against £486,220 capital called up.

Statistics as to alluvial mines are not so readily available, the bulk of the claims being in private hands; but from the returns furnished to the Department by eighteen companies or parties it has been shown that £134,329 was paid in dividends, against £175,059 actually called up. Some of these companies or parties own valuable plants and water-races, and their claims will last for a very considerable time.

One fact stands out prominently in connection with this branch of mining—namely, the abnormally low value of auriferous gravels that can be made to pay. The same remarks will apply to quartz-mining in the Ohinemuri and Reefton Districts.

I have dealt at some length with this branch of the mining industry, because of its stimulating effect on coal and lignite mining, and its indirect results to the farmer, the carrier, the artisan, and the business man.

Coal-mining has developed to a great extent during the past twenty years. In 1885 the coal raised in the colony was 511,063 tons; in 1895, 726,654 tons; and in 1905, 1,585,756 tons; so that within a comparatively short period the coal-output has trebled. The wide distribution of coal and lignite is a material aid to other industries, and, if the experiments now going on with regard to the utilisation of lignite for producer-gas plants and for the generation of electricity should turn out as successful as anticipated, New Zealand is destined to become the great manufacturing centre of the Pacific. Anthracite coal, which is at present principally used for gas-producer plants, is likely, at no very distant date, to be a marketable commodity in this colony.

The papers on the auriferous ironsands show their great importance as an undeveloped asset to the colony. These sands still await the introduction of a machine for their economic treatment, and when that is forthcoming the annual yield of gold will receive a material addition, and hundreds of men should find profitable employment on the West Coast. I might here call attention to the vast undeveloped resources of that part of the colony, and would refer the reader to the various papers on the subject.

The deposits of hæmatite iron at Parapara, in the Nelson District, and the close proximity of coal and limestone, have attracted much attention of late years, and the people of New Zealand may look forward to seeing iron-manufacture included amongst the leading industries of the colony within the next few years. The manufacture of the magnetic ironsands which abound on the west coast of the North and South Islands into the best tool-steel, for which it has been shown by analysis to be peculiarly well suited, is also amongst the possibilities of the near future.

There are other minerals awaiting capital for their development, such as copper, antimony, cinnabar, manganese, mica, and asbestos; while limestone is distributed over a wide area, and lithographic limestone occurs in the Auckland District and on the West Coast. Scheelite is now regularly exported from Otago, and lately from Marlborough; fullers' earth and hæmatite paint from the Thames; hæmatite paint and powder from Parapara; while there is a variety of grinding and polishing materials in Otago and different parts of the colony.

There are many other points that might well be touched upon, but the reader will find the information he requires in a compact form under the various headings into which the MINING HANDBOOK is divided. I can with every confidence refer him to that branch of mining in which he is most interested. Where the matter has not been written by gentlemen specially cognisant with the industry, it has been compiled from information supplied by those intrusted with the legal or mining management of the numerous undertakings that are chronicled in its pages. These would have been considerably added to had all the other mining companies and parties responded to the invitation sent to them to furnish information.

The aim has been to give the general reader a bird's-eye view of the mining industry as carried on over a very long and wide stretch of country, from the Great Barrier Island in the north to Stewart Island in the south; and I think it will be admitted that the Editor and his various coadjutors have admirably succeeded, though at short notice, in carrying out the duties intrusted to them.

JAMES McGOWAN,
Minister of Mines.

Mines Department,
Wellington, New Zealand,
31st October, 1906.

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MINING HANDBOOK.

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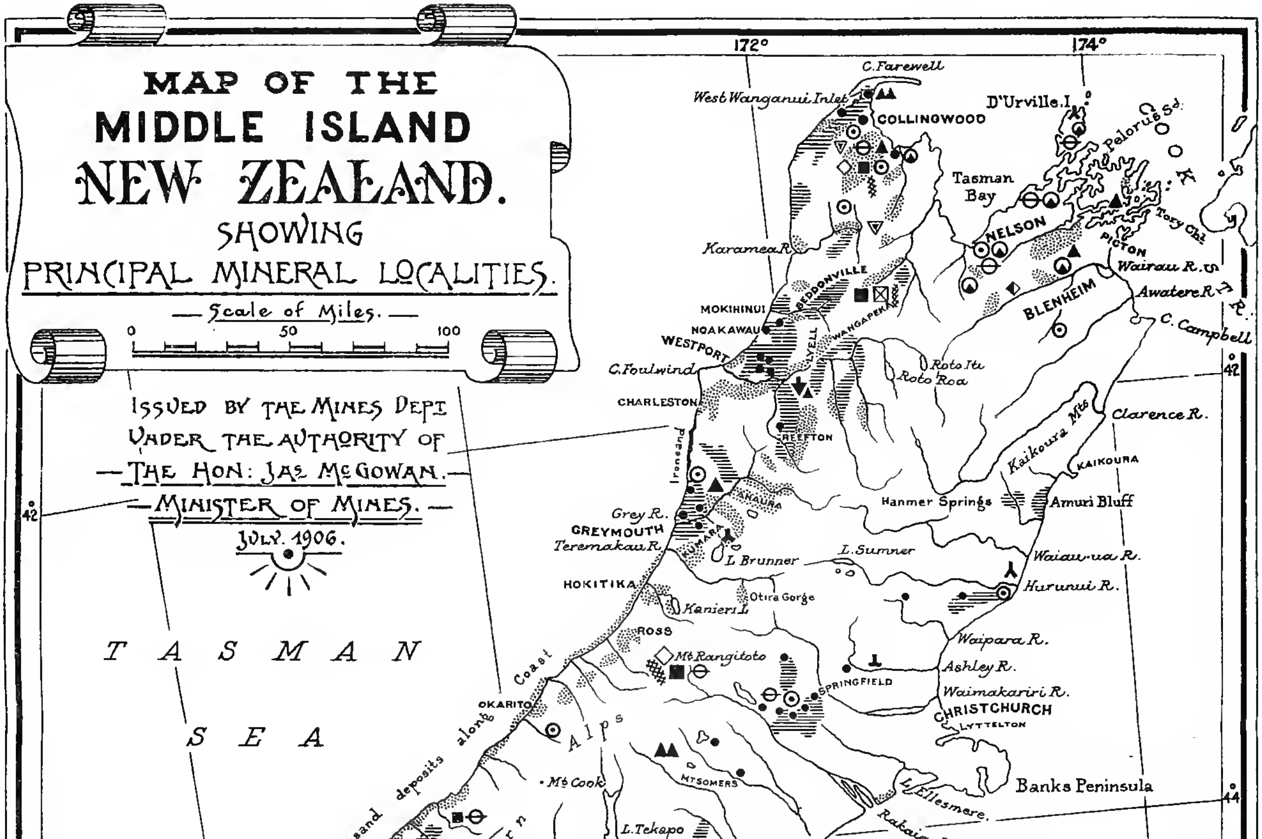
MAP OF THE
MIDDLE ISLAND
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Scale of Miles.
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ISSUED BY THE MINES DEPT
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JULY. 1906.
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COLLINGWOOD
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Pelorus Sd.
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Awatere R.
C. Campbell
BLENHEIM
Karamea R.
BEDDONVILLE
MOKIHINUI
NOAKAWAU
WESTPORT
LYELL
WANGAPEKA
C. Foulwind
Roto Itu
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CHARLESTON
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KAIKOURA
Hanmer Springs
Amuri Bluff
AHAURA
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Teremakau R.
KUMARA
L. Brunner
L. Sumner
Waiau-ua R.
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A SKETCH OF THE ECONOMIC GEOLOGY OF NEW ZEALAND.

———o———

By James Mackintosh Bell, M.A., Ph.D., Director of the New Zealand Geological Survey.

1. Introduction.

In travelling about New Zealand one frequently hears the statement that, since the strata composing our Islands have in general undergone so much faulting, due to seismic activity, continued through long ages, large deposits of minerals of commercial importance need be expected only under unusual circumstances. A somewhat hasty consideration of the mineral resources of New Zealand, as compared with those of other countries formerly more familar to me, has given the conviction that this sweeping assertion, made about a land-area as large as the British Isles, is partly incorrect. As far as metalliferous veins are concerned, the converse of the statement is more exact, and, in fact, in no part of the world are deposits of this nature certainly known to exist, excepting where fissuring of the earth's crust has allowed the exit of mineral-bearing solutions issuing from profound depths beneath the surface. Dislocation of the strata subsequent to the formation of the metalliferous veins may have a detrimental effect by breaking the continuity of the lode, or a beneficial one by bringing new mineral-bearing solutions which give enrichment of the lode along the line of fault. Faulting of bedded deposits, such as coal-seams, must be considered always an objectionable feature.

Another statement often made regarding ore-deposits in New Zealand is that they are generally very small and patchy. In this respect New Zealand is not unlike any other country in which mineral deposits are found—the small ore-body is the rule; the large deposit the exception.

I shall endeavour in a brief paper to show the wide distribution and varied mineralogical range of the mineral deposits of New Zealand.

2. Résumé of the Stratigraphical Geology of New Zealand.

The oldest rocks in the North Island are stratified Palæozoic sediments, which compose the main *massif* of the mountain chains. Overlying these in places are Mesozoic and Tertiary sediments—in the western part of the Wellington Province, in the Wairarapa, near Auckland, around Whangarei, and elsewhere. Much of the northern and central parts of the Island is composed of volcanic rocks—lavas and tufa—of Tertiary and possibly Pleistocene age.

In the South Island, the heart of the Alps exhibits ancient crystalline schists, which are flanked by younger Palæozoic and Mesozoic strata. Much of the country bordering the coast on either side is underlain by Tertiary strata, surmounted by gravel *débris* of varied origin. Relatively, only a small portion of the rocks of the South Island consists of igneous rocks, which are prominent, however, near Dunedin, in Banks Peninsula, in the granitic buttress of the south-western corner of the Island, and in the granitic ridge extending northward from this area through Westland into Nelson.

The geological phenomena which are exhibited in New Zealand are many, and of unique interest. In the South Island the rugged chain of the Alps rivals in beauty and charm the other great mountain chains of the world. Amid the Alps are spacious permanent snowfields, from which emanate great glaciers, one of which is longer and wider than any single glacier in that famed glacial area, Switzerland. In addition, there are the wonderful fiords, the numerous lakes, and many other features.

In the North Island, the hot-lakes district exhibits a great variety of hydrothermal phenomena — hot springs, geysers, fumaroles, and other evidences of expiring vulcanism which give it a very remarkable interest. One feature discovered in connection with some of the hot springs near Rotorua has an especial bearing on this paper: this is the occurrence of gold and silver in solution and in the sinter deposited from the springs. Thus may be seen the unique phenomena of gold and silver lodes actually forming.

3. The Principal Geological Fields of Present Economic Interest.

The Distribution of Coal.

Perhaps in no country in the world is coal more generally distributed than it is in this colony, as it occurs in almost every part—a fact which makes up for the narrowness of the coal-seams and the inextensiveness of the basins in which they lie as compared with coal-deposits in other parts of the world. The coal varies considerably in quality, both in regard to the amount of ash and in the state of carbonation.

The coals of Kaitangata, Shag Point, and Nightcaps, used in Dunedin and Invercargill, are lignites, often of high quality. The coal-seams which are so widely distributed on the Canterbury Plains are all lignites, but not generally so highly carbonised as are the southern coals. The coals of Greymouth, Brunnerton, Westport, and Puponga are bituminous coals of varying degrees of purity. The northern coals, in the Waikato, near Whangarei, and elsewhere are in general intermediate in state of carbonation between the bituminous coals and lignites.

No extensive seams of true anthracite have as yet been exploited in New Zealand. Small deposits occur near Cabbage

Bay in the North Island, and near White Cliffs in the South Island, produced in both cases by the heat of intrusion of igneous rocks. Anthracite has been reported from Fox's River, near Charleston, on the West Coast, and from a property recently taken up on the Paparoa Range.

The Great Hauraki Goldfields.

The goldfields of the Hauraki Peninsula have yielded large quantities of the precious metal in the past, and are still very productive owing to the immense output of the great Waihi Mine. Mining in the Thames has recently been rejuvenated by the development of the rich pay-streak discovered in the deep levels of the Waiotahi Mine. At Thames enormous bonanzas were worked in the past, and there seems every reason to hope, from the evidence given by the Waiotahi, that others will be discovered in the future. In Coromandel, also, new discoveries may naturally be anticipated, the area having given very rich bonanzas in the past.

The goldfields at Waihi, Thames, Coromandel, and elsewhere in the Hauraki Peninsula occur for the most part in andesites, often much decomposed. This gold-bearing horizon is of extensive distribution, and so there is great reason to hope for the discovery of lodes in parts of the district other than near the present centres of mining activity. In fact, detailed prospecting may be said to have been limited up to the present to the mining centres. Elsewhere the surface has been examined in a very cursory manner, and investigation is in many parts of the district precluded by the dense growth of luxuriant vegetation which clothes the hills and lowlands.

The Kaipara Copper-belt.

Recently considerable excitement has been aroused by the discovery of a mineralised horizon containing native copper, malachite, and other ores of copper in the Kaipara district. The present high price of copper makes the discovery a very important one. The horizon is said to extend for many miles in longitudinal direction across country from the Kaipara Harbour towards Whangarei. Since much of this northern

Bridge over Shotover River, at Skippers, Otago.

country is but little explored, new developments may be expected in the future.

The Quartz Veins of Otago.

In Central Otago the alluvial goldfields which gave such wealth in the "sixties" are still very important, though naturally the returns are not nearly so great as in the early days of the gold "rush." Reefing is being carried on at a number of places—Barewood, Skipper's, &c. Careful prospecting may bring to light new reefs, since much of the wilderness of western Otago is still but little known.

The Possibilities of Stewart Island.

The occurrence of ores of tin in Stewart Island has long been known, and desultory attempts have been made to work the deposits. The island, covered for the most part with a dense forest, is difficult of exploration, but much may be done in this line when it is opened up.

The Collingwood Area.

No part of New Zealand is more interesting from an economic mineral standpoint than the peninsula lying west of Golden Bay, and on which is situated the Township of Collingwood. There are the auriferous reefs of Taitapu, the great iron-deposit of Parapara, and the coalfields of Puponga.

The Parapara iron-deposit, which is composed of hydrous hæmatites, is a most remarkable one, and bears a striking resemblance, both in its large proportions and its mode of origin, to the great "soft-ore" deposits of the Lake Superior region in America. It is rare, however, in that part of the world to find deposits of such size actually occurring on the surface.

A mineral-bearing country is said to stretch southward from the much-mineralised area around Paparoa to and beyond the Karamea River. Most of the country has been explored only in a very rough manner, but it is thought that much mineral wealth may lie concealed in that rugged part of the colony.

The Nelson Area.

Near Nelson, in the Aniseed Valley, and north-eastward towards D'Urville Island, are a number of small deposits of copper-ores, which have been exploited to some slight degree. The ores consist generally of cupriferous iron-sulphides, locally oxidized to native copper cuprite and the carbonates of copper, and lie in small, disconnected, and generally parallel lenses, disposed along the planes of stratification of the argillites which contain them.

The discovery of a quartz vein carrying gold in bonanza richness at Blackwater, about twenty miles from Reefton, has given an impetus to prospecting in that relatively old mining locality, and has shown that there may be many rich veins as yet undiscovered even near the centres of mining activity.

The Westland Area.

The recent explorations of a detailed character carried out in the Hokitika sheet of North Westland—an area of about five hundred square miles, stretching from the Town of Hokitika to the Alpine divide—has shown the advantages which may be expected to result from a detailed geological investigation. In the Hokitika sheet have been discovered, among other features, considerable deposits of the valuable greenstone, and both auriferous and platiniferous veins. The Westland Reefs area, situated near Browning's Pass, shows several very promising prospects.

Much of the mountainous hinterland of Westland is unexplored, and the southern portion of this interesting province is in great part still a wild *terra incognita*. The discoveries which have been already made during the conduction of investigations in North Westland seem to warrant the expectation that much mineral wealth may yet be brought to light in this rugged belt of country lying to the south. In fact, the casual investigations conducted by the few prospectors who have penetrated into the interior have shown the occurrence of many minerals of economic value—ores of copper, antimony, iron, and manganese. It yet remains to be seen whether or not these occur in sufficient quantities to be put to commercial use.

THE RISE AND PROGRESS OF THE GOLD-MINING INDUSTRY.

By H. A. Gordon, F.G.S., Consulting Mining Engineer, Auckland; late Inspecting Engineer, Mines Department, N.Z.

EARLY GOLD DISCOVERIES.

In every country where mining is carried on great strides have been made in its progress and prosperity. In regard to lode- and coal-mining, which are the permanent classes of mining in any country, they are generally carried on in a rough, hilly, or mountainous part of the country, where the soil is not suitable for cultivation; and, even where mining is carried on in the plains, the surface of the ground is very little affected by the operations. Mining also gives an impetus to other industries, and is a great factor in settling people in the back country on the land. In this respect the mining industry has been one of the principal factors in the development of this country. When gold was first discovered in the Collingwood district in 1857 the European population in the North and South Islands was only about 50,000; in 1861, when the Otago goldfields were first discovered, the population rose to 99,000—an increase of 49,000 in four years. In 1864, when mining was in full swing at Tuapeka, Wetherstone's, Waitahuna, Waipori, Dunstan, and Shotover, the population increased to 172,000—an increase of 73,000 in three years. During the next three periods of three years the average increase was close on 42,000 for each of the three periods. In 1901 the population was, in round numbers, 773,000, and at the present time we may calculate on a population of about 880,000, exclusive of Maoris and half-castes.

Mining has been the means of greatly facilitating the settlement of the people on the land in New Zealand. Before the goldfields were discovered there was very little cultivation carried on; the country was held in large holdings for purely pastoral pursuits, the revenue from which was very small. There was no inducement for industries to be established, nor for small holdings to be taken up for cultivation, unless in the vicinity of the largest centres of population. Now what a change has come! There is a demand on all sides for more land for settlement, and the supply is not equal to the demand. Large estates were acquired in the early days for comparatively little, the governing bodies being glad to part with the heritage of future generations for what money they could obtain in order to open up the interior of the country. These estates are now being rapidly acquired, and as soon as they are cut up into small sections they are readily applied for and taken up.

It may be asked, What has this to do with mining? The answer is: it was mining that brought the majority of the yeoman class into this country. Had it not been for mining New Zealand would, in all probability, at the present day be a pastoral country, and this industry could not give employment to a large labouring population. Mining is a bigger industry than many suppose. It is the means at the present day of supporting one-tenth of the European population of the colony; therefore it forms a great element in the progress of this country.

Mining also had a great effect on the settlement of Australia. When gold was discovered in New South Wales and Victoria the progress in these colonies proceeded by leaps and bounds. No other industry but mining could have caused such an influx of people from every part of the world.

Otago.

The progress made in mining, and the system of conducting mining operations, has also made great strides. In the early days of the Otago goldfields mining operations were almost confined to shallow alluvial drifts, which required very little capital to procure an outfit to carry on mining operations with success. The great factor in separating the gold from the auriferous drifts is a good supply of water to enable the drifts to be box-sluiced, or, when sufficient water was not available, the use of a tom (or rocker) had to be resorted to. Although

HYDRAULIC SLUICING AT TINKERS, OTAGO.

Mining Handbook.

Collingwood was the first field in the Middle Island where gold was discovered, the area was not of any great extent where gold could be readily obtained from shallow drifts. It was not until after the discovery of gold at Gabriel's Gully, near the present Town of Lawrence, in Otago, that the large influx of population set in. This gully contained very rich auriferous deposits. The whole of the ground was soon taken up in ordinary claims, and as the population increased other gullies and creeks in the neighbourhood got prospected, with satisfactory results. Munro's, Wetherstone's, and Waitahuna Gullies yielded up sufficient of the precious metal to give several holders of claims, if not a competency, a good start in life. Waipori field, although not so rich in gold as the former gullies, afforded profitable employment to a considerable population. Men of every calling and profession, fellows of universities, doctors, and even clergymen, could not resist the temptation, the novelty, and the desire to acquire wealth by manual labour.

In 1862 the news of a fresh discovery of gold by Messrs. Hartley and Riley, on the Clutha River, caused a large rush to that locality. Men left rich claims in Gabriel's and elsewhere to try their fortunes at this new El Dorado. Horses, drays, wagons, and all conveyances were in great demand; fabulous prices were paid by those who wished to leave quickly; carriage of goods went up to £120 a ton from Dunedin to the Dunstan. The first wagon-load of flour that went up was stopped at what was known as Sheehan's station and quickly emptied, the miners paying 2s. 6d. for every pint-pannikinful of flour. There was no grumbling at the price; the difficulty was to get a sufficient quantity of it at that rate. Empty gin-cases sold at £5 each, and some of the first drays that reached Dunstan Flat were stripped of every piece of board used in their construction. The country in this locality being destitute of timber, it had to be brought from Dunedin, and fabulous prices were paid for it; wagon-loads of timber sold at 15s. per superficial foot, and in some instances at a much higher rate. The beaches of the river in places were literally strewn with golden sands. Every one who possessed a rocker, shovel, and tin dish was getting more gold than ever he anticipated. It was looked on as the richest field that had been discovered.

By this time a large population had gathered to the place; townships, at what are now known as Clyde and Alexandra, were formed; large stores were being erected, all of canvas covering; hotels were being built, and an extensive assortment of goods of every class was in transit between Dunedin and the new El Dorado.

This was, however, of short duration. The melting snow from the mountains caused the water in the river to rise very rapidly and cover the whole of the beaches where the gold was found. The sudden rising of the river threw nearly every one out of their previous employment. Merchants were bewailing their fate at having large consignments of goods in transit, the lowest rate for carriage being £100 per ton. The mining population then began to scatter about through the country, prospecting the different creeks and gullies in the locality. Conroy's, Bannockburn, Dunstan Creek, Hogburn, Hamilton, and Hyde all gave good results. Townships sprang up at all those places, most of the new arrivals being satisfied that the goldfields of Otago were of a large extent. Attention was directed to the different streams that were capable of supplying water for sluicing purposes. Small water-races were constructed, and before long all the available water was applied for that could command the ground to be worked. Prospecting was still being carried on. Fox's (now known as Arrowtown), the Shotover River, Moke Creek, and the Twelve-mile, on the side of Lake Wakatipu, were opened up. The Township of Queenstown also sprang into existence, and is now one of the most delightful spots in New Zealand. The beds of the Shotover and Arrow Rivers yielded large quantities of gold; and, although over forty years have gone by since these gold-bearing rivers were first opened up, there are still numbers of men who obtain a livelihood by washing the auriferous alluvial drifts.

As time went on attention was given to auriferous-quartz lodes. The Achilles reef, at Skipper's; the O.P.Q., at Waipori; and the Cromwell reef, at Bendigo, were opened up and found to contain highly payable ore. This class of mining required far more capital to be invested than was necessary in the alluvial workings, and for many years only a few persons persevered in the development of lode-mining.

West Coast.

In 1865 gold was found at Greenstone Creek, and this led to the west coast of the Middle Island being prospected. Kanieri, Ross, Donoghue's, Waimea, and the different fields in the Grey Valley were opened up. Extensive water-races were constructed, and the ground principally worked by hydraulic sluicing. Amongst the latest fields opened up on the West Coast was Kumara, from which gold to the value of over £1,000,000 has been extracted, all by hydraulic sluicing. There are two large water-races on this field—one constructed by Government, having a carrying-capacity of 120 sluice-heads, the other constructed by the late Hon. Mr. Holmes. These races have been the means of the whole of the gold being obtained from this field, with the exception of a small quantity obtained in shallow ground on the face of the terrace. There is still a considerable number of men employed on this field, but the ground is not nearly so rich as formerly. It is only by using a large supply of water and washing away huge quantities of material that men are now able to earn a sufficient livelihood. Kumara is a field where hydraulic sluicing is conducted on a larger scale than anywhere else in the colony. There are five long tail-races extending back into the flat from the Teremakau River at various points. These tail-races are from 2 ft. 6 in. to 3 ft. wide, paved with wooden blocks to a depth, in some cases, of 12 in. The tailings from the different claims in the vicinity of these tail-races are discharged into them, the maintenance and repairs to the main tail-race being borne conjointly by all those using it. The ground in the Kumara field contains a very large percentage of big stones; the removal of these stones occupies about one-half of the workmen's time each shift, so that if hydraulic sluicing is carried on for four hours it takes another four hours to remove the stones before the water can be used again.

The expense of hydraulic-sluicing ground, where there is a considerable overburden containing large stones, is very considerable. Before a claim is equipped with pipes, tail-races, boxes, blocks, water-wheels for hauling up the stones, and all appliances, it would cost fully, on such a field as Kumara, from £2,000 to £3,000. This does not include head-races or dams, as the water on this field is supplied from the water-race constructed by the Government, which charges 10s. per sluice-head per week of eight hours per day. As the tail-races are now constructed on low gradients, it requires ten to twelve sluice-heads of water to work the ground.

The general method of working the alluvial auriferous drifts in New Zealand is by hydraulic sluicing and by the employment of dredges. The only place where the alluvial drifts have been worked from deep shafts is Ross. The ground has been worked at this place to a depth of over 300 ft. without reaching the rock bottom. In this depth there are eight separate layers or beds of auriferous gravel, some of which were very rich in the precious metal. These deep workings have been suspended for many years, not on account of the lack of gold, but through the water that flows into the old workings from Jones's Creek. Before work in the deep ground can ever be resumed, Jones's Creek will have to be diverted and the water prevented from getting on to the surface of the flat where the deep auriferous drifts lie. In the early days of this field the shallow auriferous beds of gravel were worked; also other beds down to such a depth as could be drained by a tail-race constructed from near the mouth of the Totara River to what was then known as Jones's Flat. A timber flume was constructed to convey the water in Jones's Creek from the head of the flat to Donnelly's Creek, but this flume was not of sufficient capacity to take the whole of the water in flood-time. The claim-holders on the flat, together with the residents, subscribed sufficient capital to place a drainage-engine on the flat, which worked two pumps 14 in. in diameter, but these were not of sufficient capacity to contend with the influx of water percolating through the ground. An effort was then made to get more capital, but this proved a failure; the claim-holders got disheartened, abandoned

Goldfields Town: Ross, Westland, showing Hydraulic-sluicing Nozzle at Work.

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their claims, and disposed of all their plants. After a lapse of about four years Mr. Patrick Commisky induced London gentlemen to embark in the venture; sufficient capital was subscribed; a water-race which belonged to the Jones's Creek Company was purchased; a tail-race from near the ocean-beach was constructed to drain the water to a depth of nearly 100 ft. below the surface; a hydraulic pumping-engine was erected, which worked four draw-lift pumps of 14 in. diameter to a depth of 200 ft. below the level of the tail-race. This plant was capable of contending with the water so long as there was a solid barrier left between the old workings and the shaft, but as soon as the old workings were broken into the mine was flooded to such an extent that it was hopeless to attempt working it again before a further expenditure was incurred in entirely diverting all streams from getting into the old workings. The company's capital being at this time expended, all operations were suspended.

Several attempts have been made to form a company to work this flat since its abandonment, but without success. Reports have been obtained from mining engineers, who have favourably reported upon it as an investment. They recommended that an electrical installation plant should be erected near the Mikonui River, where a plentiful supply of water could be had, and from that place to convey the current to Ross Flat—a distance of three miles—by cable, and by this means use electricity as a motive power to work the pumping and winding plants. This scheme was so favourably considered that the Government offered, or agreed to give, a subsidy of £15,000 to any company with sufficient capital to erect machinery, sink shafts, and make all provision to work the ground in a systematic manner. No company, however, has so far been found to undertake the work. The ground still remains as waste lands of the Crown, but there is little doubt that the time will come when this area will be opened up and its hidden treasure extracted. Gold to the value of about £300,000 has been taken out of the shallowest portions of Ross Flat; but in carrying on the workings towards the ocean the auriferous layers or beds of gravel dipped on an inclination in that direction, until the water could not be overcome with the machinery then employed.

Geologically, this portion of the Middle Island is most interesting. The auriferous beds have been worked down to a depth of 200 ft. below sea-level without any indication of a rock bottom being reached. The upper gravels belong to the Pliocene and Pleistocene periods, but the lower gravels belong to the Miocene. These lower gravels are found for about ten miles to the south of Ross, where they disappear, or are overlain by the gravels of the more recent periods. The Miocene gravels can be traced over the top of Mount Greenland, 3,000 ft. above sea-level, through Ross, where they are covered with more recent drifts. They are again seen at Rimu, the Blue Spur, Waimea, Callaghan's, Maori Creek, Maori Gully, No Town, Nelson Creek, Ahaura, and thence on to Soldier's Creek, near Reefton. The line of these gravels passes at the back of Reefton on to Coal Creek, where it comes against a granite intrusion. These gravels are not seen again until near the Hope Saddle, but from there they can be traced on the surface into Golden Bay, near Nelson. The course of these gravels indicates that at some prior period a large river from the West Coast flowed across what is now the backbone of the country and discharged its waters into the ocean at Golden Bay. It also indicates that the land at one time was, in all probability, fully seventy miles further to the westward than Bold Head, and perhaps considerably further. A great convulsion must have taken place, causing a submersion of the land. This is referred to by Dr. Ferdinand von Hochstetter in his work on "New Zealand: its Physical Geography, Geology, and Natural History." He states, in regard to the absence of passes in the central chain of mountains, "The clue to this system of ravines and ridges is to be found in the fact that the Palæozoic rocks forming the main range have been at a very early period subjected to intensive pressure, the effect of which has been to crumple them up into huge folds." He shows by a map on page 484 that the grinding or folding radiated from one common centre, situated about fifty miles north of Mount Darwin in the sea near Cliffy Head. Mr. McKay, F.G.S., Government Geologist, in his report in 1890, made an examination of the different earthquake rents in the colony, and states that " one of these rents runs out on the sea-coast near the mouth of the Flags River, and is traceable across the south-east spur of Benmore into the lower course of the Benmore Stream. The same rent is clearly traceable from the western end of Hanmer Plains along the Waiau-ua and Hope Valleys, and the trend line runs out on the West Coast a little to the south of Hokitika." He also shows by map an earthquake rent from Castle Point, on the east coast of the North Island, crossing Cook Strait and running out into the ocean a little to the southward of Hokitika. There are shown on his map no less than seven earthquake rents across the Island, converging in a somewhat similar direction to that indicated by Dr. Hochstetter.*

The auriferous gravel-beds worked at Ross under the sea-level, dipping towards the ocean, indicate the existence of high land at one time a long distance out of what is now the ocean. It clearly shows that a great submersion of the land has taken place, and that other portions have been folded up and raised above the water. About 60 chains inland from Ross Flat, at an elevation of about 200 ft. above sea-level, the skeleton of a whale was discovered, and it is now in the Colonial Museum, Wellington. Great changes are taking place in the crust of the earth from time to time, and the earth is most unstable in its movements. Nevertheless, we go on from day to day, fancying that we are perfectly secure so long as we are on *terra firma*.

Ocean-beaches.

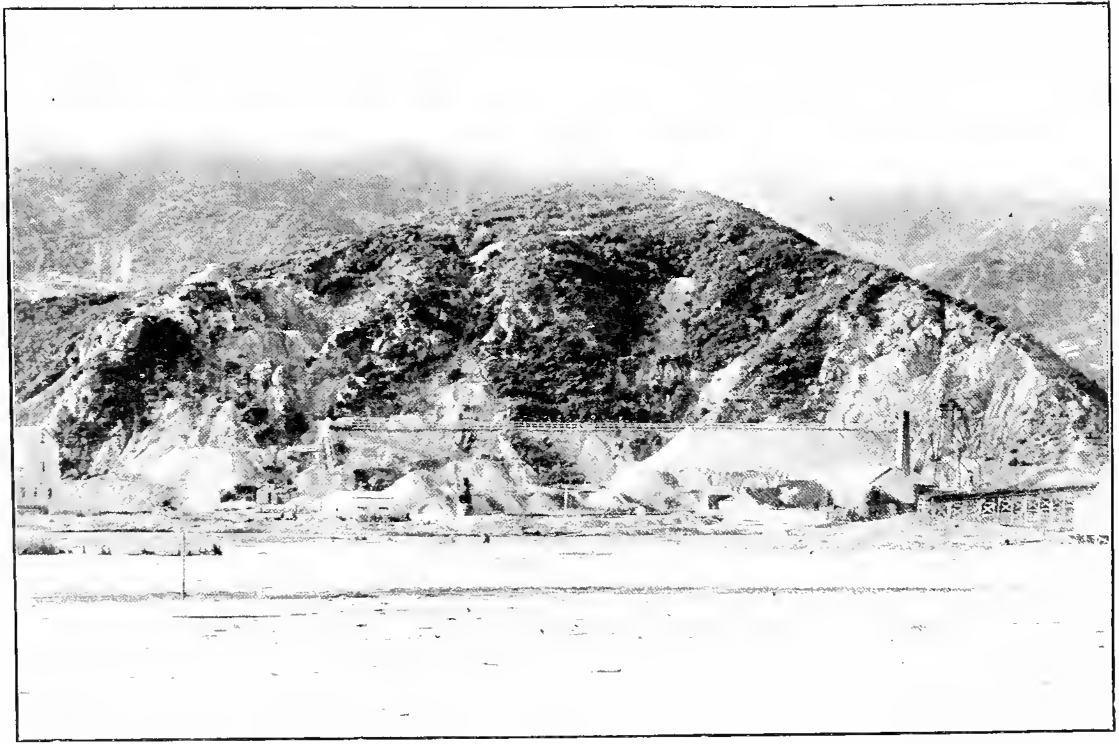
A great deal of gold has been got on the ocean-beaches and in sea-beach leads now inland. The richest portions of these beach leads lie between Karamea, on the west coast of the Middle Island, and Jackson's Bay. In regard to the ocean-beaches, at times they are covered with loose shingle, while at other times the shingle is removed and carried onward by the currents of the ocean, leaving the beach bare of all shingle and covered with black sand (magnetite) thickly diffused with fine

* See Geological Transactions, 1890, p. 1.

particles of gold. Some claims have been constantly worked —when not covered with shingle—for upwards of twenty-five years, and are still giving the shareholders a livelihood for working them. The Shetlanders' Beach, about a mile and a half north of Charleston, may be instanced as an example. The plant required to work these beaches is very simple and inexpensive. The whole appliances are fixed on a barrow, which is wheeled back and forward on the beach as the tide ebbs and flows. It consists of a hopper to separate the rough from the fine particles of sand. The fine sand is washed over a system of inclined copper plates coated with quicksilver; in some instances it is run over inclined tables covered with plush or cocoanut matting; while the water for washing is either supplied by a hand-pump or taken by a flexible hose from a flume placed above high-water mark. The sand is skimmed off the top of the beach and filled into the hopper; the latter, being set on an inclination, is self-discharging.

Some of the richest of these ocean-beaches in the early days were south of Okarito. The Three-mile and Five-mile beaches were exceptionally rich when they were first discovered. Quite recently gold to the value of £2,500 was stated to have been taken from a small area near Okarito in the course of a few months. At low tides they presented the appearance of a cloth of gold. Gillespie's, Hunt's, and different beaches along the coast-line afforded profitable employment for many years to those who were working on them. Prospecting was carried on a little inland from high-water mark, where deeper auriferous beds of sand were met with. Water-wheels were constructed to work Californian pumps wherever water was available for power to drain the ground. By this means these deep leads were worked, and gave in many instances famous returns to those engaged in the pursuit of the precious metal.

These beach leads in places show a sinking of the land, while in other places they indicate that the land has been raised considerably. Near the mouth of the Totara River, between Charleston and Westport, workings are carried on below sea-level, or at least below high-water mark; while two miles inland sea-beach leads are worked at a considerable elevation at Charleston, Brighton, Cronanville, and Addison's Flat.



THAMES GOLDFIELD, SHOWING KURANUI-CALEDONIAN BATTERY AND THE OLD BIG PUMP.

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In these localities there are large quantities of cemented auriferous sand, which have been for many years, and are still, worked by crushing the sand in a stamp-battery; the gold is recovered by being run over cocoanut matting with a stream of water.

At Addison's Flat there is a considerable number of men employed working the beach leads, where a large expenditure is in many instances incurred in procuring plants, constructing head and tail races, and opening out claims, the underground tail-races being in some instances a mile in length. The ground is worked by hydraulic-sluicing the whole of the overburden; the material is carried by water on to a hopper, which separates the stones and large shingle from the fine stuff; the latter passes down the tail-races, whilst the stones are hauled up on an inclined tramway by a water-balance and deposited on the worked-out ground. Some of these claims have yielded large returns to their shareholders, and still give handsome profits for working them.

QUARTZ-MINING.

Coromandel.

The quartz-mining centres are Coromandel, Thames, Karangahake, Waihi, and Te Aroha, in the North Island; and Reefton, on the west coast of the Middle Island. Coromandel was the first field opened for working auriferous quartz. Gold-specimens were found in creek-beds, and in tracing up these creeks it led to the discovery of rich auriferous lodes at Kapanga, Tokatea, Tiki, and other localities. The richest portions of the lodes are in the stringers and veins running through both lodes and the country rock, the latter being of an altered volcanic formation. In some of these narrow stringers—as, for instance, in the Success Claim—the gold was found in a thin sheet. The lodes in this field vary greatly in regard to value; the lodes may continue, but the gold will disappear; a thin clay-vein across the lode will cut it off as though it had been completely severed with a knife, and the gold will make again quite as suddenly as it cut out. The lodes are what the miner terms "very patchy," and in general very small, but often extremely rich. A few years ago a rich shoot of gold was found in the Hauraki Claim, where shattered quartz was literally held together with strings of gold, and a somewhat similar discovery was made in the Kapanga Mine. A commencement was made to work the auriferous-quartz lodes in this district in the latter part of 1858.

Thames.

The Thames field was opened in 1867. A rich auriferous lode was found at Shellback Creek by Messrs. Hunt, Copley, and others. When the lode was opened out it showed amazing richness, and this led to a rush of miners from different parts of the colony to the field, and claims were taken up in every direction, but very little gold was found to the north of Shellback Creek, while to the southward every claim contained rich auriferous stone between Shellback and Karaka Creeks. The claims known as the Kuranui, Long Tunnel, Moanataiari, Caledonian, Cambria, Waitotahi, Prince Imperial, Saxon, and Queen of Beauty all proved good investments for the shareholders. In the Caledonian Claim the quantity of gold in the lode was astounding, and in some instances the gold had to be cut out of the lode with a chisel. Within twelve months dividends amounting to over £550,000 were paid to the shareholders. Shares went up to fabulous prices, as no one expected that the gold would cut out of the lode as soon as it did. This claim was looked on as a safe, permanent investment, but these hopes were doomed to disappointment. The shoot of rich stone proved only a patch; at the same time, it was a large one.

The Moanataiari, Prince Imperial, and Queen of Beauty Claims contained rich shoots of ore, which gave the shareholders good returns for their investments. Recently a discovery of rich ore in the Waiotahi Claim, in which mining operations have been carried on for the last thirty years, has caused renewed interest to be taken in mining ventures at the Thames. Before the discovery of this rich shoot of ore there were 6,000 shares in the company, some of which were selling at 7s. 6d. per share, making the value of the property about £2,250; but after this late discovery of rich ore, or stringers, the stock was watered; every shareholder got ten shares for each share previously held, making 60,000 shares, having a present value of about £7 per share. Taking the share-value as a basis, within twelve months the value of this property, on which mining operations have been steadily carried on for at least thirty years, jumped up in a short time from £2,250 to over £420,000. Quartz, or lode, mining is entirely different from alluvial. In dealing with auriferous-gravel deposits, we know when the claim is worked down to the rock the whole of the deposit has been taken out; but no one can tell in lode-mining when the whole of the gold has been taken out. There is a certain fascination and attractiveness in connection with auriferous-quartz mining that induces men to invest their money in this industry. There is always a chance of a rich shoot of ore being discovered which will repay tenfold the money invested. No mining engineer, whatever his experience or ability may be, can tell with certainty what lies hidden in the bowels of the earth. He may deduce from observations of the nature of the lode, and the formation in which the lode is enclosed, that there is a fair prospect of good ore being obtained, or that the continuity of the lode has to a certain extent been ascertained; but beyond this the question of value at depths not penetrated, or in places below the surface where the eye of man cannot behold it, is still a blank.

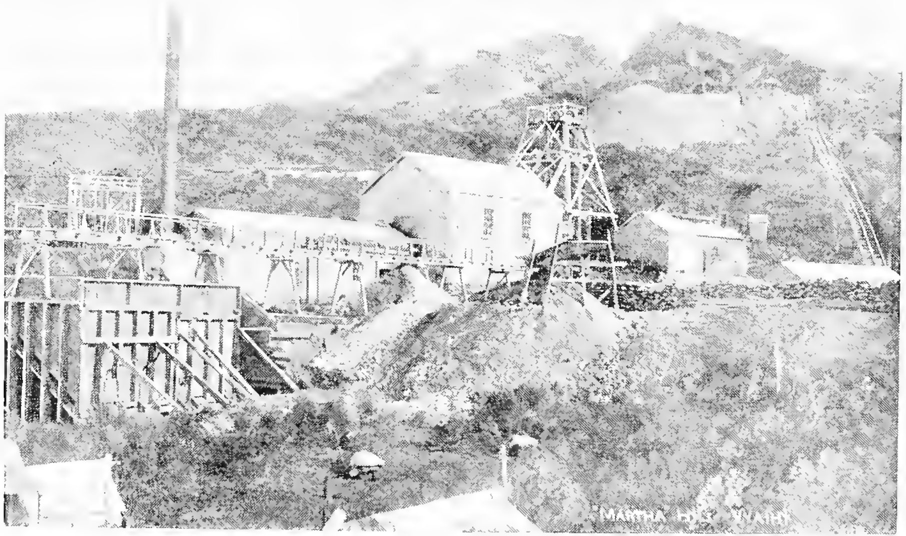
Karangahake.

Quartz-mining has been carried on here for about thirty-four years, but no rich deposits of ore have ever been found, such as was the case at Thames and Coromandel. The ore in this field is far more refractory, and requires a different method of treatment from that on the other fields mentioned.

It was on this field that cyanide of potassium was first used for the extraction of fine gold from the pulverised ore; it was here that experiments were made to perfect the process; it was to this place that the MacArthur-Forrest Company sent Mr. John McConnell to treat the first ore with cyanide-solutions. The appliances and plant sent out from Glasgow proved that the question of successful treatment was one in which only a crude knowledge had been obtained. It was left to those engaged in quartz-mining in this colony to perfect the process, which has been the means of claims being successfully worked that were, before this process was introduced, perfectly valueless. A large number of claims have been taken up on this field, worked for a short period, and abandoned; still the New Zealand Crown Mines and the Talisman Consolidated continue to carry on mining operations with success. Both these companies have erected expensive plants of the most modern design, and have expert workmen employed in all branches. Nothing is done, as in former days, by rule-of-thumb. The ore, when it comes out of the mine, is carefully assayed, and the percentage of metals extracted is accurately ascertained. The ore at Karangahake contains a large percentage of silver, and in some instances copper, which makes the value of the bullion extracted only a little more than £1 per ounce. All the ore treated is calculated on the value of the bullion it contains, and not on the weight of the gold in the ore, as was originally the case.

Waihi.

This is one of the greatest quartz-mining districts there is in the colony. The lodes are of enormous width, in some places fully 200 ft. from wall to wall; and over 50 ft. of this width is taken out and put through the different processes of treatment. Quartz-mining has been carried on here since 1882. The Martha Company took up a large claim on the Martha Lode, erected a crushing-battery with the ordinary quicksilver-tables and a plant of berdans—the only appliances used at that time for the treatment of ore. Portions of the lode were quarried from the top of the Martha Hill and put through the battery. This went on for several years, but, although it was supposed that only the richest portion of the lode was taken, it could not be made to return a value to do more than cover the actual expenses of working. An adjoining claim was taken up by the Waihi Company, which commenced operations on a different lode from the Martha. Shafts were sunk, levels constructed, Globe mills erected, with amalgamating machinery; but as these mills proved a failure they



"MARTHA" HILL, WAIHI.

were removed, and sixty heads of stamps used instead. Kilns were constructed for roasting the ore as it came from the mine before putting it through the battery, but the lode the company was working did not give returns for the large outlay the company had made—indeed, it seemed at one time that liquidation was not far distant.

The whole credit for the existence and success of this company is due to Mr. Henry Russell, who came out from England with no experience in mining, but on his arrival here he spent some time in gaining a little knowledge of assaying. He went to Waihi and watched the method used in the treatment of the ore; he was so bent on obtaining a knowledge of the different processes of working that he almost lived in the battery while it was at work. At that time a system of dry-crushing had been established, which caused the building to be full of fine dry dust, highly injurious to those employed in it. This began to impair Mr. Russell's health, but he still continued to watch the experiments that were being made, not only with the view of reducing the cost of treatment, but also to obtain a larger percentage of the bullion contents. The lode the company was then working was a comparatively small one, and there was little hope at that time of the operations being extensively carried on with much success. The system of treatment — namely, pan-amalgamation — did not extract a large percentage of the gold in the ore, and less than 50 per cent. of the silver. The cyanide process was then in its infancy; Messrs. McConnell and Napier were making experiments with it at the New Zealand Crown Mines at Karangahake, while the Waihi Company was stacking the tailings, awaiting the results of that process. Mr. Russell, in the meantime, had been occasionally visiting the Martha Company's workings, with the view of seeing the nature of the lode and the manner of working it, and took samples of the ore for analysis, until he was satisfied that it was a valuable property. The shareholders in the Martha Company were so disheartened at working the mine for years and not meeting with success that they sold it to Mr. Russell for a very small amount. After the purchase was completed a sample of the ore was sent to the Crown Company's works to be treated by the cyanide process, and it gave results far exceeding expectations. It is from this period onwards that success attended the Waihi Company's operations.

The Waihi Company now possesses one of the finest mining properties in the world. It is the premier gold-mining company in New Zealand, and indeed in Australasia, at the present time. There are very few mining companies in the world equal to it when the number of lodes and dimensions come to be considered. The company holds several mining claims, all contiguous to each other, on lease from the Crown. In these claims there are no fewer than sixteen distinct lodes passing through them, and six of them are big lodes carrying highly payable ore. The largest of these is the Martha Lode, which on some of the levels is 200 ft. in width from wall to wall; but the whole of this width is not broken out and sent to the mill. The width of pay-ore varies in this lode from 25 ft. to 70 ft. In order to give an idea of the enormous ore-body in this mine, the returns for the year 1904 are herewith given, showing the quantity of ore taken from each lode, with its value:—

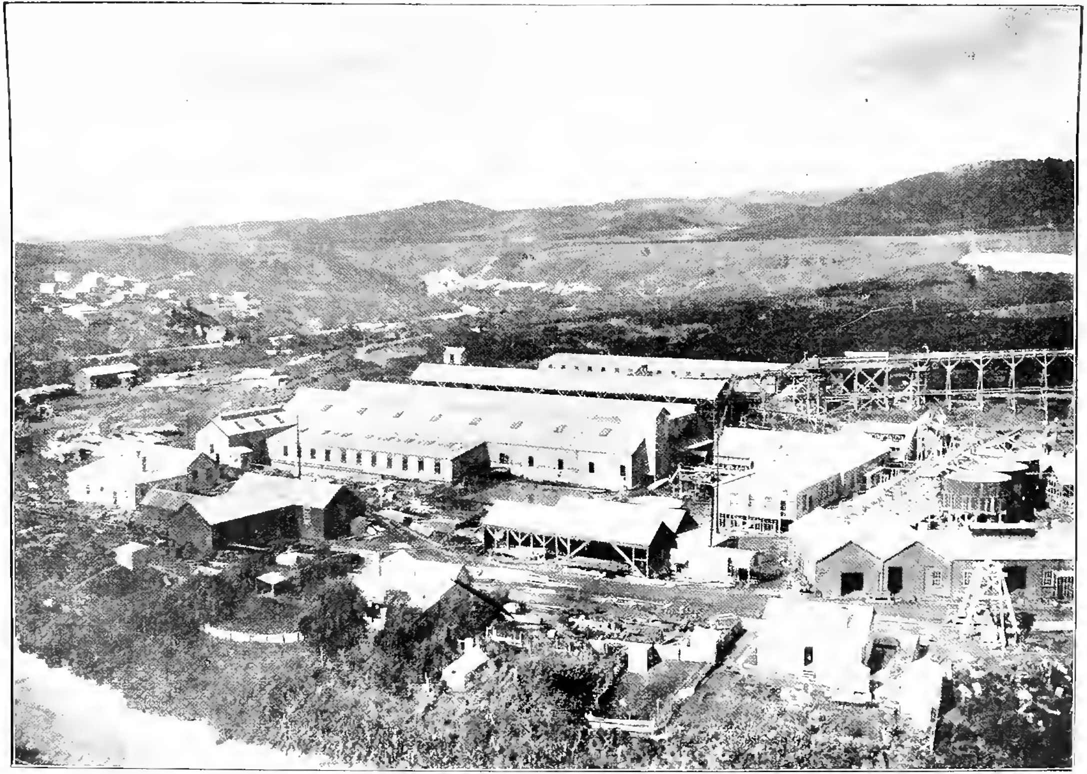
Name of Lode.	Tons.	Name of Lode.	Tons.
Martha	98,339	Victoria ...	5,735
Empire	50,161	L	4,204
Welcome	41,746	J	3,682
Regina	13,684	No. 2	2,553
Royal	12,125	I	1,819
Albert	11,652	Surprise	743
Magazine ...	6,753	E	51
Princess	6,731		
		Total ...	259,978

From this quantity of ore bullion was produced to the value of £683,882 3s. 10d., equal to an average yield of £2 4s. 11d. per ton; while dividends for that year, amounting to 10s. per share, were paid, and also a bonus of 2s. per share, making a total of £297,554 4s. The comparative proportions of the value of the gold and silver in the bullion, as valued at the mine, were: Gold, £594,243 3s. 4d.; silver, £78,858 5s.; making the value at the mine £673,101 8s. 4d. This however, realised in London £683,882 3s. 10d. The total value of bullion taken from this mine during a period of sixteen years amounted to £4,549,334, out of which £1,877,896 has been paid in dividends to the shareholders. During the year 1905 298,531 tons of ore was crushed for 1,192,046 oz. of bullion, valued at £751,233 (including value of concentrates and slags tailings shipped for treatment), and dividends were paid amounting to £322,339 11s.

To show the magnitude of this company's operations, it may be stated that six shafts are sunk to considerable depths, one of which is the pumping and drainage shaft, intended to drain a large area of the field. One of the largest pumping condensing engines in Australasia is erected at this shaft. The low-pressure cylinder is 11 ft. in diameter and 12 ft. in length, having a weight of about 21 tons. This engine and all its connections are of beautiful workmanship, every joint being accurately fitted as though it were a piece of mechanism belonging to a chronometer. This huge machine is placed on a concrete foundation, which had to be carried down to a great depth before a solid rock-bed was reached. No one except a wealthy individual or corporation could have gone to the expense of providing for the drainage of so large an area of this field as the Waihi Company is now capable of draining. The number of steam-engines this company has at work for winding, driving air-compressing machinery, haulage, and working electric plants, and in various capacities, together with the buildings, poppet-heads, workshops, laboratories, &c., gives the place the appearance of an immense factory, covering over 100 acres of ground. Mining stores, tools, implements, and modern appliances of every description are handy on the ground when required. To the workshops a foundry has recently been added, so that all repairs, and even a great deal of new work, can now be undertaken by the company's workmen.

The ore from the mine is treated at three distinct crushing-batteries — the Union Mill, alongside the Ohinemuri River, with forty heads of stamps; the Waihi Mill, near the mine, with ninety heads; and the Waikino Mill, about six miles from the mine, with 200 heads; making a total of 330 heads of stamps, which are worked continuously day and night, Sundays excepted. The machinery is all driven by water-power when water is available, but steam-power is provided if the water runs short. There is an immense number of cyanide-vats, sumps, solution-tanks, zinc extractors, montejus, filter-presses, tube mills, concentrators, and a railway with locomotive engines to bring the ore from the mine to the Waikino Mill. Mark the prosperity this company has hitherto enjoyed and the ore-reserves in sight in its mine. Notwithstanding the large tonnage daily treated, it will take years to exhaust the ore, while there is no diminution in the size and value of the ore, as far as can be seen, underfoot.

What a difference this place now presents from that which it presented at the time of my first visit. In 1884 it appeared to be a barren desert plain, with a bare knoll, and one public-house; bleak and uninviting, a traveller was glad to reach that solitary habitation. No formed road, nothing but wheel-ruts to indicate the direction of the house and show one that this was the only highway leading from Ohinemuri through Mr. Vesey Stewart's celebrated settlement (Katikati) to Tauranga. On the top of this bald hill was to be seen a large lode of quartz, which was taken up as a claim by the Martha Company, the late Mr. Adam Porter, of Auckland, being one of that company's promoters and afterwards one of the directors. A few huts began to be built at this locality, and a battery of forty heads of stamps was erected, which was driven by water-power from the Ohinemuri River. For years this company kept struggling on, hoping that better ore would be met with, until it got disheartened at not seeing any signs of meeting with success, and it finally disposed of the property. Years have gone by since then; the property was developed, and far exceeded in value the most sanguine expectations. The share-value—that is, what shares were being disposed of in open market—at the time of purchasing the Martha Company's property was not over £22,500, and to-day it is about £4,500,000. Several hundred thousands of pounds have been expended in machinery and development-work. About fourteen hundred men are employed by this company. A flourishing town has sprung into existence; good roads and streets have been constructed; large, commodious buildings have been erected; orchards and gardens give a cheerful as-



Waihi Gold-mining Company: Waikino Battery.

pect to the place, where now resides over 5,000 of a population. Compare that with a solitary publichouse in the year 1884, and note the gigantic strides due to the mining industry.

The success attending the efforts of the Waihi Company has induced other mining companies to take up claims in this locality, but so far none of them has met with great success. The Waihi Grand Junction Company has been for the last ten years prospecting for the Martha Lode, but owing to the large influx of water met with it was unable for a long time to get down a sufficient depth to strike the lode. The difficulties encountered have now been overcome; the lode has been cut, levels are being opened out, and there is every prospect of this company reaping a rich reward for its labours. The Waihi Extended Company has also done a considerable amount of dead-work. It has cut lodes in its claim, but the present machinery and appliances belonging to this company are inadequate to carry on mining operations successfully at such depths. The Waihi field has a great future before it. The enormous auriferous lodes which exist, as far as have been yet tested, are not likely to cut out until a great depth is reached. Gold has been found in lodes on the Bendigo field, in Australia, to a depth of over 4,000 ft., but these lodes were only comparatively small in comparison with the Martha Lode at Waihi. One of the pleasing features in connection with the Martha Lode is that its value continues as it goes down, which in a measure indicates that the lode, with its bullion contents, is likely to go down to a great depth. Mining on this field is still only in its infancy. Very little work has yet been done, beyond scratching the surface, by other companies, irrespective of those already mentioned; and even in the Waihi Company's mine, where the most work has been done, it is comparatively little compared with what will yet be done before it is exhausted. Another century may pass away, and still see lode-mining an important industry in this locality.

Te Aroha.

Te Aroha was opened in 1882, but no ore was crushed until November, 1883. Several mining companies were formed to work claims on this field, amongst which were the New Find, Colonist, Premier, Werahiko, and Waitoko; in all, there were about thirty registered companies having claims. These claims were situated from one to nearly three miles up Waiorongomai Creek, from the place where it debouched into the Thames Valley. Messrs. Firth and Clark erected a crushing-battery, consisting of forty heads of stamps, and a plant of berdans on the flat, at the entrance of the gorge of the Waiorongomai Creek, to crush the ore from the different claims. The County Council constructed a tramway, a subsidy being obtained from the Government, to connect the different mines with the crushing-battery, at a cost of about £18,000. A monster lode traverses the country for a long distance, and rich specimens of ore were obtained. From this lode several smaller lodes branch off, as well as cross-lodes, which have no apparent connection with the main lode.

When the claims referred to were first opened and the lodes cut they showed a good class of ore. Veins containing rich specimèns were found traversing the lodes, showing gold in extremely fine particles disseminated through the quartz. The results from the crushing of the oxidized ore near the outcrop of the lodes were highly satisfactory, but on sinking the ore became refractory, and the process of treatment at the battery was not of such a nature that the bullion could be recovered. The ore in many instances, although containing a high value, was so complex that by the recognised method of treatment—crushing and amalgamation—very little of its valuable contents could be recovered. The ore contained in some instances gold, silver, copper, zinc, arsenic, and antimony, principally as sulphides. The result was that the valuable plant, which was said at that time to have cost £20,000, was found to be of little service, and company after company abandoned their claims. One of the proprietors of the crushing-battery (Mr. J. C. Firth) took his battery-manager to America to visit some of the mining centres there, to see if there was any system adopted in that country for the treatment of similar ores to that found at Te Aroha. On returning to this colony they chanced to be fellow-passengers with the late Mr. W. R. Wilson, who was connected with the Broken Hill Mines, in New South Wales. Mr. Wilson visited the Te Aroha field, and from what he observed, and from the reports that he obtained, purchased the crushing-battery and took up some of the abandoned claims. A mining engineer and metallurgist of considerable experience came from America to take charge of the undertaking. A smelting and also a roasting furnace was erected, and the ore crushed and concentrated. The concentrates were first roasted, made into briquettes, and smelted; but this process did not give good results. It was far too costly a process to deal with any ore unless it was of an exceptionally high grade. Mr. Wilson abandoned the undertaking, and sold the plant and claims to Messrs. Adams and Wicks.

About this time the cyanide process was being experimented with by Messrs. John McConnell and James Napier at the Crown Company's mine, Karangahake. Mr. Adams, after again experimenting with the ore by the amalgamation process, erected a cyanide plant, and employed Mr. James Napier to work it. It was found, however, that the percentage of copper-sulphides in the ore was too great to permit it to be treated economically by the cyanide process, and the consumption of cyanide was too great. Possibly, the cyanide process of treatment was not then sufficiently understood to apply it in the proper manner. The outcome was that the claims were again abandoned, the plant sold in parts, and the field once more deserted for a time.

There are large lodes of complex ores on this field, which on assay show a high value; but some cheap method of treatment is required to deal with refractory ore of this class. Improvements in mining machinery, appliances, and chemical methods of treating these complex ores will, no doubt, from time to time be made. Lower-grade ores will then be worked than at present, and when that time comes Te Aroha will be a field capable of supporting a large mining population.

Reefton.

The auriferous lodes in the Reefton district were first opened in 1870. Amongst the claims then taken up were the Ajax and Golden Fleece. In both claims rich ore was obtained. They were situated on a steep hill, about 1,400 ft. above the level of the flat. Machinery had to be erected before the claims could be worked. There were no formed roads, and even the pack-tracks were in their native state. The shareholders of the Ajax Mine had to get steam machinery before they could get any return from their mine. Any portion which could be conveyed on pack-horses was a simple matter, but a steam-boiler was required of sufficient capacity to supply steam for an engine to drive ten heads of stamps, with berdans, and also supply steam for a winding-engine. To get this boiler on the ground was a herculean undertaking. It was conveyed up the Buller River on a punt, and up the Inangahua River to the place where the Township of Black's Point is now situated. From there it was taken up the face of a steep hill by constructing capstans at different points and parbuckling the boiler to the top of the range; thence along the top for one mile to its destination. Miners in those days had difficulties to surmount that almost seemed incredible, and hardships to undergo which the rising generation have little conception of. In this portion of the colony men had to carry all their belongings on their backs for a considerable time after gold was discovered; they had to climb steep ranges, cross flooded rivers, and in many instances pass the night in front of a fire in wet clothes, with no other covering from the inclemency of the weather than the canopy of heaven.

Other claims were rapidly taken up—the Wealth of Nations, Energetic, Keep-it-Dark, Inkerman, and many others which have been abandoned years ago. Quartz lodes were prospected in every direction. Specimen Hill and the Welcome, at Boatman's, were opened up. The Globe, Progress, and Big River Claims have yielded a large quantity of gold, whilst their shareholders have received handsome dividends. Up to the end of 1904 there were 1,083,575 tons of quartz treated, from which 603,169 oz. of gold was obtained, representing a value of £2,382,208, and out of this amount £694,356 was paid in dividends to the shareholders, while the calls amounted to £482,340. In the early days of this field claims were taken up, and companies were floated which expended all their capital without getting scarcely any gold, and it was considered ruinous by a great number of people

General View of Progress Mines (Reefton) Reduction and Chlorination Works.

to invest money in mining property in this district. This led me in 1887 to prepare a table of all the quartz-mining companies which had up to that time been carrying on operations in the Reefton district, which showed that the actual cash paid in calls into mining companies was £163,015 5s. 1d., while the dividends paid to the shareholders amounted to £210,306 8s. 2d., thus showing a balance of £47,291 3s. 1d. to the credit of profits. No doubt, a large sum was lost in purchasing shares far above their nominal value, but, to take the industry on the whole, it gave a handsome profit.

About eleven years ago Mr. David Ziman came to this colony and purchased the Globe, Progress, Wealth of Nations, and Golden Fleece Mines, and formed a company in London which is known as the Consolidated Goldfields of New Zealand. Since then that company has purchased the Welcome and other mines at Boatman's. It also formed the Globe and Progress Mines into a separate company, which has been carrying on mining operations successfully since its formation. The workings of the Globe and Progress Mines are now down to a depth of over 1,300 ft., where good ore is still being met with. This company has a crushing plant of sixty-five heads of stamps, which are kept running continuously, unless stopped for repairs; large concentrating, cyanide, and chlorination plants are erected; also a long series of slime-tables, covered with light canvas, which saves very fine concentrates. This product is roasted in a reverberatory furnace and chlorinated.

Operations are steadily carried on at the Golden Fleece, Wealth of Nations, and the Energetic Mines, belonging to the Consolidated Goldfields Company, with satisfactory results. The workings in the Golden Fleece are down to a depth of over 1,300 ft. below the surface, but the ore at this depth is said to be decreasing in value. The workings in the Energetic Mine are down to a depth of over 1,500 ft. below the surface, but so far the results have been disappointing.

The Keep-it-Dark Mine has been constantly worked for the last thirty years. It has given the best return of any mine in the district for the capital expended in opening it out. Up to the end of 1905 the actual paid-up capital was £6,208.

The value of the gold won was £380,430, out of which £145,667 was paid in dividends to shareholders, while there was paid in wages and other expenses £251,293. The only other mine in this district that returned large dividends to shareholders is the Welcome, which now belongs to the Consolidated Goldfields Company. The actual paid-up capital of this company was £8,609 17s. 6d., while the dividends paid to its original shareholders amounted to £110,250. The Big River Company has returned £47,366 in dividends to its shareholders, whilst the paid-up capital of the company is only £11,475.

An interesting discovery in recent years was made, in 1898, on the Victoria Range by Mr. Kirwan, at an elevation of 4,000 ft. above sea-level. The surface of the range for a considerable distance was strewn with quartz containing gold, and some remarkably rich specimens were obtained. The character of the quartz which contained the gold was of a pure-white sugary appearance and of a very friable nature. Wherever this class of quartz was found it contained gold. A great deal of prospecting was done with the view of finding a lode, and several tunnels were driven into the range without success. A shaft was sunk in Saw-pit Gully, which revealed about 4 ft. of rich auriferous stone, but all of a loose character. The surface material, wherever the quartz containing gold lay on the surface, gave good prospects. The company erected a crushing-battery near the Waitahu River, and an aerial tramway connecting the claim with the battery, and has since been putting all the surface material down to a great depth through the battery, with the result that it has returned over £14,700 in dividends to its shareholders, while the actual paid-up capital was only £3,092.

Reefton is a very extensive district for auriferous lodes. The gold is of a high value, and the ore free-milling. No complex ore is mined here of the same character as that found in the Auckland goldfields. The lodes, although not so rich as at Coromandel and Thames, are more regular in value, but it is difficult to get machinery and plant on the ground on account of the rough, rugged nature of the country, full of deep ravines and steep declivities. It is a district that will take years to properly prospect. Only recently a rich discovery of an auriferous lode has been made at Blackwater, the extent of which is not yet known. The whole of the country being covered with timber and dense undergrowth makes prospecting a difficult undertaking; trenches have to be cut before one can tell whether a lode exists or not, and unless the prospecting operations are in the locality of a known lode, it is only by mere chance that a surface outcrop is seen. If the line of a lode is once ascertained, trenches can be cut across that line with some prospect of finding it; but when prospecting is carried on a long distance from the line of known lodes it is only by the merest chance that an outcrop is found.

Otago.

Quartz-mining in Otago has not yielded the quantity of gold that has been obtained in other quartz-mining districts. The lodes at Skipper's Creek were opened in the early days of the goldfields, and, although there was rich ore near the outcrop of the reef, the value of the ore decreased rapidly as the lode went down. Messrs. G. and F. Bullen carried on operations on this lode for a number of years with comparatively little success; indeed, up to the time that they sold the mine to an English company the total value of the gold won did not exceed the amount paid in dividends to the shareholders in the Keep-it-Dark Mine, in the Reefton district, and since then the returns have not given any interest on the capital invested. Rich lodes may be found in the mountains, but they are difficult of access, and it is only during a few months in summer that prospecting can be carried on. There are several lodes in this district and in the vicinity of Macetown, where rich auriferous ore has been found at comparatively shallow depths below the surface which gave good returns; but, generally, in all the mines opened up in the same rock formation as there is in this district the value of the ore decreased in depth.

The most successful quartz-mining company in the Otago District was the Cromwell Company, at Bendigo. It got exceedingly rich ore down to a depth of 200 ft., but below this depth the ore rapidly decreased in value. A new shaft was sunk to a depth of 400 ft. a little to the northward of the old workings; it cut the lode, which had a width of from 9 in. to

12 in., but did not contain gold of a value to work. This is a part of the country and a lode worthy of being prospected. The lode is well defined, and there is a great probability of a shoot of rich ore being discovered along the line of lode, both in northerly and southerly directions. The dividends paid by the Cromwell Company cannot be accurately ascertained, but from my knowledge of what was paid to some of the shareholders they must have amounted in the aggregate to something like £100,000. Small lodes have been opened up in other parts of Otago—as, for instance, the Carrick Range and Waipori—but the same characteristics prevailed: the ore did not carry down its value to any great depth, although very rich quartz was obtained near the surface.

Quartz-mining at Great Depths.

It may be asked, Do the lodes retain their value as the lodes go down? or what reason can be given for suggesting the probability of rich lodes not being found in great depths in Otago? It is difficult to answer this satisfactorily. No one can tell what lies hidden from the eyes of man below the surface; one can only deduce from what can be seen and the character of the country rock. The Otago rocks are of a very old quartzose schist; probably it may be classed as Archæan schist, older than Silurian, as no fossils have been obtained in it, so that its age cannot be determined. The mountains in Otago have at some period been at a much greater height above the sea than at present. These rocks at high elevation, owing to intense frost and atmospheric action, have been greatly denuded, and time after time disintegrated and decomposed. The material has been washed down these steep slopes by heavy rains, and the mineral contents concentrated by flowing streams. The large deposits of quartz-gravel drifts in different parts of Otago are due to erosion and the ravages of time. The disintegrated materials have been carried into lakes and still water; the heavy particles have settled on the bottom, and the fine sediment has gradually settled down and formed into a sedimentary-rock substance, as can be seen

UNDAUNTED GOLD-MINING COMPANY'S CLAIM, MATAKANUI, OTAGO. SLUICING AND ELEVATING.

in recent hydraulic workings at Vinegar Hill, in the valley of the Manuherikia. It is, however, worthy of note that in none of this quartz drift has any gold been discovered in the solid stone, but gold has been found in the schist rock in the Achilles Mine, at Skipper's.

As to the depth at which gold is likely to be found in lodes in any formation, that is a question not yet determined. It is known to exist in the Garden Gully Lode on Bendigo, in Victoria, to a depth of over 4,000 ft., but even in this lode the value of the ore decreased in depth, and probably will be found to do so in the New Zealand lodes in whatever formation they may occur. The circumstances connected with the New Chum Railway Mine, Bendigo, call for special notice. In a recent report on this mine Mr. Dunn, F.G.S., the Victorian Geological Director, writes as follows: "A development fraught with importance is that at a depth of 4,156 ft. in this mine, and 800 ft. below the last body of quartz of a payable nature, excellent-looking quartz of great size and in centre country (the anticline) has been sunk through in the winze. The slate and sandstone are highly mineralised. The quartz also carries sulphides and, what is more important, gold. In no part of the mine have the appearances for gold been more favourable than in the bottom of the winze. The quartz resembles a broken saddle reef, and is in centre country, and the winze passed through over 20 ft. of quartz, and what appeared to be a spurry country leg occurs in the western side. Further work is necessary to definitely settle the nature of the quartz-body, and also to prospect it so as to determine whether there is sufficient gold present to be payable; even at this great depth 7 dwt. of gold per ton is considered worth working. Should this body of quartz prove payably auriferous, it adds enormously to the proved resources in gold of this State, and it is certain to exert a powerful influence in the further development of the Bendigo Goldfield. Then, as to the possibility of working at such depths, it is to be noted that in the bottom of the winze, 4,156 ft. from the surface, the rocks are cool and the water cool, while the supply of air is excellent. The rocks and the water are cooler at the bottom of the winze than at the bottom of the shaft, 3,900 ft. deep. There appears to be no reason why the shaft should not be continued to 5,000 ft., or more, in depth, and the conditions there, as regards temperature, should be such that mining can be carried on satisfactorily and without undue distress to the miner. With the cheapened methods of producing ice the air might be cooled and filtered that would be sent below."

GOLD-DREDGING.

The use and employment of dredges in connection with working alluvial drifts has revolutionised the system of obtaining gold out of the beds of rivers. Spoon-dredges were used in this and other countries for many years, but the employment of bucket-dredges to work the auriferous gravels in the beds of rivers was first introduced in New Zealand. The introduction of these bucket-dredges was due to the rich auriferous gravel that was known to exist in the bed of the Clutha River. Gold was first discovered on the beaches in 1862 by Messrs. Hartley and Riley. The water in the river at that time being very low, some of these beaches were literally strewn with golden sands. The melting of snow on the mountains soon after this discovery was made known caused the water in the river-bed to rise in a few hours to a vertical height of about 16 ft., carrying away rockers and tools that had been left on the beaches. After using spoon-dredges, which proved successful in lifting the gravel from the river-bed and showing that it was rich in gold, current-wheel bucket-dredges were constructed and placed on the river. These were found to give far better results than spoon-dredges, but they had the disadvantage of not being able to work the beaches where there was not a swift current; also, in eddies they were of no service.

Several years passed on, and steam bucket-dredges were introduced. The first of these was constructed by Messrs. Kincaid and McQueen, of Dunedin. This dredge lifted a very large quantity of gravel, but sufficient washing appliances were not provided. Experiments were made from time to time with the view of arriving at the best class of dredge to deal successfully and most economically with the auriferous drifts from river-beds. Mr. Welman constructed a suction dredge, which was expected to supersede the bucket, as it would suck up the sand from the bed-rock much cleaner than could possibly be done by the bucket-dredge. This dredge was only of small proportions, and after it was launched into the Clutha River it was capsized in a flood; but before being submerged its trial proved that it was not capable of dealing with the large stones met with in the gravel-drift. It was far too small for the work it was intended to perform on such a swift-flowing stream as the Clutha. As dredging appliances progressed, some of the dredges gave phenomenal returns, which led to a boom taking place in this class of mining. Claims were taken up in every flat and river where there was any prospect of gold being obtained; companies were formed, and dredges were constructed that in many instances were incapable of working the ground; the ladders were in many cases too short to dredge to the rock-bottom, or the washing appliances were defective. From one cause and another many of the dredging companies went into liquidation. The shareholders lost their money—not, in many instances, owing to the claims taken up being valueless, but rather on account of the incompetency of those who had charge of directing the affairs and operations of the company. Contracts were let for dredges whose ladders were not sufficiently long to reach the bottom; any description of a dredge was deemed good enough, so long as it did not cost more than £3,500 or £4,000. The most of the dredges first placed on the Clutha, between the Beaumont River and the Township of Clyde, proved successful in their operations, and as time went on dredges were placed on the Kawarau and Shotover Rivers. A company known as Sew Hoy's had three dredges constructed, and for some years, in dredging the place known as the Big Beach, on the Shotover River, a large quantity of gold was obtained by these dredges; but their washing appliances were very defective. Some of the ground was dredged over three times, and there was as much gold got the third time as there was at the first working.

Dredges were placed on the Shotover, at its junction with the Kawarau, but the ladders of these dredges were not nearly sufficiently long to reach the bottom of the gravel-drift.

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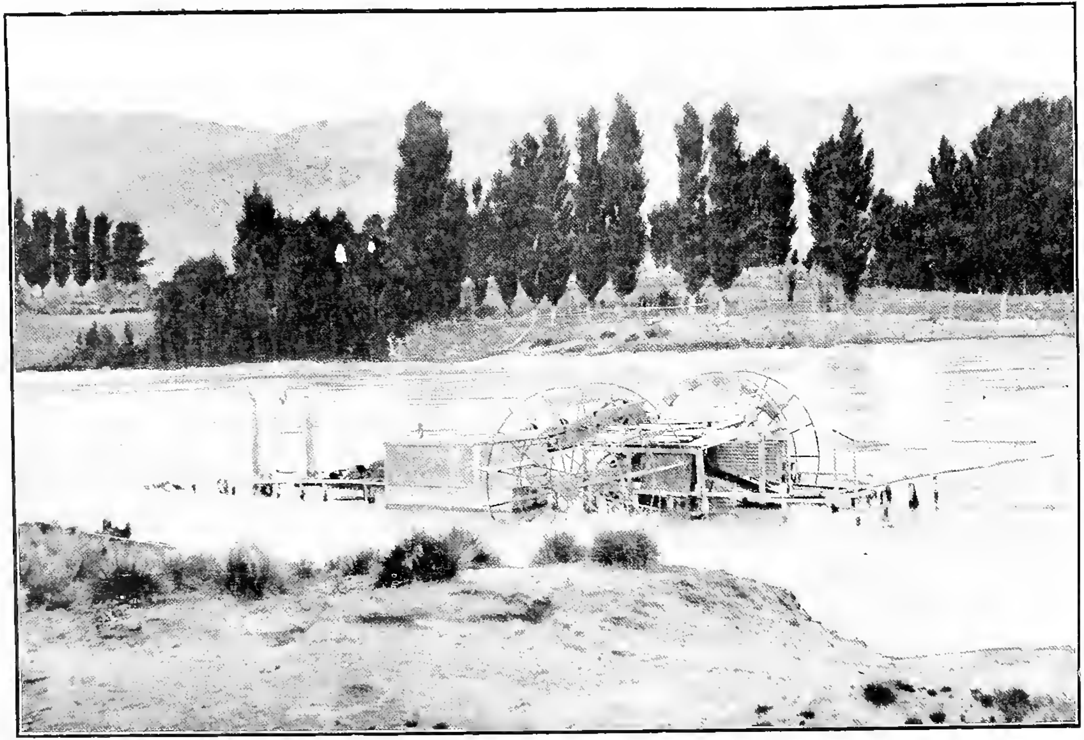
So confident were some of the shareholders as to the success of the dredges in this locality that they put in all the little earnings they had saved, and lost the whole of them.

Claims were taken up in the Kawarau River, between the mouth of the gorge and Cromwell. Dredges were placed on these claims, but the first of them failed to reach the bottom. Several attempts were made to successfully dredge this portion of the river before it was accomplished, and yet very rich auriferous wash-drift was found when it could be dredged to the rock bottom. The Electric Company's dredge, which gave phenomenal returns, obtained the gold by working in this portion of the river.

A claim was taken up in the Clutha River, including the Hartley and Riley Beach, where such rich returns were obtained in the early days; but the river at this place was full of rocks and of so uninviting an appearance that a considerable time elapsed before a company could be formed to find sufficient capital to construct a dredge. After this dredge commenced to work as much as 1,100 oz. of gold was obtained in one week, and shares of a face value of £1 changed hands freely at £20 to £25 each. One of the shareholders in this dredge who held a good appointment in a Government Department was, it is said, so satisfied with the prospects of this company and his chance of obtaining a competency for life that he threw up his appointment, and blossomed forth as a mining expert with no other experience than being one of the fortunate shareholders in the Hartley and Riley Company! The success of this company gave a great impetus to the dredging industry. Claims were taken up in all rivers where prospects of gold were obtained on the beaches. Flats and shallow alluvial ground, where water was available, were taken up in claims to be worked by dredges, and the dredging industry still continues to be carried on successfully in Otago. It has been the means of a large quantity of gold being obtained in that part of New Zealand which could not have been got by any other known system. The quantity of gold obtained by dredging operations for the past seven years has been 533,668 oz., representing £2,134,674. Taking the quantity of gold obtained by fifty of the dividend-paying dredging



Gold-dredging in the Clutha River, Otago: The Old Current-wheeler.

Mining Handbook.

companies in Otago, for four years ending 1904 it amounted to £920,019, out of which £319,268 was paid in dividends. The capital of these companies amounted in the aggregate to £393,272, which shows that gold-dredging is a fairly profitable industry.

West Coast.

Dredging on the West Coast has not been carried on so extensively as in Otago, nor have dredges been used for the same period. The nature of the river-beds on the West Coast is different from that of the river-beds in Otago. The rivers flow through a densely timbered country, and in their beds are large quantities of submerged timber; in addition to this, there are huge stones among the gravel-drift. This necessitates much stronger dredges than were at first employed. When dredging commenced on the West Coast some of the small dredges from Otago were purchased, and for a considerable time only small dredges were constructed, which resulted in many failures. These dredges were practically useless for the operations they were intended to perform, but the dredges latterly constructed have worked with considerable success.

Taking the three years ending the 31st December, 1905, twelve dredges obtained gold to the value of £314,054. The total value of gold obtained by dredges on the West Coast is approximately about £650,000, out of which about £80,000 has been paid in dividends.

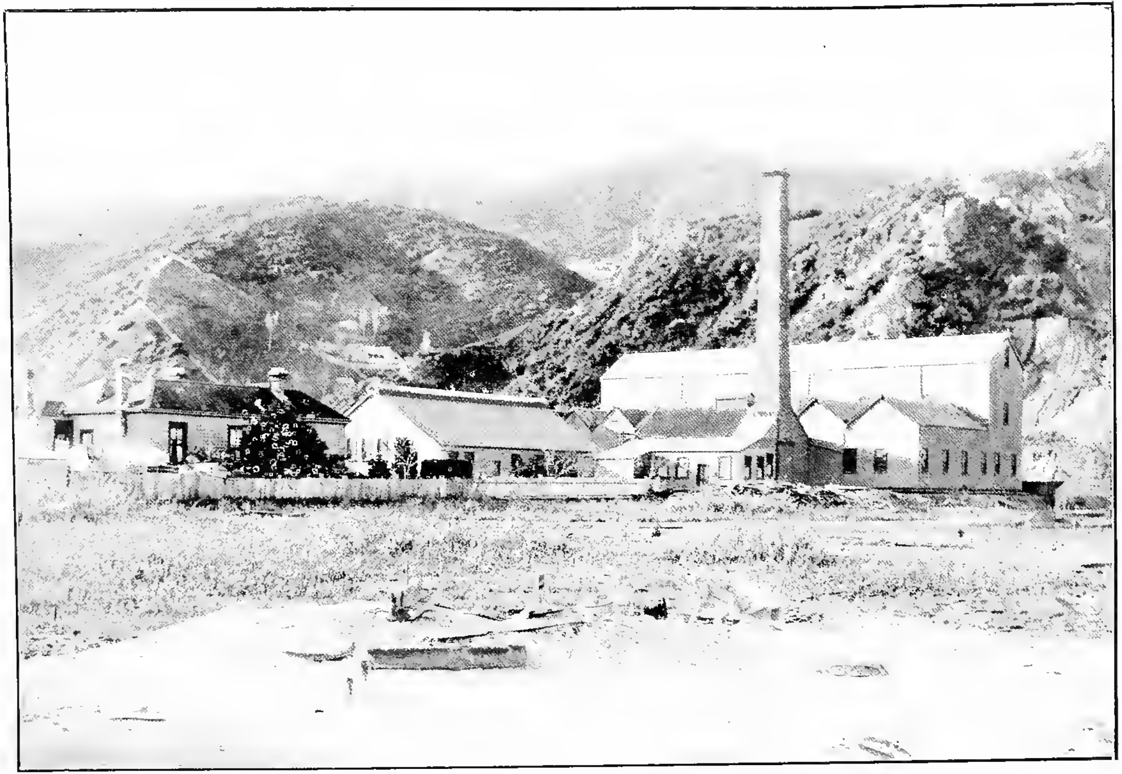
Conclusion.

The dredging industry in the colony has given employment to a large population, and has been the means of gold to the value of £2,784,674 being obtained which otherwise could not have been got. It has given fresh impetus also to mining in parts of the colony where the population was turning its attention to the finding of employment in other channels. Dredges applied to mining are machines which can be profitably employed in working the beds of rivers and swamps, which they drain and render cultivable; but in working flats and alluvial ground, where water is available or can be brought on for hydraulic elevating and sluicing, their use is not commendable. The reason of this is apparent. In working ground by hydraulic elevating the bottom is laid bare on the bed-rock; the crevices can be completely cleaned out, and all the gold obtained. This cannot be done by dredging, especially if the rock bottom is hard and jointy; dredges cannot avoid leaving a deal of gold on the bottom. Stationary washing and gold-saving appliances, where the inclination of boxes and tables is completely steady, are far more effective for saving gold than when they are subjected to the vibrations of a dredge. Dredges are capable of lifting large quantities of gravel-drift, but they are very defective in appliances for saving the gold. Many improvements have already been made in the gold-saving appliances on dredges; the difficulty lies in the character of the gold found in river-beds, being in many instances in very finely divided particles, requiring a much greater width of tables to save a large percentage of it than can be constructed on a dredge. The fine material requires to be carried by water in a thin film over the tables, and this cannot be done on dredges raising a large quantity of auriferous drift.

HAURAKI MINING DISTRICT.

By James Coutts, Inspector of Mines

The Hauraki Goldfields extend from the Great Barrier Island, north of Auckland, to Te Puke, twenty-five miles south of Tauranga, a distance of two hundred miles. The discovery of gold was first made in 1852 by a settler named Charles Ring, who asserted that he had found gold upon Cape Colville Peninsula, forty miles east of Auckland, in the vicinity of Coromandel Harbour, and in the Kapanga Stream (now known as the Driving Creek). The specimens produced by Mr. Ring were pieces of auriferous quartz and some fine gold obtained by washings from the gravel in the creek. A reward committee having been formed in Auckland, a reward of £500 was promised to the discoverer of a payable goldfield in the northern district of New Zealand, and as Mr. Ring put in a claim for the reward, commissioners were sent to investigate the matter, and confirmed the existence of gold, but left it doubtful as to whether there was a goldfield extensive and rich enough to pay for working. The excitement in Auckland at this time was intense, and nearly all work was suspended, the general conversation being about the rich discovery of gold, all being eager to make a bid for fortune. The greater number of the male population, including three thousand miners, flocked to the scene of the discovery; but, as at all new finds, most of them were greatly disappointed in not getting gold without much labour. The land upon which the gold was found belonged to the Natives; therefore an agreement had to be made with them, resulting in an exemption being given for the first two months, £1 10s. to be then paid by each for a digger's license. The diggers obtained good prospects in the Kapanga Stream and Matawai Creek, but as nothing of a payable or permanent character was met with, and difficulties again arose with the Natives, the place was practically abandoned within six months. The general verdict was that the field was too poor, and the promised reward of £500 was withheld from the discoverer. The whole produce of the goldfield was about £11,000. The largest nugget found was a round piece of quartz about 1½ in. in diameter, which contained gold to the value of £10. In October, 1861, Coromandel again attracted attention, and in April of the following year about two hundred and fifty diggers assembled on the field. Owing probably to a better knowledge of sluicing for gold than the diggers had at the previous rush, better results were obtained. On the 28th June, 1862, Coromandel was proclaimed a goldfield, and Mr. H. H. Turton was appointed Commissioner. On the Matawai and Tiki Creeks pieces of quartz weighing from 30 oz. to 40 oz. and one piece of 11 lb. in weight were found, containing, it was supposed, 50 to 60 per cent. of gold. A party who began to work a quartz reef on the Kapanga is said to have obtained from one ton of quartz, by crushing and washing, 2½ oz. of gold. From this time the development of the quartz lodes commenced in this locality, and from 1864 to 1867 (the year the Thames Goldfield was opened) the Kapanga Mine was worked in a systematic manner under the able management of Mr. Reeves, and a large quantity of gold was produced, some of the specimens obtained yielding from 1 oz. to 6 oz. of gold to the pound of stone. With the rush to the Thames at this time Coromandel was again almost deserted. Then rich gold was found on the Tokatea Hill, when a reaction took place, and, as new finds were discovered from time to time, mining has been carried on continuously ever since, although there have been depressions at times, as is the case at present. There are still great probabilities of the prospects of Coromandel improving, more especially as there is a large block of country unprospected, extending from the Manaia to the Mata Stream, and from the Thames–Coromandel Main Road, on the western side of the range, to the foot of the hills on the eastern side. This portion of the district seems to have been neglected in the



Thames Goldfield, showing Moanataiari Battery.

past, no doubt on account of it being heavily covered with bush, and owing to the rough, broken nature of the country.

In 1865 it was rumoured that gold had been discovered at the Thames, two men having reported the circumstance to a gentleman connected with the *Herald* (Auckland), and several specimens were exhibited which were said to have been found in the Karaka Creek. The find was reported to the Superintendent of the Auckland Province (Mr. Robert Graham), but, owing to troubles and disagreements with the Natives, the matter stood in abeyance until the dispute was partially settled. In 1867, through the influence of the Hon. Dr. Pollen, aided by Mr. James Mackay's thorough knowledge of the Maori language and manners, the Natives consented to open up that block of land between the Kuranui and Karaka Creeks for gold-mining, on condition that the miners would give to the Natives £1 for each miner's right issued for the block and £1 5s. for each kauri-tree used by them. The first batch of diggers that arrived on the field directed their attention to finding alluvial gold in and at the lower end of the Karaka Creek. Shafts were sunk to a depth of over 100 ft. through gravel and boulders, but without finding a bottom, the water being heavy to contend with, necessitating constant baling; and, although gold was found in washing the gravel, it was not in sufficient quantities to pay. On the 10th August, Hunt, White, Clarkson, and Cobley discovered a gold-bearing leader in the Kuranui Creek under a small stream of water that was running over a waterfall about 12 ft. in height. Owing to the gold being of a light colour, due to a fair percentage of silver, a number of the miners who had been on the diggings on the west coast of New Zealand and Australia had doubts as to whether it was gold or not, but this was soon proved by a parcel of the ore that was treated in Auckland. A rush immediately set in, and claims were pegged off in every direction, and in a number of them, especially in the Kuranui Hill, gold was found in the leaders cropping out on the surface. The country being a soft tufaceous rock, requiring little timbering, mining was carried on without much danger, even by those unaccustomed to this kind of work; and, as specimens could be treated at small expense, in a very short time after the field was opened it was as good as an alluvial diggings for a number of miners. The importance of the discovery and opening-up of the Thames Goldfield can be gathered from the fact that, between August, 1867, and 30th June, 1869, duty was paid in Auckland on 129,211 oz. of gold, the value of which was estimated at £264,425.

When it was found that the Thames was so rich there was a great clamour for the opening-up of the Ohinemuri district, but on account of the opposition shown by the Natives it was not until the early part of 1875 that this portion of the country was declared a goldfield. In April of that year gold in payable quantities was found at Tairua. In August, 1880, traces of gold were again found at Te Aroha, and three months later the district was thrown open for prospecting and for the location of claims.

The gold in the Thames portion of the district is more or less patchy as a rule, and the subsequent annual production of the Thames Goldfield has fluctuated considerably. The highest point was reached in 1871, when the value of gold entered for export amounted to £1,188,708. This was due principally to the rich shoot of ore discovered in the Golden Crown Company's property and followed into the old Caledonian Company's mine, which enabled the latter to pay in dividends £553,440 within twelve months. After this the production greatly diminished, and for the year ending the 31st March, 1895, only 22,810 oz. were returned from what is termed the Thames Goldfield—the lowest production since the field was first opened. The claims overlooking Grahamstown, with few exceptions, have been continuously worked since 1867, although some of them have changed their names. Every claim from the Kuranui to the Karaka Creek has produced large quantities of gold and paid handsome dividends to the shareholders; and not later than eighteen months ago a rich shoot of ore was discovered in the Waiotahi Company's mine at the No. 4 level, in what is termed the "Big Reef," from which the magnificent sum of £51,000 was paid in dividends to the shareholders during last year. There are 60,000 shares in the company, and it is fully expected sufficient gold will be obtained to enable the directors to declare a dividend of 5s. per share every month during the present year. This has given great encouragement to the other companies holding the adjacent mines, and, although nothing of importance has been discovered in any of the other mines for some time past, yet some shareholders are still sanguine that rich finds may be got at any time.

There is a large tract of country unprospected between the mines worked at the Thames and the east coast, where gold may yet be found in payable quantities. Tairua Broken Hills Mine continues to employ a number of men, and the Golden Belt Company's battery at Neavesville, comprising forty heads of stamps, with all the necessary amalgamating and cyanide appliances, is to be started at an early date, when it is expected payable returns will be obtained from the company's ground, which includes several of the mines that were worked in the early days and which produced a large quantity of gold. The Auckland (late Mananu) and the Waimangu mines, at Whangamata, are employing a number of men, the former producing gold in payable quantities from the upper levels.

The Ohinemuri district, when it was opened, proved very disappointing. The Karangahake Gorge was rushed, and the ground pegged out for miles around, but as the gold-bearing quartz was different from that found in Thames and Coromandel, and as no quartz could be treated for some time, a number of the claims were soon abandoned. A small battery was erected, and, although some of the quartz treated contained gold in payable quantities, the mode of treatment being by amalgamation, a large percentage of the gold was not recovered, and in consequence the claims did not pay. This was some time prior to the cyanide process being discovered, and little systematic mining was carried out in this locality for some years afterwards.

At Waitekauri mining for a time was more successful, as rich gold was found in the Waitekauri Claim, in which Messrs. Bleazard and Brown had an interest. They erected a forty-stamp mill, a large water-wheel to drive the machinery, and a ground tramway over a mile in length connecting the mine with the battery, costing several thousands of pounds. After working the mine for something like two years, the rich shoot of ore not continuing down and the ore from the other parts of the mine not paying working-expenses, the mine was closed down. After this little was done in that locality for several years. The same may be said about this as Karangahake: a large percentage of gold was lost in the treatment at the battery.

There were very few left in Waitekauri after this, as there was no employment for labour, but Mr. John McCombie and Mr. Robert Lee, who were prospecting in the district, decided, in the month of February, 1878, on trying the country eastward; this led them in the direction of what is now known as the Waihi Mine, and before reaching the place they could see the outcrop of the lode on a rounded spur rising above the plain. They then made for the place, and no time was lost in breaking out samples of the quartz and crushing it with the head of their picks and then washing it off, with the result that fair dish prospects were obtained, and on examining the lode they found it to be about 20 ft. in width, running in a northerly direction, and dipping towards the east. As the ore appeared to be richest at the northern end of the outcrop, they determined to test the lode there at a depth of 60 ft. below the surface by driving a crosscut from the western side of the spur. The crosscut required to be driven 200 ft. to intersect the lode. This was accomplished in about four months, when the footwall branch of the lode was cut through and found to be 17 ft. in width, good prospects of gold and silver being obtained from any part of it. A trial lot of 2 tons was conveyed to Owharoa, where it was treated in the Smile of Fortune battery for a return of 1 oz. 3 dwt. of bullion, value £2 17s. 6d. per ounce. But previous to this samples were assayed at the Bank of New Zealand, Thames, that gave assay values as high as £4 6s. per ton, which showed that a large percentage of the bullion was lost in the treatment of the 2 tons by the usual amalgamation process then in general use. The prospectors tried their best to induce others to find money to develop this property, and several mining experts examined the lode from time to time, but in every case it was unfavourably reported upon.

View of Karangahake, showing Woodstock Reduction-works and Water-race, and N.Z. Crown Mines Water-race.

While waiting for something to turn up, gold was discovered by Hone Werahiko at Te Aroha, and Messrs. McCombie and Lee left for the new find. During their absence a prospector from Coromandel, named W. Nicholl, inspected the workings, and was so well pleased with the prospects he obtained from the lode that he induced some of his friends to peg out and apply for several claims on the strike of what is now known as the "Martha Lode." As there was no person on the claim at the time Nicholl went there, he had no difficulty in getting it forfeited, and was put in possession of the ground. Through the influence of Mr. Adam Porter he succeeded in forming a company in Auckland, and soon got two batteries erected. One of these was kept going for a number of years, and something like 18,000 tons of ore was treated for about an average of 4 dwt. to the ton. As the Waihi Company has since worked out the blocks of ground on the lode that were left both above and below the old workings for returns varying from £2 to £3 per ton, it shows that the loss of gold by the mode of treatment in use at that time was something incredible. As the mine was not paying operations were suspended, and it was let on tribute to Mr. Hollis and party. Mr. J. W. Walker and others, holders of the Union and Rosemont Mines, induced Mr. Thomas Russell to form a company in London to work those claims, which are situated in the lower ground and nearer the river than the Martha Mine. The Waihi Company was registered in 1887, but in 1895 it was again known as the Union-Waihi Gold-mining Company (Limited). There were two reefs in this ground—the Union reef and the Amaranth reef—both of considerable size, besides several smaller reefs, and upwards of £33,000 was obtained from the Union lode in the earlier years of the company. This did not prove a payable concern, although the company had expended a large amount of money in erecting machinery. In 1890 the company purchased the Martha Special Claim, and from 1891 the Martha ore and that won from the Union ground was all crushed together up to 1893. The quantity of ore treated that year was 19,805 tons, for £61,900 10s. 11d. From this time on the returns have steadily increased, till in 1905 no less than 298,531 tons of ore was crushed and treated for 1,192,046 oz. of bullion, value £751,233 8s. 4d.,* and dividends amounting to £322,339 11s.† were paid to the shareholders during the year. To enable this large quantity of ore to be treated the machinery and appliances, both at the mine and batteries, had to be increased proportionately at considerable cost, and great credit is due to the management for the substantial and satisfactory manner in which everything has been carried out. The Martha Mine, being situated on rising ground, gave an opportunity of constructing the tramways on an easy grade for conveying the ore from the mine to the three crushing-mills, which consist of 330 stamps, tube mills, &c., which are all erected as low and near the river as possible, so as to take advantage of the available water in the river and streams to be used as motive power. In the mine there are also great natural advantages. The lodes in most cases have only a slight underlie, being sometimes nearly vertical, and on this account the pressure on the timber in the workings is comparatively light. The surface of the hill being of a soft, friable nature, and easily broken, is sent down the passes for filling into the stopes, where the ore is broken out at comparatively little cost. There are numerous lodes opened up and worked in the mine, varying in places from 3 ft. to 87 ft. in width, to a depth of 700 ft. The prospects at the lowest level are promising and exceedingly encouraging, as is borne out by the recent large monthly returns.

The Grand Junction Company's mine, which adjoins the Waihi Company's mine on the eastern side of the Martha Hill, continues to be vigorously exploited by sinking, driving, and opening up blocks of ground on the lode between Nos. 1 and 2 levels preparatory to commencing crushing. The prospects met with at No. 2 level are said to be very satisfactory. The company being evidently well satisfied, a large crushing plant, consisting of forty stamps, together with all up-to-date machinery and appliances for the treatment of the ore, is in course of erection and completion.

The Waihi Extended Company, Waihi Consolidated, and others are carrying on prospecting operations, but beyond

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*Including values of concentrates and tailings slags shipped; also treated at Waikino.

† Also bonus; making total of £346,223 10s. 3d. for year.

assays there has been very little ore treated outside of the Waihi Company's mine for some time past.

During the last ten years a number of men have been constantly employed at Karangahake in the New Zealand Crown and the Talisman Consolidated Mines. Although the Crown Mine has not been as successful for the last two years as formerly, the prospects are again more encouraging, and it is expected that better returns will soon be forthcoming. 17,541 tons of ore was treated during the year 1905 for £36,516 8s. 10d. On the other hand, a great improvement has taken place in the Talisman Consolidated Mine, 44,725 tons of ore being treated for the splendid return of £129,088 8s. 10d., which, after all expenses were paid, left a profit enabling the directors to pay dividends amounting to £30,000.

The Komata Reefs Mine has been steadily worked, and, although no rich runs of ore have been met with to cause any excitement, the returns of gold have been maintained. 16,820 tons of ore was treated last year for a value of £42,432 17s. 8d. Through careful and economical management, dividends amounting to £13,333 6s. 8d. were paid to the shareholders.

The Golden Cross Mine, which was discovered by Lowrie brothers in the latter end of 1893, and afterwards purchased by Mr. T. H. Russell, and called the Waitekauri Company, has been closed down for the last two years. This mine at first bade fair to be better than even the Waihi Mine, as the first crushing of 600 tons of ore treated yielded 7,600 pounds' worth of bullion. A large quantity of valuable ore was extracted from the mine, but the gold did not go down, and prospecting at the deepest level, as well as boring, failed to give the company any encouragement to do further work.

The Te Aroha and Waiorongomai mines, which gave promise at times of turning out successfully, have proved very disappointing, as Hardy's company has stopped all operations, owing to the mine not paying, and pending the construction of a new company. This is the most southerly mine in which gold has been obtained in this district in payable quantities; but gold has been found on the eastern side of the range, in the Eliza Claim near Katikati, and also on what is termed Fleming's Freehold, at Te Puke, twenty-five miles south of Tauranga.

To the north of Auckland, on the Great Barrier Island, there are two mines working — the Barrier Reefs and the Sunbeam Gold-mining Companies. The Barrier Reefs Company, although in liquidation, have seven men employed in the mine and two men at the battery treating tailings, which contain gold in payable quantities. The Sunbeam Company, which has been prospecting its mine for some considerable time, is well satisfied with the results obtained, and has erected a five-stamp battery, with the necessary gold-saving appliances, and intends to commence crushing operations at an early date.

Copper, Antimony, Manganese, and Galena Lodes.

Something like forty years ago a copper-mine was worked on Great Barrier Island, which gave employment to a number of men, under the management of Captain Higgins; but, as the ore was all shipped to England for treatment and the freight at that time was something like £1 per ton, and high wages had to be paid to the miners, these factors had a good deal to do with the mine not paying and with its abandonment.

A copper-mine was worked on the Kawau Island nearly fifty ye[illegible]. Here they had a smelting-furnace, &c., but for similar reasons to those given in connection with the Great Barrier Mine the venture did not pay.

Antimony, manganese, and galena lodes have also been found on Kawau, varying from 1 ft. to 5 ft. in width, but little work has been done on them to prove their value.

Prospectors have lately discovered copper-ore near Kaeo and Whangaroa, which is said to contain from 15 to 90 per cent. of copper, and, as further developments are proceeding, a discovery of importance may be heard of here at any time.

The Puhipuhi district, north of Whangarei, was first opened in 1875. A number of people rushed to the place in anticipation that a new El Dorado had been discovered, as the ore resembled Karangahake quartz; but as it was argentiferous ore containing little gold, and as it got into the hands of people who had little knowledge of the treatment of this kind of ore, and who formed companies and erected

Talisman Battery, Woodstock Hill, and Karangahake Peak.

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machinery unsuitable for the work it had to perform, it turned out a failure. Still, the Puhipuhi Range, which extends a distance of twenty miles in a northerly direction, is unexplored, and an important discovery may yet be made in this locality.

Manganese was worked for a number of years. It was found at the following places: Bay of Islands, Purua Bay, Mangapai, Otonga, and Waiheke. The Waiheke Island is distant about twelve miles in an easterly direction from Auckland. Dr. John Storer, who reported on the manganese lodes on what is known as the Ardrossan Estate, consisting of about 6,000 acres, says, "From the northern end of the island there is traceable for a distance of some seven miles an intrusive belt of rock giving abundant indications of manganese on the surface. At two points during the past years manganese has been worked, and some thousands of tons mined and shipped." Mr. Dunn, the Victorian expert, said of the same estate, "On the south side of the property water-access is furnished by Man-of-War Bay, and a substantial jetty has been built. From this point ore could be shipped from the southern half of the estate. On the west side there is a small bay where scows, &c., can be conveniently loaded, and which commands the northerly portion of the property." Of the manganese-deposit he says, "Manganese-ore occurs in a more massive form than I have ever met with elsewhere, and its excellent quality is shown by the results of two assays made by Mr. Pond of two quantities of 30 tons each taken from different portions of the estate. No. 1, metallic manganese, 56·63 per cent.; No. 2, metallic manganese, 56·34 per cent." Ten tons of ore was shipped from this estate about seven years ago, but nothing has been done on it since. The lodes being bunchy (opening out and contracting suddenly), and as the price of manganese fell in the market, this, doubtless, had something to do with this property not having been more vigorously worked.

Gold-mining a Profitable Industry.

Referring to gold-mining again, it not unfrequently happens that people are heard to say gold-mining is a hazardous thing to have anything to do with; but this is not so with careful speculation. It has, no doubt, paid handsomely in this district. Speculation in the rise or fall of shares in the market, where unlucky persons buy in at a high price and sell at a low price, or *vice versa*, is not mining; it is simply gambling. But when it is considered that the sum of £416,972 17s. 8d. has been paid in dividends from four mines in this district during the year 1905, it will convince most people that mining as an industry does pay. What other industry can show such a profit as this has done to the original shareholders of those companies? Should no unforeseen accident happen, the value of the output of bullion from the mines in the Hauraki Mining District for 1906 will surpass the record return for 1871, which is the largest up to the present, being £1,188,708.

Coal-mining.

The coal-mining industry in the North Island is increasing, but the coal is entirely used for house-consumption, local industries, and the coastal steamers. The coal-seams north of Auckland are semi-bituminous, but the coal is not adapted for exportation, and not equal to the West Coast coal of the Middle Island. There are only three mines working in the Whangarei district. The Kiripaka Mine ships its coal from Ngunguru in small coasting-boats. The Hikurangi Coal Company and the Northern Company's mines are both at Hikurangi. The coal is carried on the railway a distance of fourteen miles and shipped at Whangarei. The seams of coal in all these mines are opening up exceedingly well, and there is no difficulty in getting sufficient coal to supply the demand. The seams generally vary from 5 ft. to 8 ft. in thickness. There appears to be a large tract of coal country between Whangarei and Kawakawa (Bay of Islands), but in all probability it will be found at a depth, and, as Mr. Moody has started boring operations with the diamond drill to the north along the railway-line from the present mines, an important discovery may be made at any time.

In the Waikato district, south of Auckland, brown coal is mined. The Taupiri Coal-mines (Limited) owns the principal mine, which includes what was formerly known as the Taupiri Reserve, Taupiri Extended, and Ralph's Taupiri; and these are still worked in three distinct sections, no connection having yet been made underground from one mine to the other. The seam varies from 30 ft. to 50 ft. in thickness, and in places is worked to a height of 24 ft. A large area of coal has been opened up. At the Union Collieries, near Mercer, as the mine is opened up the seam is proving to be much better than at first anticipated. The bulk of the coal from this mine is purchased by the Waihi Company. The mine is at a disadvantage compared with the other mines in the district, as the coal has to be taken down the Maramarua River in barges, where it has again to be loaded into the railway-trucks, the distance by the river being something like ten miles. The Taupiri South continues prospecting and working a small area on the outcrop near Ralph's old mine, on the eastern side of the railway at Huntly, but the quantity of coal in sight is very limited. The Drury Coal-mine has not turned out as well as anticipated, and the company is now directing its attention to making pipes, bricks, &c.

The Mokau Coal-mine appears to be only able to dispose of coal for the small coastal steamers and the local consumption round Waitara. The output does not exceed 4,000 tons a year. There is evidently a large area of coal extending from the Mokau to the Wairoa River, south of Auckland, a distance of a hundred miles, as the outcrop has been found at various places.

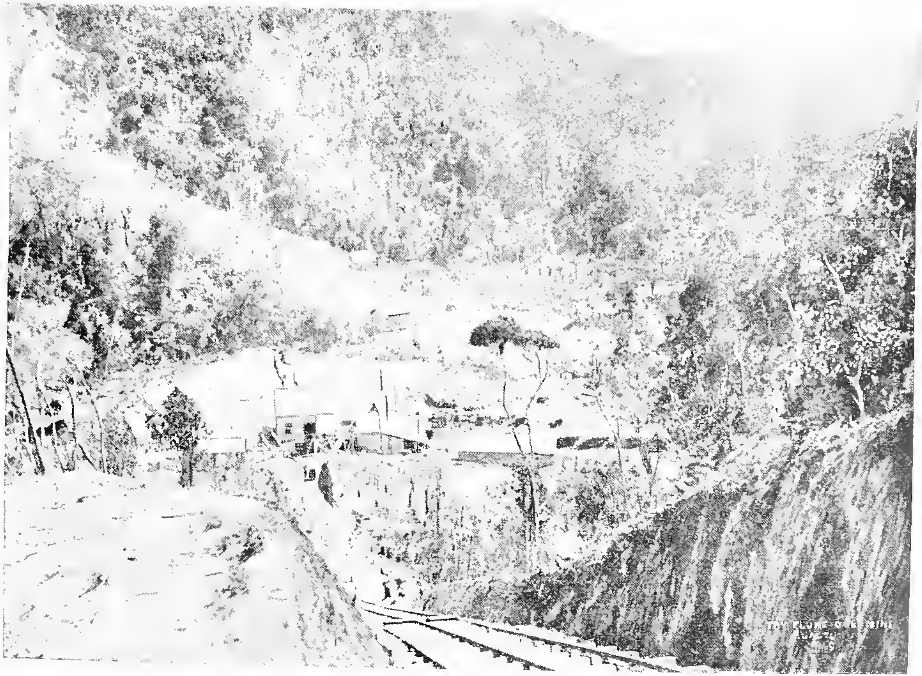
The following is a comparison of the output of coal in the Northern District during the past year and what it was ten years ago:—

	Tons.
Total output for the year 1905 ...	259,876
Total output for the year 1895 ...	135,738
Showing an increase of ...	124,138

THE COROMANDEL GOLDFIELD.

By D. V. Allen, B.Sc., A.O.S.M., Director Coromandel School of Mines.

The Coromandel Goldfield is picturesquely situated on the western side of Cape Colville Peninsula, some forty-five miles east of the City of Auckland, from which it is separated by the Hauraki Gulf. It has the honour of being the oldest goldfield in New Zealand, the first authenticated discovery of gold being made in 1852 by Mr. Charles Ring, an experienced Californian digger. A rush set in, and thousands of diggers were soon at work, but results proved disappointing, and in less than a year mining operations were discontinued. Prospecting was still carried on to a limited extent, but the work was attended with no small risk owing to the hostility of the Natives. The field remained in a languishing state till 1861, when it received a fresh impetus, and mining was carried on with great activity in the Kapanga area. The Kapanga Mine, which was the centre of operations, proved very remunerative, and was the first to attract English capital. From 1864 to 1869 it produced gold to the value of £100,000. It was then thought that the gold had been worked out, but subsequent discoveries proved this conclusion to be incorrect; the run of gold was again picked up, and the mine once more successfully worked. The history of this mine is but a recapitulation of the history of most of the Coromandel mines, for it is a characteristic feature of the field generally that the gold occurs in shoots or patches, often of phenomenal richness. It is therefore no criterion that, because a mine is apparently worked out, further developments may not prove it to be a veritable bonanza; and for this reason, if for none other, the field will always be a home to the tributer and an attraction to the speculator. None better exemplifies the glorious uncertainty and romance of mining—a single blow of the pick may unearth a fortune. Suffice it to say that this



Try-fluke Gold-mine, Kuaotunu.

mine has been in operation off and on till the year 1900, the total value of gold won from it being approximately £175,000. Two years ago it was acquired by Messrs. Cornes and Hollis, who have confined operations to the locating of a reputed rich leader. Their efforts have recently been rewarded by the unearthing of rich specimens in the bottom of a winze. Twenty pounds of selected specimens, some of them being half gold, have been valued at £250. About the year 1870 gold was first discovered on the Tokatea Range, and soon after a company that was formed worked the Tokatea reef and the No. 1 Tribute leader for about eighteen years, obtaining 55,273 oz. of gold, valued at £159,535, and paying in dividends £63,625. All this gold was obtained above the No. 7 level. For several years following very little work was done. The property then passed into the hands of an English company, was amalgamated with an adjoining property, and subsequently known as the Royal Oak of Hauraki. It gave good returns for some years, but these falling off the property was eventually sold to an Auckland syndicate, who, after obtaining some fair crushings, let it on tribute.

In 1872 the Green Harp shoot of gold was discovered, and yielded over 40,000 pounds' worth of gold. It is comprised in what is now known as the Union Beach section of the Hauraki Mine. After this period the yield of gold gradually decreased, but in 1885 a further fillip was given to mining by the discovery of gold on the Tiki. In spite of vigorous prospecting the returns were rather poor.

It was left for the famous Hauraki Mine to give the desired impetus to the field, and it may be said that the phenomenally rich gold discovered in this mine was the immediate forerunner of the biggest mining boom that has occurred in connection with the Auckland Goldfields within recent times. Under the name of the "Coromandel Gold Company," this mine first came into existence in 1886. The returns, however, were not very large, the quantity of ore being little, but exceedingly rich. The commencement of the aforesaid boom, which lasted for three years, was coincident with the discovery of extremely rich ore in this mine in 1895 by a tributer named Legge, who with his mates took out some thousands of ounces of gold in the course of a few months. The excitement was of the wildest description, and very soon the whole field became a scene of great activity. In four years 250,000 pounds' worth of gold was raised from this mine.

Such is a brief account of some of the leading mines. In indicating the possibilities of future operations we must bear in mind that the surface portions of the reefs have, for the most part, been worked out, and that work at greater depths can only be carried on at considerable expense. Adequate winding machinery and powerful pumping plants would be required. With the exception of the Kapanga, very little was done in the way of development-work, which should have been actively prosecuted when the mines were getting good returns. What is now wanted is the formation of a strong company that would undertake to unwater the mines and further sink the present shafts. The deepest workings in the Hauraki Mine are only 400 ft. below the surface. From a shaft sunk below the No. 7 adit level in the Royal Oak trial crushings of over 4 oz. to the ton have been taken out, clearly indicating that the gold is living down. In the Kapanga shaft good gold was got at the 940 ft. level, also in a 200 ft. bore put down from the bottom of the shaft, which is 1,000 ft. in depth.

The value of the gold varies for different localities from £2 12s. to £3 5s. per ounce, but is fairly constant for any given locality. It occurs mostly in shoots in small quartz reefs traversing decomposed andesite; where the latter is hard and undecomposed the reefs are generally barren. As in most goldfields, certain local indications in the country often precede the discovery of rich quartz—*e.g.*, at the intersection of cross-reefs carrying sulphides, the presence of native arsenic, &c. The andesite rocks are underlain by the older Palæozoic slates and shales, which are mostly non-auriferous. These sedimentary rocks have been met with in the lower levels of the Royal Oak, but from their dip they are not likely to be encountered in the other mines — at least, not until great depth has been attained. Thus, in the Kapanga Mine there is no sign of them at 1,200 ft. in depth.

Probably no reefs could be more variable in course, dip, and gold-content than those of the Coromandel Goldfield. Those in the Hauraki Mine are so disturbed by repeated faults and slides that their economical working demands great care and experience. They ramify in all directions, and it is almost impossible to state their general trend. The Kapanga reef is probably the most defined. It runs north and south, dipping to the west at 45°, and was cut in the shaft at 600 ft. Parallel to it, 100 ft. away, is Scotty's reef, which has yielded a lot of gold. The Big Tokatea reef, or blow, is a mass of quartz outcropping at an elevation of over 1,000 ft., striking north and south and dipping west at 50°. It contains gold to the extent of about 2 dwt. per ton, and is therefore unpayable to work under present methods. The cross-reefs running east and west on the foot-wall side of the Big reef are the most important, and from these has been derived nearly all the gold from the Tokatea. The cross-reefs on the hanging-wall side have proved profitless.

The Success Mine is further to the south, but still on the foot-wall side of the Big reef. Its reefs are patchy in nature, and have yielded good returns.

The New Four-in-Hand, in the Waikoromiko district, is a mine of considerable promise, and has yielded a good deal of gold in the past. This district presents great possibilities for future prospecting.

From the foregoing it will be admitted, even by the most sceptical, that the possibilities of the field are great, and there is no reason to doubt but that the abandoned mine of to-day is the dividend-paying mine of the future.

HAURAKI WARDEN'S DISTRICT.

By Warden Bush.

Gold-mining in the Hauraki district is really in its infancy, very little mining below 500 ft. to 600 ft. having been done. Many portions of the goldfields have not even been prospected, although taken up as mining claims at times when rushes are on, to be dropped again shortly afterwards, as the holders could not work the ground for want of capital. Large areas were taken up and held for purely speculative purposes, in the hope that some one might be induced to put money into them. There are many abandoned claims about in which more or less gold has been obtained, but as the run of gold ran out the owners, not having means to carry on development-works, had to abandon the claims. These, no doubt, will again be sought after in course of time, and may then become fairly good properties.

Minerals other than Gold and Silver.

On the Hauraki goldfields other minerals besides gold and silver have from time to time been discovered, but none have been handled on a sufficiently large-enough scale to prove whether they will recompense extensive development. The want of means is mainly the cause of this, very little beyond proving their existence having been so far undertaken. The minerals referred to are cinnabar, manganese, copper, fullers' earth, and hæmatite. The latter is the only one that has been worked to any extent. Opals have also been found, but the want of means on the part of the discoverers has prevented the value of the find being ascertained. No doubt, in the no-distant future persons will be found to provide capital to thoroughly test these areas where these minerals are known to exist. Should this be done it is possible some of the ventures may prove profitable.

Cliffs of Wilsonite, Ohinemuri Valley, near Victoria Battery, Waikino.

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Opals. — Two mineral licenses to search for opals were issued, both on Block III, Tairua Survey District, but nothing beyond the fact of eliciting that opals existed was done on the areas taken up.

Manganese and Copper.—A mineral license to search for manganese and copper was taken out for a piece of ground in the parish of Otau, Block XIV, Wairoa Survey District. This area is still being worked, but with what result is not ascertainable. The ground has never been protected since it was taken up in the year 1900, and as the rents have been paid up at fairly regular intervals it may be presumed that the owners have some inducement, from indications known, for retaining possession of the ground.

Hæmatite.—Some thirty years ago a miner found crude hæmatite-ore in seams of various thickness at Thames, and started roasting it in a very primitive fashion, but for want of means he eventually gave up the task of trying to do something with it. Later on others made an attempt to work it, which led to its being taken up by a party, and a company was subsequently formed to work it. The hæmatite has for some years been worked by the New Zealand Varnish and Paint Manufacturing Company (Limited), Thames. This company employs about ten hands, and manufactures about 2 tons of hæmatite weekly. At the present time the crude hæmatite is obtained from the 250 ft. and 400 ft. levels of the Kuranui-Caledonian Mine; the ore, however, is obtainable in many other mines at the Thames. This is an industry well worthy the attention of investors, as very large quantities of oxide of iron are procurable in the mines here. The Varnish and Paint Company does not confine its operations to the production of hæmatite alone, as it also manufactures some 50 gallons of varnish weekly.

Fullers' Earth.—A mineral license for 30 acres has recently been taken up at Tararu for the purpose of mining for cimolite. Several lodes, varying from 1 ft. 6 in. to 16 ft., containing about 80 per cent. of mineral, have been found. The crude ore, it is claimed, is worth from £5 10s. to £11 per ton, and when refined and boxed it fetches 6d. per pound. The proprietors intend refining and boxing it here in 2 oz. and 8 oz. boxes. The big lode, 16 ft. thick, has been traced for 300 ft. Six hundredweight of this earth was sent to Lever Bros., soap-manufacturers, Sydney, who have requested to be supplied with more. This bids fair to become a thriving industry in the no-distant future, as the refined commodity is much in use all over the world. Probably there are other deposits in the vicinity, which only require to be searched for to be discovered.

Quicksilver.—At or near Ohaeawai, in the Bay of Islands, an attempt was made some years ago to work the quicksilver-deposits by an English syndicate, but the large volumes of sulphuretted-hydrogen gas and the intense heat of the ground, coupled with the limited extent of the deposits, led to the abandonment of operations. The hot springs, better known as Tuwhakino and Ngawha, around which the various quicksilver-deposits are clustered, lie about two miles to the south-east of Lake Omapere, which is situate at the foot of Putahi, an extinct volcano. (See paper by A. P. Griffiths, who conducted the prospecting operations and retorting of the quicksilver for the syndicate, in *New Zealand Mines Record*, Vol. ii, 16th March, 1899.)

Cinnabar.—Ninety-four acres up the Kauaeranga Valley are held under license to search for cinnabar, which is known to exist there. The area is on Block V, Thames Survey District. This ground has been continuously held by various parties since 1898, but the want of capital to develop it has prevented the extent of the deposit being ascertained. Cinnabar appears to be distributed over this area in several places, but no well-defined lode has yet been discovered outcropping near the surface. There are, however, very good indications for the finding of a lode or an occurrence of cinnabar here sufficient to warrant systematic prospecting. Could a well-defined lode or an occurrence be found which would yield from 1 to 2 per cent. of mercury it would pay handsomely.

TAURANGA WARDEN'S DISTRICT.

By Warden Roberts.

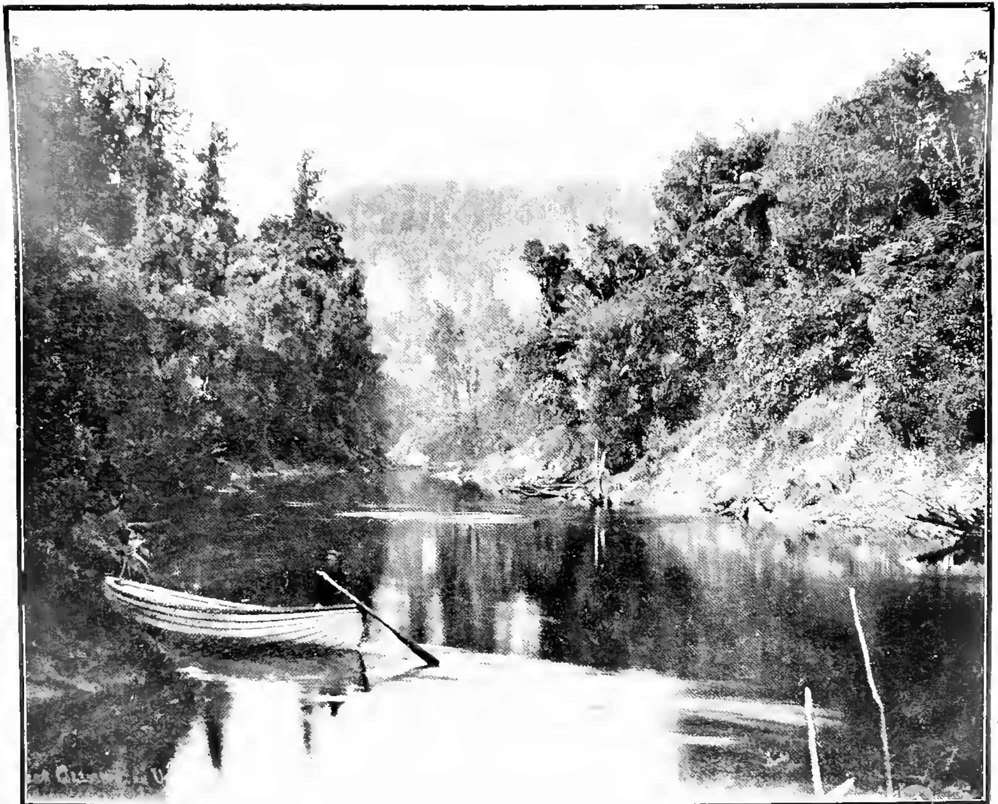
The Te Puke Goldfield has received a good deal of attention in the way of prospecting during the last ten or twelve years. It is situate in the main range running through the country from Waihi, and offers great inducements for capitalists and mining men to exploit it.

In the Mines Reports for 1898 there is an exhaustive report on Te Puke Goldfield from the Government Geologist, Mr. Alexander McKay, F.G.S., who, accompanied by Mr. James Coutts, Inspector of Mines, paid a visit of inspection to the district. In his report Mr. McKay states that the stone generally resembles that of the Waihi Mine.

In 1901 the Thames School of Mines reported on some Te Puke ore sent for treatment, that 560 lb. of soft, flaky, white quartz averaged by pan-amalgamation £26 9s. 10d. per ton, the percentage saved being 75·6; by the cyanide process a parcel of 4,640 lb. of the same class of quartz was treated, returning an average value of £42 9s., the percentage saved being 96·3. Another parcel of similar stone, 6,800 lb. weight, yielded at the rate of £29 4s. 8d. per ton, the percentage saved being 97·7. These, of course, were picked lots of stone, but they prove beyond doubt that the ore-body is a highly auriferous one.

The Te Puke Mine is a freehold of 1,100 acres, and to the north there is a large area of auriferous country, also freehold. To the west and south there is a considerable stretch of Crown land that seems equally promising if properly prospected. Mr. E. J. Dunn, Government Geologist, Victoria, reporting on the Te Puke Mine in 1902, states, "The enormous reef at Te Puke has a marked resemblance, both in the character of the stone and the manner in which it projects above the general surface, to the Martha Reef at Waihi." At Te Puke Mine exceptionally favourable conditions exist for mining on a large scale and at a cheap rate. Mr. Dunn winds up by stating, "In the whole course of my experience I have not met with a gold property offering greater inducements than this does for vigorous and extensive development." Mr. John Hicks, mine-manager, who inspected the Te Puke Mine for Home capitalists, states, "The reef on the top level is over 60 ft. across, and averages £2 17s. 6d. per ton. The ore could be mined and treated for 15s. per ton, and the ore-reserves can be worked by adit for a depth of 450 ft.," and adds, "As soon as a battery is erected crushing operations with payable results could be carried out." Mr. Andrew Gordon French, mining engineer and metallurgist, reporting on the Te Puke Mine in 1901, fully confirms both the above reports, and adds, "There are striking features of similarity to the great Mount Morgan, in Queensland." Mr. French made exhaustive tests of the value of Te Puke ore, and fully confirms Mr. Hicks's estimate.

Several attempts have been made without avail to get the introduction of the necessary capital to work this reef. So far success has not attended these efforts, owing to unforeseen and fortuitous circumstances, and the field is at present lying idle and languishing for the want of capital. Judging by the favourable reports referred to, there is no doubt that, should the necessary capital be forthcoming to prospect this portion of the Hauraki Mining District, there is every likelihood of it eventually developing into a profitable goldfield.



First Glimpse of Upper Mokau Mines.

THE MOKAU DISTRICT, TARANAKI.

By A. Weller, Journalist, New Plymouth.

Taranaki is often called "the Garden of New Zealand," and, presuming that the chief characteristics of a garden are its beauty and productiveness, Mokau is certainly deserving of premier position in this favoured province. By sea it is thirty-five miles northwards from New Plymouth and twenty miles from Waitara. The river, which gives its name to the district, flows into the Tasman Sea between Waitara and Kawhia, and has at its mouth a bar, which is covered at spring tides by 13 ft. of water, and, except in exceptionally rough weather, vessels of 80 to 90 tons can easily negotiate the entrance to the port, the rise and fall of the tide being about 10 ft. On the south head (which is a high cliff) is a signal-station with lights; a new wharf has lately been erected on the north side of the river adjacent to the township, which stands on high ground, and contains the usual accommodation-houses, stores, &c., a Maori settlement occupying the lower ground near the river, which in its tortuous course flows mostly between high perpendicular cliffs covered with dense vegetation, presenting scenes of majestic grandeur and surpassing beauty. For twenty-four miles the river is tidal: beyond this, for thirty or forty miles, it is navigable by canoes; then the Waireri Falls present an obstacle to further progress. It was a recommendation of the Scenery Preservation Commission that the rougher portions of the river-frontages, as well as the exceptionally fine reaches, should be reserved for all time, and, though this has not yet been done, there is little doubt that ere long the necessary steps will be taken to prevent the hand of the destroyer from ruthlessly effacing some of the grandest river and forest scenery in the colony.

Mokau is accessible both by land and sea. The two vessels trading there at present use Waitara as a port of departure, and there is a fairly regular weekly service between the two ports. By road the distance from New Plymouth to the ferry is 58½ miles. In the summer months, when the roads are dry, it is a very pleasant trip by land, and some exceptionally fine scenery *en route* well repays the time spent on the journey, accommodation-houses being met with at convenient stages of the route. During the wet weather of winter visitors to Mokau would do better to proceed thither by sea—a short and safe journey for which the steamers are suitably equipped, and passengers well catered for.

In addition to its utility as a means of transport and its charm for scenic beauty, the river possesses enormous potentialities for the generation of electricity. Possibly the time may come when this force may be turned to good account as the motive power for a light railway that is greatly needed to develop the district. At all events, this valuable asset exists, and is only waiting for orders to carry out its destiny.

Milling-timber.

It is estimated that the Mokau Valley contains at least 5,700 acres of good milling-timber, or about 17,000,000 ft., the Mohakatino Block alone containing about one-half of the quantity mentioned.

The Land.

The best soil is naturally found on the river flats, where some of the richest land in Taranaki exists. The district as a whole is all fit for settlement, either agricultural or pastoral, though some of the rougher portions would require to be cut up into large holdings, and, above the mines, roading would be a matter of difficulty. The undulating and flat portions of this country are well adapted for dairying, the climate being particularly favourable for stock.

On the southern side of the river is to be found the Mokau-Mohakatino Block, of 56,000 acres, the subject of so much litigation by Mr. Joshua Jones. As a strong effort is being made to induce the Crown to acquire this land for closer settlement, a brief description of the block may be interesting. One-fourth of this land is very rough, though available for sheep. A similar quantity is considered suitable for subdivision into sections of 200 to 500 acres for farming or dairying (worth, when roaded, from 12s. 6d. to £1 15s. per acre), the remaining half being only fit for large areas up to 2,000 acres, at a minimum price of 10s. an acre. The highest point (1,740 ft.) is to be found at the south-east corner. The block is well sheltered, and contains large coal-deposits.

On the north side of the river, stretching as far as Totoro, there are about 36,000 acres, making altogether in the Mokau district some 100,000 acres of land. Probably another 100,000 acres are contained in the Awakino country, which lies to the north, and uses Mokau as its port of shipment for wool and other produce. As a whole, the land may be described as good, though there is a considerable quantity of broken country. The soil is largely of limestone formation—a very great point in stock-rearing—some fireclay, and what appears to be either white marble or a quartz outcrop, being met with.

Coal.

On both sides of the river coal is to be found in abundance. That on the south side has, up to the present, only been the subject of very primitive operations. There are, however, plenty of outcrops, the seams being from 3 ft. to 5 ft. thick in the Mokau-Mohakatino Block, where the coal has a dip from the river of 1 in 20 to 1 in 30, but in all probability cannot be worked as profitably as on the northern side.

Thirteen miles and a half from the bar, on the north bank of the river, is the Manga-Awakino Block No. 1, of 4,700 acres, which has been acquired by the Taranaki Iron Syndicate for the coal and limestone it contains. There are seven largs seams of coal outcropping at a short distance from the river, which at this part is deep and easily worked by steamers. As an integral part of the scheme for developing the ironsand industry this block is extremely valuable, especially as there is a good quantity of red and white pine and matai, while the land is excellently adapted for stock-raising as well as dairying.

The only sustained effort in colliery-work in this district is at the Mangapapa Mine, the area of this holding, which is on the north side of the river, being 13,000 acres. This mine, which is now held on a long lease by Mr. George H. Stubbs, of Waitara, has its entrance only 50 yards from the river-bank at a point twenty-three miles from the heads. At the wharf the depth of water suffices for vessels drawing 8 ft. Apparently the coal underlies the whole area of the property, and far beyond. The seam now being worked has proved to be far superior to any previous output from the mine. It is about 7 ft. 8 in. thick, separated in the middle by impure beds of fireclay, and has an easy gradient (thus keeping the mine dry), enabling the coal to be run out by gravitation, while the sandstone roof reduces the usual timbering to a minimum. The output can either be discharged direct into the hold of steamers or tipped into the bunkers erected on the bank of the river, thus enabling vessels to be loaded with great despatch. For the last few years the output has been small owing to difficulties of transport, but latterly these have been overcome, satisfactory arrangements having been made for the carriage and distribution of the coal. Two steamers, carrying 40 and 80 tons respectively, are now regularly engaged in the work. This service, however, only suffices for local requirements, but it is anticipated that in the near future, when the bar at the entrance to the river has been improved and the river itself cleared of snags, larger steamers will be employed and the business greatly increased. The coal is very popular for household use, also for steam purposes where large boilers are used.

In describing this coal Dr. Robertson, M.E., F.G.S., the well-known mining engineer of Sydney, classes the upper seam as superior lignite, and the lower as bright bituminous coal of superior quality, both igniting easily, giving off little gas, burning with a bright flame, and leaving a very small amount

Coal-mining at Mokau: Bayly and Ogle's Mine and Shoots.

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of white pulverulent ash. He considers that the quantity is practically inexhaustible, and that the conditions are probably more favourable for easy and profitable working than in any colliery he had seen in the Australasian Colonies. Other experts, such as Messrs. G. J. Snellus, F.R.S., R. Price Williams, and Professor Stevenson MacAdam (Edinburgh), have reported favourably of this coal, and classed it with the better English and Scotch coals.

As to the mine itself, the Mining Commission, when reporting in 1900, regarded it as being the safest, and its natural conditions more favourable for working, than any mine they had seen.

The Mokau as a Tourist Resort.

The surpassing beauty of the virgin forest which covers the surface of the land in this district should make it a favourite resort for tourists. With a good soil, supplemented by an abundant rainfall, its settlement should add materially to the welfare of the colony, while beneath the surface there lies a wealth of mineral fuel which has yet to be thoroughly exploited. Mokau is unique in possessing these manifold attractions, and has a future that may well be envied by any less favoured district. It is rare, indeed, that there is to be found in one area such a combination of valuable assets as those mentioned above.

MARLBOROUGH MINING DISTRICT.

Gold was first discovered in Marlborough in 1860, but the goldfield was not proclaimed for three or four years afterwards. Iron was found in 1870, antimony in 1876, and coal in 1880. There are also indications of lead, silver, and copper. The Wakamarina was, for its size, one of the richest goldfields in the colony. Miners were attracted to it from all parts of New Zealand, and many came from the Australian Colonies. In June, 1864, the "City of Hobart," "Otago," and "Albion" shipped from Picton 3,393 oz. of gold; in July the "Auckland" took away 2,256 oz.; and in September the "Claud Hamilton" shipped 961 oz. These shipments do not by any means represent the quantity of gold which was got during that short period, as many of the miners went to Wellington and other places, taking their gold with them. In 1864 the total export was stated at 24,838 oz., valued at nearly £100,000; and in 1865 about 8,000 oz., valued at over £30,000. As the alluvial ground got worked out, the miners gradually drifted away to the West Coast and other fields; but some enterprising men remained in the district. The Ravenscliff Company, which started work in 1883 with a 12-horse power portable engine, a set of water-elevators, an undershot water-wheel, and two Californian pumps, constructed a flood-race 500 ft. in length, and a dam 65 ft. in length by 12 ft. in depth, with the view of controlling the waters of the Wakamarina, in order to work the river-bed below it. Mr. M. Leahy spent three years in cutting a tailrace 550 ft. in length, on which he expended £400, his yield of gold during that time being only 12 oz. Other parties have also expended capital and labour in endeavouring to get at the deeper ground. There is a large area of rough, bush-covered mountains and gullies, showing fair indications of auriferous reefs and alluvial country; but it cannot be properly prospected until tracks are opened up. Gold-bearing quartz-specimens have been picked up in several watercourses, and alluvial gold has been found in nearly every gully on both sides of the high ranges which divide the Wakamarina from the Wairau Valley.

There are indications of lead, silver, copper, and scheelite in different parts of Marlborough, and some residents have looked forward to the possible discovery of precious stones.

Auriferous quartz was found some years ago at Top Valley; several claims were pegged off, and reduction-works were erected by the Jubilee Company. So far the results have not justified anticipations. During the year 1903, 1,704 tons of quartz gave a yield of 548 oz., and 1,100 tons of tailings treated by the cyanide process produced 72 oz. of gold, the total value being £2,118 17s. 3d. It was then estimated that a tunnel would require to be driven a distance of 1,200 ft. in order to render available 500 ft. to 600 ft. of backs. This mine has been let on tribute for some time past. Scheelite is found in association with portions of the auriferous lode, and some of it is stated to be of high quality. Recently the tributers sent 3 tons of this mineral to Wellington, where it was disposed of at a rather low rate, considering the prices ruling in London and Hamburg. Scheelite is valuable for the tungstic acid it contains, and is used in hardening the metal for large guns.

The King Solomon Mine, Cullensville, is owned by a private syndicate, Messrs. R. Cragg, A. Jonson, and E. Knutson (secretary), who hold a freehold lease from W. J. Cullen, of Cullensville. Comprised in this lease are the Golden Gate, King Solomon, Alice Fell, and Hibernian Claims, which extend in a continuous line along the Cullensville Creek for a distance of 3,600 ft. The two latter claims were worked to very considerable profit previous to flooding. With the object of following the continuation of the rich auriferous drifts, which form a river-bed deposit of prehistoric age, the King Solomon shaft was sunk and equipped with pumps to a depth of 90 ft. Having thus completed sinking operations, driving was commenced dipwards on a rich lead, which yielded £750 from the ground taken out from the last set of timber previous to the collapse of the shaft. Stimulated by this rich find, the Golden Gate shaft was sunk and equipped with pumps to a depth of 120 ft. On commencing operations from the bottom of this shaft driving was extended riseward with varied success, but before a holing was effected with the King Solomon shaft the pumps were replaced and the workings unwatered. This connection led to a still greater inflow of water, which the pumps in use were not able to cope with.

Dredging has been tried at Wakamarina, but the results obtained were not commensurate with the outlay.

About twenty-five years ago the Endeavour Inlet Antimony Company secured a lease of 500 acres of ground for a period of thirty years, between the head of Endeavour Inlet and Port Gore, with the view of working the antimony-lodes that were known to exist in that locality. The antimony was first discovered in loose, detached blocks on the side of the range facing Queen Charlotte Sound, and also in the beds of the creeks and watercourses coming out of the range; and a lode was afterwards discovered running in a northerly and southerly direction across the range from the head of the Inlet towards Port Gore. This lode has been worked near the top of the range, which is 1,600 ft. above sea-level. About 3,000 tons of ore was taken from this lode, some of the best of which was sent to England, and realised in its raw state £10 per ton. A tunnel was constructed through the range 275 ft. below the level of the crown, and the lode from this to the surface was nearly all stoped out. The ore near the crown of the range, and also for a certain distance in from the side, occurred in the form of valentinite; but towards the centre of the range, and for about 100 ft. above the level of the tunnel, the ore was in the form of stibnite. This tunnel carried the lode right through the hill, and by continuing further along the range the lode was proved along its lateral course, or strike, for over 1,000 ft. At this level, where the lode was left underfoot, it was found to be getting into settled country, and the valentinite in the lode was to a great extent replaced by rich stibnite ore. The company opened a drive 175 ft.

Clarendon Rock-phosphate Deposits: Stacks of Rock-phosphate at the Burning-ground.

Mining Handbook.

lower down the range, and reached the lode which, at the point of intersection, showed very rich ore. Reduction-works were erected at Endeavour Inlet, trained men were brought from England, and star antimony of excellent quality was produced for some time; but there was a considerable fall in the price of antimony afterwards, and that, coupled with the broken character of the lodes, led to the abandonment of the mine.

At Jackson's Head, close to the company's workings, a reef was found containing gold and antimony, and gold to the value of £8,000 was said to have been taken from it, though there was very little work of a systematic character done. A tramway was constructed by the company from the tunnel down the side of the range to the flat near the head of Endeavour Inlet, where the dressing machinery and smelting-works were erected. In bringing this tramway down the range, which is very steep, there were three separate inclines, each of which was worked by a brake constructed with two pulleys working vertically and one horizontally. The full truck going down brought up the empty one, the speed of the trucks being regulated by a double-hand brake, which was worked with a long lever.

Cement-works have been started near Picton, and the quality of the cement is said to be equal to Portland and other imported cements. Recently an order was received for 1,000 tons for shipment to San Francisco, and it is believed that other large orders will follow.

THE NELSON GOLDFIELDS.

NELSON WARDEN'S DISTRICT.

By Warden Eyre-Kenny.

The Warden's District of Nelson, which includes the Counties of Waimea, Takaka, and Collingwood, furnishes an apt illustration of the surprising vicissitudes attending gold-mining, and indeed mining in general. Gold was first found in the Nelson District at the Moutere and along the shores of Massacre Bay (now called Golden Bay) almost simultaneously with the discoveries at Coromandel in 1853, but it was not till 1856 that the discovery of gold at the Aorere gave mining a start in the Nelson Provincial District. Mr. John Ellis and Mr. John James claimed to have been the first to find a payable goldfield, but their pretensions were disputed, and it was some time before the merits of the discovery were set at rest. The Gold-bonus Committee of Nelson, which had offered a bonus for the discovery of a payable goldfield, appointed referees, who after taking evidence decided that Messrs. Ellis and James were the discoverers, but that the credit of developing the goldfields belonged to Mr. G. W. Lightband. Many persons were, however, satisfied that Mr. Hough's services deserved equal recognition, and they presented him with a substantial testimonial.

Although far and away the most important mining operations have been, and are, carried on in Golden Bay, the Wangapeka portion of the Nelson District—which comprised the valleys drained by the Wangapeka and its tributaries, the Rolling River and Sherry, and the Tadmor and Baton Valleys lying on either side of the Wangapeka River—was of note in its day. This locality is now mainly occupied by small farmers, some of whom occasionally put in their spare time at mining. The more easily worked parts of the field have been exhausted, and long water-races and tail-races are now necessary. Some six or seven miners only are at present working here, and none of them are earning more than a living-wage, while the dredge on the Wangapeka is idle. But the country is known to be auriferous, and energetic explorations would doubtless lead to satisfactory results. The construction of the Midland Railway, however, which passes through this subdistrict, by attracting surplus labour at good wages, has had the effect of keeping some men from prospecting who might otherwise have engaged in that enterprise. In the years 1857 to 1859 there were at times over a thousand men mining in Golden Bay—mainly on the Aorere and in its vicinity. These men were all making good wages, whilst some won small fortunes. According to the Nelson *Examiner*, from April, 1857, to May, 1858, no less a sum than £70,000 was obtained in the Nelson goldfields, mainly in Golden Bay, and new houses, stores, and tents were to be seen in all directions. Diggers were constantly coming and going, and Collingwood especially looked very busy. But a change came in 1859. The population and yield of gold steadily dwindled down, and up to the present Golden Bay has not regained its former prosperity. The Statement of the Minister of Mines, made in the House of Representatives in 1905, showed that twenty miners only were employed in the County of Takaka and 149 in the County of Collingwood, apart from those engaged in collieries. Nevertheless, there are still large tracts of auriferous country which have scarcely been tested, and in the opinion of expert miners quite as rich patches yet remain to be worked as those which gave employment to such a large number of men in 1857, 1858, and 1859. It is greatly to be desired that prospecting parties should be organized to prospect the Quartz Ranges, the Gouland Downs, the Heaphy, and other likely localities. This need is now being supplied in Takaka, where the Anatoki Prospecting Syndicate has engaged the services of Mr. C. E. Storie, a mining engineer and geologist of considerable experience. I am indebted to this gentleman for a report of his operations, which so far have been confined to that portion from the Takaka Valley on the one hand to Snow's River and Boulder Lake on the other.

The impressions gleaned from the structure of the Takaka Valley as far south as Mount Hoary Head were not of a character to justify further operations in that quarter. The rock-structure consists of limestone, granite, schists, and sandstone rocks. What was represented as being a large quartz-body turned out to be, on inspection, a coarsely crystalline metamorphic rock, which is referred to locally as "marble."

The Waituhi Mountains were next investigated, but with unsatisfactory results. The Waingaro River and Devil's River were not examined. Mr. Storie then proceeded through the Anatoki Valley as far as the "Forks," and from there up Dry Creek to the saddle overlooking Snowdon. The country passed through in this section was much more promising, and several reefs occur, some of which are auriferous. Above the "Forks" a fair amount of gold is being won from the river-bed. Mr. Storie saw about 26 oz. taken at one clean-up.

Mr. Storie made a further careful examination of the area from Snow's River to the Boulder Lake, and found values in this portion which induced him to apply for a prospecting license.

The head-waters of the Anatoki, Slate, Snow, Rocky, and Boulder Rivers were examined, and there is satisfactory evidence of value in both quartz and alluvial in these places.

The Aorere watershed on the western side, beyond Mount Olympus and Lead Hill, was casually examined, but not sufficiently in detail to justify a report.

The principal difficulty in this district is the want of suitable tracks, and whilst this drawback remains very little legitimate prospecting can be done. The local miners consider that the Anatoki River, at the head, would probably support two hundred men if a horse-track was made so that the miners could get their food by pack-horses. At present it takes two days to get supplies on the ground from Takaka, as the men have to carry their food several miles through the bush and up the mountain on their backs. It is understood that the local body will soon be in a position to expend a Government grant for this purpose. Mr. Langridge, storekeeper, had a short time ago some really splendid samples of gold from the Upper Anatoki.

Hydraulic Sluicing, Ross, Westland.

But it must not be supposed that gold-mining is dead in the region of Golden Bay. The value of gold entered for exportation for the year ending the 31st December, 1905, reached the substantial figure of £25,862. This includes a small quantity of gold from the County of Waimea. The price of gold per ounce in the Nelson District is as follows: Collingwood, £3 13s. 6d. to £4 1s.; Takaka, £3 14s. 6d.

This appears to be a convenient place to refer in detail to some of the more prominent mining privileges which are still in existence in Golden Bay.

At Bubu, in Takaka County, the Takaka Hydraulic and Elevating Company is getting payable gold. For the year ending December, 1905, three dividends were paid to the shareholders of 1s. per scrip in each instance. The part of the ground the company is now working is only 8 ft. deep, showing gold freely. On the 29th March, 1901, this company applied for, and was granted, a right to divert fifty heads of water from the Anatoki River, above the big bend of the Bubu, to sluice the territory between the Anatoki and Bubu Rivers. There are the best reasons for supposing that the ground which this water commands is payable. The company was fortunate in obtaining the services of a capable man, Mr. Charles Campbell, as manager, and by the judicious utilisation of water this property, which had been worked for years by hand-labour, making small wages only, has become a really satisfactory concern. The claim is a very inexpensive one, employing only ten men all told. The men work three shifts of eight hours each. In the refuse, after washing-up, a considerable quantity of garnets and rubies is found, too small, however, to be of commercial value.

The West Wanganui portion of the goldfield is about twenty-eight miles north-west by road from Collingwood. There is also communication by sea, and vessels drawing 12 ft. of water may enter the inlet with safety at high-water spring tides. Gold was found here in 1868; the quality was good, and there were some alluvial workings. Extensive operations were ultimately undertaken by the Taitapu Gold Estates Company. The area of land held by this company is 79,000 acres. A large amount of development-work has been done by the parent company and by the present company, and when quartz is found, as a rule, values are good; but the lode has been so much distributed that it makes it very hard for the management to keep the quartz clean.

The Golden Blocks (Taitapu), held by a subsidiary company in this locality, is the most consistent claim as regards the gold-yield of any concern in the district, and during the year 1905 no less than 2,320 oz. 10 dwt. of gold has been obtained from 1,950 tons of stone treated. The reef, however, is more or less patchy, and during the last few months the returns have been below the average, but the company's manager, Mr. Giles, is confident that the next clean-up will show a considerable improvement.*

Leaving West Wanganui and coming to Collingwood proper, a considerable amount of prospecting-work has been done during the last six months at the old Johnston's United Gold-mining Company's mine at Bedstead Gully, which is held under application by Mr. Charles Y. Fell pending completion of survey, and hopes are entertained that the rich reef will again be struck.

The Parapara Hydraulic Sluicing and Mining Company is the holder of several special alluvial claims, but of late labour has been concentrated on sluicing operations at the Hit-or-Miss Saddle, and the returns have been fairly encouraging. The ground is heavy and rough; the gold-bearing wash underlies hills of considerable height, so that as the wash is removed enormous slips from the hillsides occur, bringing down large quantities of shattered rock, which has to be broken up and stacked or sluiced away. The gold-bearing wash at this face is now, however, almost exhausted, and the company is proceeding to work its freehold property, known as Appo's Flat (so termed after a Cingalese who first got gold there). A contract has been let to drive a tunnel 620 ft. long through rock. This tunnel is only being driven from one end, and will therefore take some months to complete. When finished it will serve as a tail-race, through which the whole of the surface or upper portion of Appo's Flat will be sluiced down

* Clean-up on 23rd July. 1906, gave 188 oz. of gold from 155 tons of quartz crushed.

to a depth of 25 ft., below which depth elevating will have to be resorted to. The ground on Appo's Flat is very deep, and it should be the means of providing years of profitable work. This company's claim is generally regarded as a promising property. About an acre at the upper end of this flat was worked in the early days of the goldfield by the primitive methods then in use, and it gave good returns. The quantity of gold won by this company for the year 1905 was 769 oz. 2 dwt. 19 gr., valued at £2,985, making a total of 8,087 oz., value £31,088.

The Slate River Sluicing Company's operations have been for some time considerably hampered by shortness of water, and steps have now been taken to augment the supply, passing it into the company's big dam at Toi-toi Flat for storage purposes. A license for a dam in Bedstead Gully has been obtained, and also a license for a water-race commencing at the dam in Bedstead Gully and conveying the water to the big dam in Toi-toi Flat. With the increased water-supply available when the dam and water-race mentioned are completed the company should be able to carry on sluicing operations with much less broken time than hitherto. It is the manager's intention to cease work at the old face and to open up a fresh face at the claim formerly known as Nicholas's, where good prospects have been obtained. During the year 1905, 313 oz. of gold, valued at £1,179 10s., was won.

At the Quartz Ranges sluicing operations are being carried on by a party of tributers on the special claim held by Mr. C. Y. Fell, lately the property of the Collingwood Goldfields Company. This tribute party has command of a splendid water-supply, enabling operations to be carried on throughout the whole year. The quantity of gold actually taken from this claim during 1905 was 194 oz., valued at £769. This however, does not represent more than seven or eight months' working. It is confidently expected that the next run will prove highly payable, as the ground to be attacked is known to be rich.

The Slate River Gold-dredging Company is defunct. On the 12th January, 1906, the shareholders passed an extraordinary resolution to wind up the company voluntarily. The dredge produced 459 oz. of gold, valued at £1,659 15s., during its last year's working, the cost of carrying on the operations of the company for that period being £1,804.

The river at the point at which this company's dredge has been engaged is narrow and confined between high banks. The dredge was therefore subjected to considerable danger of being carried away in times of flood, and it was on two occasions actually left stranded on heaps of tailings over which it had floated during flood. The working of the dredge was also rendered difficult by the rocky nature of the bed of the river. It is important to note that owing to these and similar causes the failure of no less than four dredging companies has been brought about in this portion of the district.

Before quitting finally the subject of gold-mining, it may be interesting to state that an aggregate area of 680 acres of land is held under gold-mining license in various parts of Golden Bay, over some of which alluvial mining is carried on, and from which, taking it as a whole, fairly good returns are being obtained.

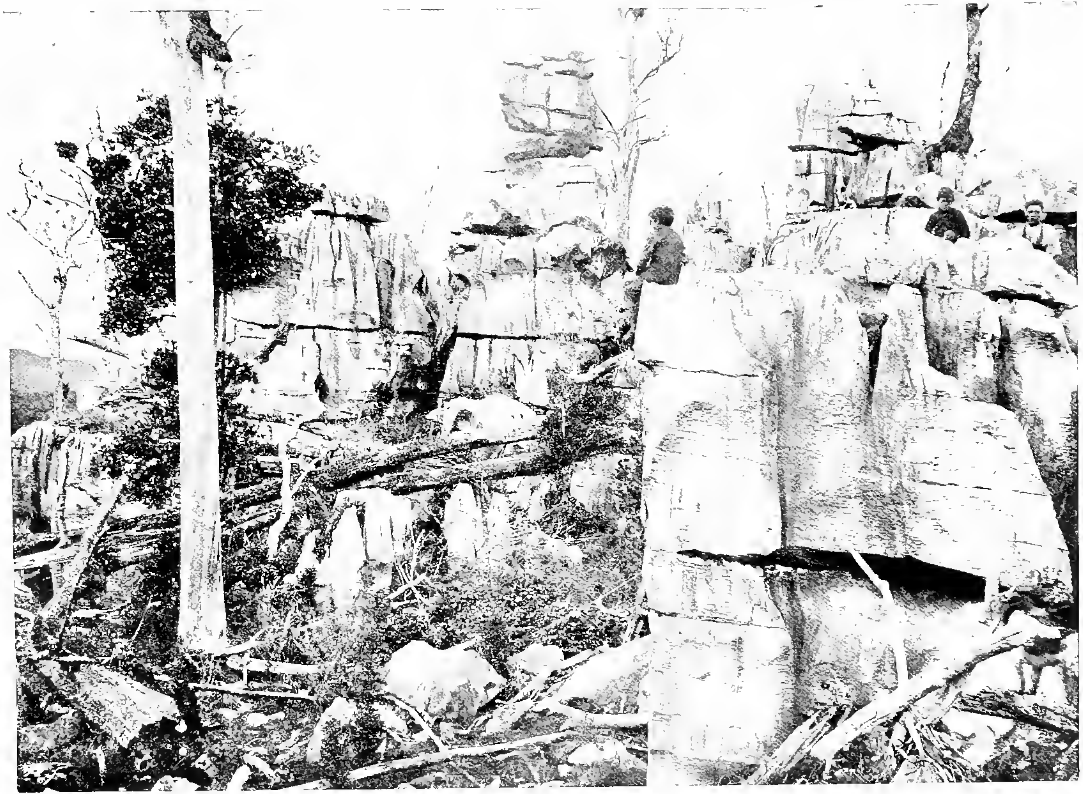
Plumbago and Cement.

There is every indication of the existence of plumbago in considerable quantities on the Pakawau side of the Aorere River. Samples that have been obtained are undoubtedly of high value.

At the present time Mr. French is working cement-machinery at Motupipi, near Takaka. The machinery was started in the latter part of the month of April, 1906. Mr. French is well satisfied that cement can be profitably manufactured from the materials at Motupipi, and he has put a large amount of capital into the venture.

Silver-lead Ores.

Silver-lead ores are found in the Mount Owen district, and they presumably extend into the Rolling River, on the northern fall of Mount Owen, as numerous boulders of silver-lead ores have been found by sluicers in the Rolling River, and their contents have been assayed to over 300 oz. of silver to the ton. Very little, however, is known of these deposits,



Sub-crystalline Rocks overlying the Coal-measures at Hikurangi, near Whangarei.

but the opening-up of the railway and roads in this direction will render the country more accessible and facilitate prospecting in this locality.

Coal-mining.

We now come to the all-important subject of coal. A coal of excellent quality for domestic and steaming purposes is found in the Collingwood subdistrict. The Puponga Coal- and Gold-mining Company of New Zealand (Limited) is the holder of a valuable coal-mining property, containing 1,017 acres, situated in the Onetaua Survey District, from which the output of coal for the year ending the 31st December, 1905, was 20,155 tons; but the difficulty occasioned by the shallowness of the water at the company's wharf in getting the coal shipped adds seriously to the cost, and prevents the coal from taking a still better place in the markets of the colony. This, however, is a matter that the company intends to remedy. When better facilities for shipping are obtained, and vessels of larger tonnage can be safely employed, the average freight will be greatly reduced and access to the best markets in the colony obtained. The mine-workings at the Puponga Mine steadily progressed during the year 1905 to the north, or dip, of the coalfield, and are opening up well towards the east. On the west side a band of fireclay in the centre of the field until lately gave some trouble, but the thickening of the lower seam of excellent coal, together with the thinning of the band of stone between the two which formed the floor of the main seam, will enable the two to be worked together, and puts a very promising aspect on that part of the field, where otherwise some considerable driving in stone could hardly have been avoided. A larger pump than that now in use is being obtained, and another 40-horse-power boiler has been ordered. When these have been installed the main dip road will again be pushed ahead and further bands broken off, where, in view of recent developments, there is promise of an excellent field of coal. A Hayes fan has been fitted up, and is working smoothly and well, providing an ample current of air throughout all the workings. The screens have lately been improved, so that a rounder class of house-coal is now procured; and a considerable extension of the nut-washing plant and new nut-bins are now on the point of completion. The nut-washing plant not only provides for the exclusion of small pieces of stone and brasses, but also runs off the fine coaly mud, and a larger size of nuts is insured. Altogether, the developments of this coalfield, particularly in view of the recent thickening of good coal in the bottom seam, have been very satisfactory.

Great hardship and inconvenience having been occasioned to the miners working on this property, owing to the difficulty experienced by them in securing ground for residence-sites, the Government has set apart a portion of the surface of the company's lease for business and residence sites respectively. The land has been surveyed and laid out into suitable allotments, reserves, and streets, so as to meet the public convenience, and the settlement, which has been named by the Survey Department the Village of Puponga, will be the means of providing the colliers with homes, instead of holding their residences on mere sufferance. The Survey Department has also laid out another small township near the wharf.

A good deal of prospecting for coal has been done lately in the vicinity of the West Wanganui Inlet, where the most cursory examination reveals seams of varying dimensions.

Coal-mining operations have been commenced at West Wanganui by Mr. G. B. Watson, of Dunedin, who during the last few months has acquired valuable leases and options over coal-bearing land, and, with the natural facilities that exist at West Wanganui for the shipping of coal from the property now being developed by him, large quantities of coal should soon be upon the market from this region.

The Pakawau Colliery (Section 7 of Block XII, Pakawau Survey District), lately purchased by Mr. E. G. Pilcher, of Wellington, representative in New Zealand of the Greymouth-Point Elizabeth Coal Company, is attracting the attention of the people in the district. Already a considerable amount of work has been done in developing the mine and preparing for a large output of coal.

Besides the valuable coal-bearing properties just mentioned, this district contains other coalfields, which, in the opinion of experts, will in time provide a means for the profitable investment of a large amount of capital and for the employment of many hundreds of workers.

Copper-mining in the Mineral Belt.

The Mineral Belt Copper-mining Company holds 1,200 acres of what is known as the "Mountain Mineral Belt." The Mineral Belt is a serpentinous formation, from half a mile to a mile in width, extending in an unbroken line from D'Urville Island, in the north-east, to Tophouse, in the south-west, over a length of ninety miles, and possibly, with breaks, to Big Bay, at the south-west end of the Middle Island. The Mineral Belt Copper-mining Company's property lies about four miles easterly in a direct line from the City of Nelson, but twenty-six miles distant by rail and road. The ore-deposits, so far as is known at present, occur chiefly along the western edge of the belt and not far from its contact with the rocks of the Maitai series. The company has opened out and extended old levels on the United Creek, and driven a new level on the ore-channel for several hundred feet. The ore found is a sulphide of copper, and it occurs in lens-shaped bodies within a definite channel. These bodies are of no great individual size, but they are numerous and of good grade. A level has been driven on ore for 80 ft., and it is in one place 12 ft. wide.

Further north of the United Creek other ore-deposits of a rich character exist. The Saddle Lode there is stated to carry, besides 5 per cent. of copper, from 4 dwt. to 8 dwt. of gold. Little work has, however, been done at this end of the property. At the south end the old Champion Copper Company mined rich native copper and sub-sulphide ores.

Mr. Thomas A. Turnbull, M.A.I.M.E., directed operations for the company from November, 1903, till December, 1905, and expended some £6,000 in prospecting and development-work. The present company has just sold its interest in the leases to a new company for £16,000, and from date (June, 1906) development-work is to be pushed on rapidly.

Iron-ore.

In close proximity to the coalfields are the extensive deposits of the rich iron-ore of the Parapara, the whole being surrounded by an abundant supply of the finest limestone. A lease of 920 acres at the Parapara has been secured by the Public Trustee, as trustee and executor of the estate of the late Sir Alfred Jerome Cadman, and the formation of a company in England with a view to working the iron-deposits is stated to be practically assured. This lease does not by any means exhaust the iron-deposits of the Parapara, and in the event of the Cadman Company being successful no doubt other leases will be taken up and worked, to the great advantage of the Township of Collingwood in particular and of the colony in general.

There is probably no richer district in New Zealand than the Counties of Takaka and Collingwood. A large amount of valuable timber is exported from both counties. Considerable portions of the County of Takaka are limestone country, eminently suitable for sheep-farming. At Clifton, near Waitapu, a most picturesque spot, bearing in many respects a curious resemblance to the beautiful surroundings of Whangarei, in the Far North, Mr. Ellis, who has a large sawmill, fitted with the very latest appliances, also keeps a large flock of Angora goats, which he finds a profitable investment. This enterprising settler manufactures New Zealand wine on a large scale, his cellars rarely containing less than over a thousand barrels and hogsheads. This wine, unlike some of the New Zealand-made wines, though possessing a fair alcoholic strength, is unfortified by the addition of spirits of wine.

The Township of Takaka is about fifty-three miles from Nelson by steamer, but it can be reached overland by a coach that runs twice a week, connecting with Newman Bros.' coach, which runs daily between Nelson and Motueka. The Town of Takaka, which is about three miles from its seaport, Waitapu, is a flourishing little place, containing several places of worship, a commodious Town Hall, and two good hotels. There is another excellent hotel at Waitapu.

The distance from Collingwood to Takaka by road is twenty miles; to Pakawau, eight miles; to Bedstead Gully, ten miles; to Rocky River, eighteen miles; to the Quartz Ranges, twenty miles; and to West Wanganui, twenty-eight miles. Collingwood itself is most picturesquely situated at the mouth of the Aorere River. In November, 1904, the township was almost entirely destroyed by fire, but it has been rebuilt with great improvements, and from a public point of view, as occasionally happens, the fire has proved a blessing in disguise. Two excellent new hotels have been erected since the fire, and a new post-office has just been opened. Like Takaka, Collingwood boasts of a weekly newspaper.

Collingwood is distant from Nelson by road about seventy-five miles; by sea the distance is greater, the voyage taking from eight to ten, or even twelve hours, according to the weather. The steamers "Lady Barkly" and "Wairoa" make on the average two trips each per week between Nelson and Collingwood, calling at Takaka on the way, and those who encounter rough weather on the voyage are able to realise what "going down to the sea" in little ships means. Having regard to the large passenger traffic between these places and Nelson, the time has certainly arrived when these obsolete steamers should be replaced by boats of a better class.

NELSON, KARAMEA, AND WEST COAST.

By Robert Tennent, Inspector of Mines, and Arthur H. Richards, Assistant Inspector, for Marlborough, Nelson, and West Coast.

Collingwood.

In 1856 John James and John Ellis claimed the Government bonus for the first gold-discovery in this district, and were also awarded the same by the Gold-bonus Committee.

Judge Kenny, of Nelson, is Warden for the Collingwood district, and Mr. Nalder is Receiver of Goldfields Revenue and Mining Registrar. The Warden's Court is held monthly.

Between Nelson and Collingwood there is a weekly overland mail-service, calling at all intermediate post-offices, and a daily service by steamer.

Now that the Ferntown and Rockville roads are bridged over the Aorere River, and the Salisbury Creek bridged on the road to the Quartz Ranges, connection between Collingwood and the coal and gold fields is practically assured under all conditions of weather.

On leaving Collingwood the road to West Wanganui *via* Ferntown is eight miles to Pakawau, thence westward through the Pakawau Bush and six miles up the Mud Flat to Mungarakau, near the head of the inlet, which was recently bridged and connection made with the partly formed tracks leading to the Golden Ridge. The West Wanganui goldfields, owned by the Taitapu Gold Estates (Limited), comprise 79,000 acres, and are situated some twenty-eight miles from Collingwood. Mr. N. L. Buchanan is resident attorney on the Patarau River.

In 1868, and for several years following, lucrative employment was found in the various streams which discharge into Lake Otuhie, and also into a branch of the sea between the sandhills and the Anatori River. At Malone's and Independent Creeks the alluvial was rich, resulting in some very large finds, but, the ground being limited, it was soon worked out.

In 1874, whilst the miners were working the auriferous cement underlying the coal-seam at Bedstead Gully, on the Slaty Creek, specimen gold in the alluvial drift led to the discovery of a quartz reef on Friday Creek. After a few months' operations with a five-stamp mill of most primitive design gold to the value of £3,000 was obtained, but what was at first taken to be a reef proved only a slip, and work was accordingly suspended for a time. Meantime, the Golden Blocks Company is carrying out an effective system of prospecting, with the view of proving the geological features of the auriferous belt at depth.

The Parapara Hydraulic Sluicing and Mining Company was registered on the 18th June, 1902, and in July of same year commenced work on an alluvial area containing 173 acres 1 rood 17 perches, situated on the Parapara River, Collingwood. The called-up capital amounts to £26,210. The mine is worked by thirteen men, covering three shifts. The material operated on consists of crushed quartz, mixed with gravels and large boulders, underlying a decomposed schist and clay formation, the whole face being sluiced to a total depth of 50 ft. to 150 ft. on a strongly cemented conglomerate (false) bottom. During 1905, of 3 acres of ground exhausted, 150,000 cubic yards of washdirt was sluiced and treated, at the rate of 3¼d. per cubic yard, for a yield of 1,118 oz., valued at £4,341 12s. 11d., and from a total of 35 acres worked the yield was 7,813 oz. 12 dwt., valued at £30,342 16s. 5d. (at the rate of £3 17s. 8d. per ounce). Water is supplied direct from the Parapara River over three miles of races, and from the penstock a mile and a half from the face. Two miles of pipeline are employed (diameters 30 in., 27 in., 24 in., and 18 in.), from which forty heads are delivered in wet weather through 13 in.-diameter service lines on three operative nozzles, under a head pressure of 300 ft. The gold is a fairly coarse sample, saved in tail-race boxes, laid with iron rails in longitudinal lengths, and laced in cross-sections with iron ripples. The tailings are deposited in the river-bed mud-flats. Mine-manager, James Bassett; secretary, Thomas J. C. Warren, Wellington.

Attention is now being directed to developing the deeper deposits of West's Freehold Flat, and with this end in view a drainage-tunnel is in progress, which, when completed, is calculated to effect drainage to a depth of 25 ft. The present proposal is to firstly exhaust the drained area, and finally instal elevators capable of lifting the auriferous deposits from a further depth of 60 ft. In carrying out this scheme on a comprehensive scale the management anticipate that the deeper gravels can be profitably worked to a depth of 80 ft., this depth being estimated to clear the marine bottom.

The Slate River Sluicing Company was registered in July, 1900, and in June, 1901, work commenced on an auriferous area of 100 acres, situated on the south bank of the Aorere River, near the confluence of the Slate River, in the Collingwood district. The wash operated on is a strongly cemented deposit, varying in depth from 3 ft. to 20 ft., overlying a schist formation. During the year 1905 the quantity of gold obtained amounted to 313 oz. 17 dwt., valued at £1,179 10s. 3d., and since the company first commenced operations 1,152 oz. 1 dwt. 10 gr., valued at £4,431 3s. 3d. (an average value of £3 17s. 10d. per ounce). Since registration the capital actually called up has amounted to £14,723 5s. From date, the probable life of the claim is considered about thirty years, but previous to the tenure of the present company the property was a sluicing concern for over thirty years. In connection with the water-supply the company's dams occupy 49 acres, from which the water is conveyed over two miles of water-race, including about 5 chains of fluming and some 20 chains of 15 in., 11 in., and 9 in. pipe-lines, which connect with three nozzles under a head pressure of about 400 ft. The gold is of a coarse character, and saved over 370 ft. of rippled boxes, the total length of tail-race being 700 ft. Owing to shortage of water-supply one shift only is worked, which gives employment to six men. The approxi-

Waiwhero Sluicing and Dredging Company, West Coast: Sluicing Face, Buckley's
(250 ft. above H.W.M.)

mate value of the plant, races, dams, &c., is computed at £14,500. Mine-manager, Gilbert O'Hara; secretary, W. E. Pearson, Wellington.

Takaka.

The Takaka River drains the auriferous areas between the Haupiri and Pikinina Ranges. In 1854–55 the Duncan brothers discovered gold on their Onakaka property, which, however, led to nothing of importance, and not until gold was discovered by a party of Natives in January, 1857, was the district declared a goldfield. This discovery naturally led to a constant influx of diggers, including two hundred and fifty Europeans and a hundred Maoris, who found profitable employment in the neighbourhood of the Anatoki River; and, again, in 1858 gold of a very heavy character was found in the Upper Anatoki. This state of affairs continued while the gold was easily won, but in the event of fresh rushes breaking out the diggers drifted elsewhere for fresh fields, the want of proper roads being a serious drawback to the district. After a lapse of several years the Takaka Miners' Association equipped a prospecting party about two years ago to explore the upper reaches of this favourable field, and after three months' encampment they returned with a very fine sample of gold, and reported that the discovery comprised an extensive auriferous area, which would pay handsomely, provided tracks were made so that the diggers could get back supplies. Happily, attention has been directed to the construction of roads, and the Government has already voted considerable sums of money in this direction. It is reasonably anticipated that when more favourable access is available to this goldfield the association will avail themselves of every opportunity to extend development in the Upper Anatoki. During the late autumn the upper reaches of the Anatoki and Boulder Streams have been further explored with satisfactory results.

The Takaka Sluicing Company was registered on the 28th January, 1901; initiatory work commenced in May, and sluicing in November of same year. In small ways the field had been worked during the last fifty years, and it is notable that the present company is the first in the district to sluice and elevate the auriferous drifts to a height of 40 ft. by hydraulic power. The mining-area is a freehold of 200 acres, locally known as the Whelham's, which forms the valley of the Waikoromumu, a tributary of the Takaka River, and drains the large natural springs known as the Bubu, situated about four miles from the port of Waitapu. The wash operated on is a heavy river deposit, mixed with large granite boulders, varying in depth from 4 ft. to 10 ft., overlying the true and false bottoms. In 1905 there were 199,251 cubic yards raised and treated, at 2d. per cubic yard, from 6 acres of ground, for a yield of 805 oz., valued at £3,032; and from a total of 30 acres worked 3,283 oz. realised £12,328. The capital called up has amounted to £9,120, and the dividends declared to £4,104. The water-races are two miles and a half in length, and there is 1,222 ft. of box fluming, together with 4,680 ft. of pipe-lines, varying in diameter from 30 in. to 9 in.; and from the penstock, at a distance of 3,000 ft. from the face, fifteen heads are available on two nozzles, at a head pressure of 360 ft. The gold won is a fairly coarse sample, and is readily saved over 102 ft. of specially made ripple-boxes, the wash showing very small traces of platinum. The approximate value of the plant, races, dams, &c., is estimated at £3,588. A useful addition to the plant is a very complete sawmill. The original surface of the land worked is simply a pakihi, but around the old homestead the land for many acres is more valuable, and is yet intact. Ten men employed. Mine-manager, Charles Campbell; secretary, J. M. Butt, Wellington.

Taitapu.

Aorangi Mine.—This claim, having an area of 100 acres, is situated at Taitapu, in Collingwood County, and is owned by the Golden Blocks (Taitapu), Limited, an English company having a called-up capital of £84,207. During the past year the battery crushed 2,387 tons of ore, which yielded 2,796 oz. of gold, value £11,108 3s. 6d., making a total of 16,352 oz., value £62,827. Dividends were paid during 1905 amounting to £4,210, bringing the total up to £18,945. The reefs worked are of a varying character, from as low as 3 in. up to 2 ft., but the average returns are satisfactory. Thirty men are employed in mine, and four on surface. Mine-manager, G. F. Giles; battery superintendent, C. Gapper; attorney, C. Y. Fell, Nelson.

Golden Ridge Mine (Taitapu Gold Estates).—A continued series of successful prospecting was effected on the Ant-hill and Golden Ridge sections of the property, which resulted in suspension of operations towards the end of August, 1904. Again, in No. 4 Block east, and south of the Golden Blocks mining-area, prospecting was further continued with eight men, but after driving a distance of 270 ft. only bunches of quartz were found. Mine-manager, James Carroll; attorney, N. L. Buchanan.

Heaphy.

In the year 1865 Mr. James Mackay, Goldfields Warden, was the first to explore the Heaphy and Karamea. At various times prospectors have made periodical excursions through the Heaphy River district, and although alluvial gold has been reported, it is nevertheless a fact that gold in payable quantity has not yet been found. The inconvenience of getting food-supplies and mining requisites has all along been the chief source of complaint. However, it may be fair to anticipate that, when road communication is established from Karamea up through the Heaphy and on to Collingwood, there will be more favourable access for the supply of mining requisites.

Karamea.

Since 1865 alluvial gold has been found in the various streams, but, although the different terraces have been operated on by hydraulic sluicing, values have failed to maintain profitable operations. To want of capital and roads may be attributed the chief causes of non-success.

Coal is fairly abundant, and has been worked for local consumption, but until the settlement affords more favourable facilities expansion of a coal trade must await future possibilities.

Mokihinui River.

Alluvial mining on this river is now confined to a few old miners. Inquiry for quartz reefs is receiving more careful attention, as the returns from quartz recently crushed at the Red Queen Mine has stimulated the prospectors to make renewed search, and as a consequence several mining-areas have been pegged off. The local opinion is that the reef will increase in width northward, and on this understanding prospectors are actively engaged, especially between the headwaters of the Mokihinui and Lyell Rivers.

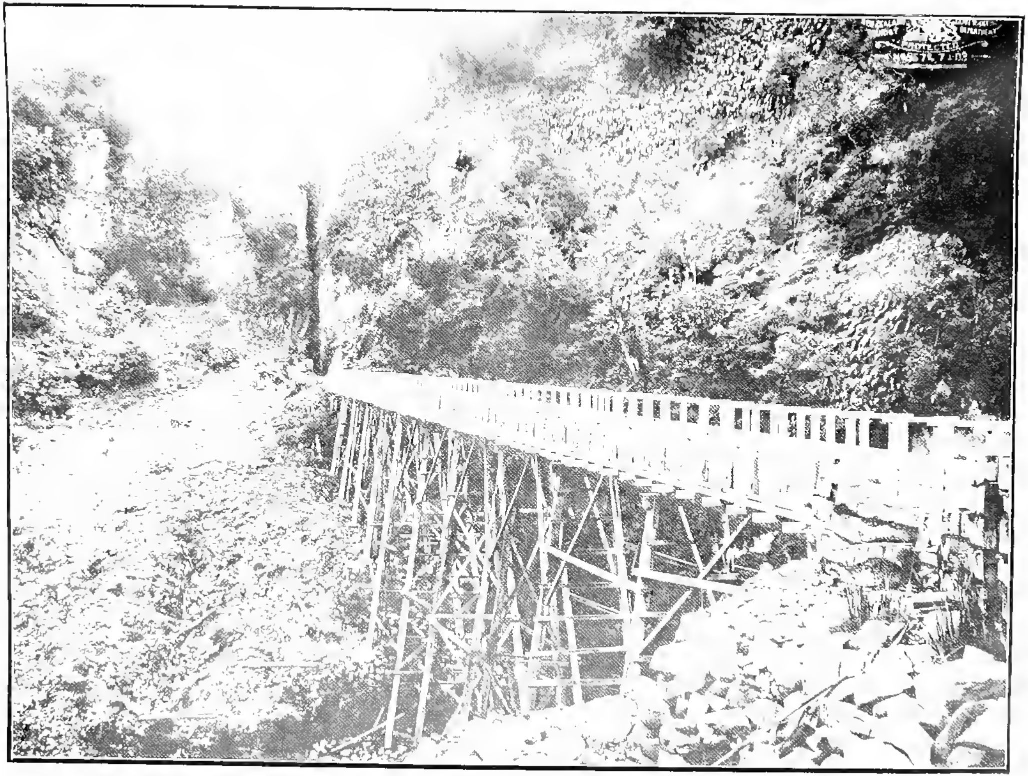
On the Rough-and-Tumble all work is abandoned.

Cascade Creek.

Cascade Creek is a tributary of the Buller River, and in the earlier years was a favourite resort of the gold-miner, as coarse gold in considerable quantity had been recovered. Whilst the miners were thus engaged some nice quartz-specimens were picked up, which led to the discovery of an outcrop showing gold. This line of reef was driven on for about 200 ft., but, owing to the great difficulty in obtaining food and mining supplies, work was abandoned. Since then, the Buller County Council having meantime received several grants of money from the Mines Department, a saddle-track has been well advanced, and as a matter of fact the district will receive renewed attention.

Waimangaroa River.

There are still a few old resident miners who make a living by tunnelling and treating the wash in long-toms in the bed of the river, otherwise there is nothing of importance to note. Some years ago a small company was floated with the object of developing the reef system on the upper side of Conn's Creek, but after a battery was erected and other preliminary works carried out the stone crushed was proved to be practically valueless; consequently all work was abandoned, and still continues so. Prospectors are still, however, sanguine that reefs of considerable value must exist in the upper reaches of the river; otherwise, they naturally inquire, Where



SLUICING-FLUME, GREENSTONE CREEK, NEAR KUMARA, WESTLAND.

Mining Handbook.

has the coarse specimen gold, which was so profitably worked in the bed and along the banks of the Waimangaroa River, criginated?

Giles, Rochfort, and Christmas Terraces.

In the Giles, Rochfort, and Christmas Terraces prospecting is now more sought after, and, aided by Government subsidy, three low-level tunnels are in active progress, which offer fair promise of payable results. Valuable services have been rendered to the prospectors by Mr. Sidney Fry, Director of the School of Mines at Westport.

Addison's Flat.

In comparing the mining operations of to-day with those of 1867, when about eight thousand people were actively engaged in the pursuit of gold, we are almost brought to the conclusion that alluvial mining belongs to past history. The absolute failure of the General Exploration and the Virgin Flat companies has not tended to improve the position, while the old Shamrock has been abandoned and flooded for several years.

Mining on St. John's Terrace has been carried on more or less for the last thirty years, a scarcity of water and suitable means of conveying mining material up to the terrace having been the chief drawbacks; but a suitable road is now constructed, and, with the increased water-supply from Back Creek, sluicing is maintained the whole year, whilst with the natural facilities afforded for the discharge of tailings into the vicinity of Dirty Mary's Creek dumping ground is practically assured for all time. The gold-returns give a fair remuneration against the capital and labour expended by Brady and party.

Halligan and party opened an extensive claim between the Westport–Charleston Road and the terraces, but it is now abandoned. Carmody and party (eight men) continue to work with profitable results. The Long Tunnel Company (four men), who hold an area of 19 acres and 20 perches, continue to show favourable promise. Milligan and party have suspended cement-working, and recently commenced sluicing an alluvial section of the property. The Venture Gold-mining Company formerly worked a cement claim with a ten-stamp battery, but for reasons of their own have recently ceased work and opened a sluicing claim on the flat.

Croninville.

With the exception of a few aged miners who fossick around the shallow ground, mining is confined to a company known as the Charleston Beach Gold-mining Company. This enterprising company, after carrying out an extensive system of prospecting by shafts, has now completed a water scheme which permits of hydraulic - sluicing operations on a large scale.

Charleston.

On what is locally known as the Shetland Beach quite a number of miners find lucrative employment by treating the black sands over movable copper-plate tables as favourable opportunities occur with the tides. On the northern section of the beach Messrs. Powell and Sons have incurred considerable expenditure to maintain an efficient water-supply to sluice and elevate the sands by hydraulic power, the sands being afterwards treated over a considerable surface of copper and plush-laid tables. In addition to the works stated, this enterprising syndicate now carries on similar operations further north on a property recently purchased from the Charleston Beach Gold-mining Company.

To the south of the district mining is almost restricted to a limited number, who utilise the water from the Argyle Water-race. South, as far as Deadman's Creek, alluvial mining is much hampered, owing largely to the imperfect system of road communication; but, as a matter of fact, mining will assume a more hopeful aspect, both for gold and other minerals, which are known to exist in the district, on the completion of the Charleston–Barrytown Road.

Barrytown.

Messrs. A. McKay and White, of Greymouth, have expended liberally to command efficient water-supplies suitable for sluicing and elevating the deep sand deposits so favourably situated in the Mawhero and Barrytown Flats. With the exception of these two large concerns, alluvial mining is practically confined to some old residents and a few beachcombers. Improved road communication will tend much to stimulate mining matters in this direction, as the geographical situation of Barrytown has long been like that of some distant place which one has read about in "Gulliver's Travels," notwithstanding the hidden wealth which the district commands.

New Creek, Lyell.

Prospecting operations were carried on in this isolated region for several months on a slide formation, but as solid country was not easily accessible work was suspended.

Prospecting in the Upper Blackwater.

For many years past quantities of specimen quartz have been found amongst the alluvial deposits of this district, and, with a view of prospecting the back ranges from which this quartz has been detached, the resident miners formed a prospecting association, the Mines Department granting a subsidy of £1 for £1 up to £200, the association finding the equivalent in labour. On the 10th October, 1905, four men—William Mates, Ernest Bannetz, David Ross, and James Martin—were sent out, and after prospecting for eight weeks they reported that a quartz reef, varying in width from 3 ft. 6 in. to 5 ft., had been cut at various points for a distance of 12 chains, and carrying good prospects of loose gold; also by pestle-and-mortar test the stone so crushed showed payable prospects. These tests were verified by the Assistant Inspector of Mines, who, on the 5th November, 1905, broke off several samples, which were assayed by Dr. Maclaurin at the Mines Department Laboratory, and also by Mr. Anderson at the School of Mines, Reefton. The following shows the assay values of the stone thus treated:—

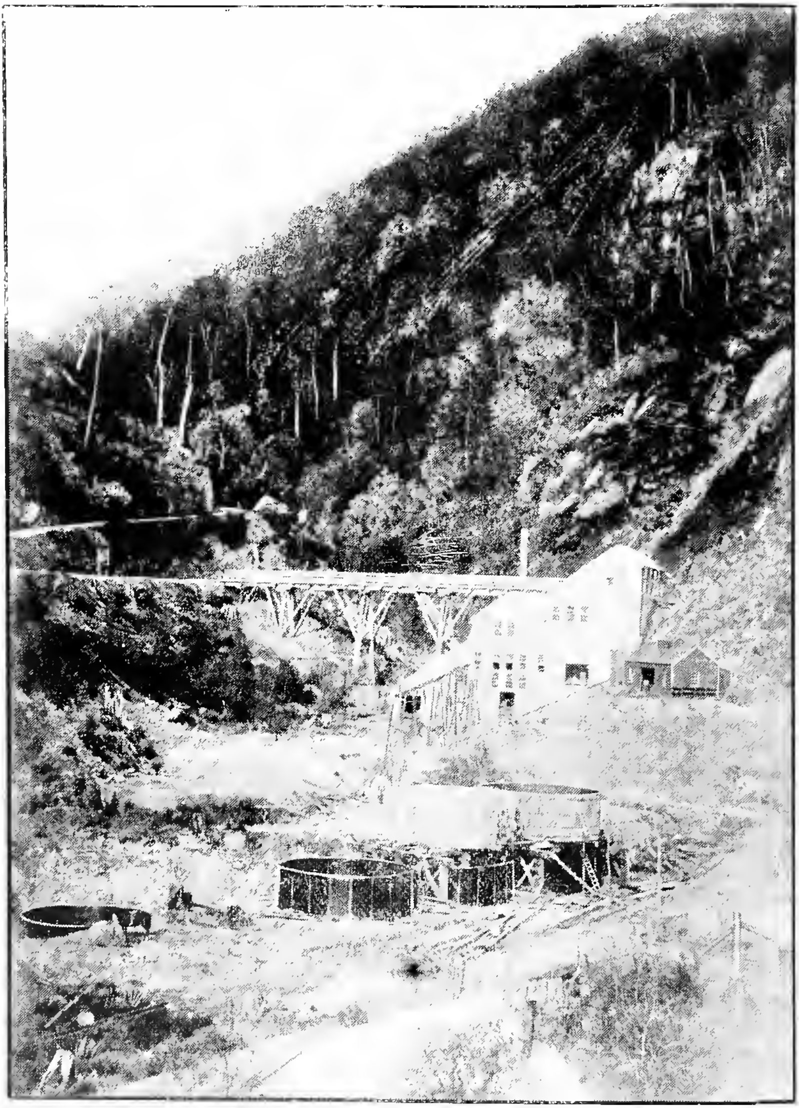
			Rate per Ton. Oz.	dwt.	gr.
No. 1 sample reef,	4 ft. 6 in. wide	..	1	4	4
No. 2 ,,	4 ft. ,,	..	1	0	8
No. 3 ,,	3 ft. 6 in. ,,	..	1	0	8
No. 4 ,,	3 ft. 6 in. ,,	..	3	0	0

This last sample was cut in a shaft 8 ft. deep under a deep cover of alluvial, the reef having an eastern underlie. On this discovery the prospectors made application for a special claim of 100 acres, which was granted. Mr. P. N. Kingswell, of Reefton, having satisfied himself as to the probable values of the property, entered into an agreement with the prospectors to expend £500 during three months, and at the end of that period either to purchase the property for £2,000 or forfeit the deposit. At the expiration of the three months Mr. Kingswell paid over the £2,000, and continued driving and sinking at various points with ten men, the reef so far developed giving favourable promise of opening up a valuable quartz-field. Conservation of the water-supply in the Snowy Creek has already engaged attention, and the construction of roads suitable for wheel traffic has been undertaken by the Inangahua County Council, under a vote from the Mines Department. The Consolidated Goldfields of New Zealand (Limited), which has the property now under option, is carrying out extensive developments.

Some Particulars of Quartz-mines.

Lyell.

Alpine Extended Gold-mining Company, formed in 1897, is an amalgamation of the United Alpine and the Lyell Creek Extended Gold-mining Companies. As the outcome of this amalgamation operations speedily attained fresh vitality, and with the timely addition of the cyanide installation the accounts of the company were once more transferred to the credit side of the ledger. Exhaustion, however, of the ore above No. 10 level unhappily changed events, which necessitated sinking from the in-bye end of No. 10, or the Lyell Creek low-level, tunnel to No. 11. This venture fully maintained anticipations, and hope was entertained that values would improve at depth. On this assumption sinking was further continued to a depth of 250 ft., but as exploitations were extended north and south on No. 12 anticipation looked more doubtful, as the lode showed a marked tendency to thin and become patchy, with naturally reduced values. At this juncture mining matters



Golden Fleece Mine, Reefton: General View of Battery, Bridge, Cyanide Tanks, etc.

Mining Handbook.

had almost attained a crisis, payable stone being a thing of the past. At the commencement of 1905 the company decided to carry out an extensive system of prospecting, but the results obtained proved fruitless. The funds being exhausted operations were suspended, and in May, 1906, the property and plant were sold by auction for £500. The reduction-works include twenty head of stamps, actuated by water-power, and equipped with the ordinary gold-saving appliances by amalgamation on copper-plate tables. During the year 1905 444 tons were crushed for a yield of 54 oz. 6 dwt., valued at £207 8s., and from the 6th September, 1897, to the 31st January, 1906, the total gold produced was valued at £43,219 11s. 3d. (at an average of £3 16s. 5d. per ounce). The total expenditure in connection with mining operations amounted to £58,086 8s. 6d., and the capital called up to £13,229 3s. 4d. Previous to amalgamation the United Alpine called up £31,333 6s. 8d., and paid in dividends £74,266 13s. 4d. A deep shaft on this property may, in course of time, prove that the gold-bearing reefs on the Lyell carry payable values at greater depths, as has been demonstrated at Reefton by the Consolidated Goldfields and Progress Mines.

Waimangaroa and Mokihinui.

Britannia Mine, owned by the Britannia Gold-mining Company, has a quartz-bearing area of 99 acres, at the head of Stony Creek, near Waimangaroa. The property is opened by four tunnels, which comprise an aggregate driven distance of 3,241 ft., and operate on the continuation of one reef 3 ft. in width, while crosscutting and winze-sinking has been effected for respective distances of 130 ft. and 330 ft. There is a four-stamp mill, driven by water-power, giving an aggregate duty of 2 tons per stamp per diem, the gold being saved on the ordinary amalgam-tables. Reduction is further effected by a recent installation of three tailings-vats, 17 ft. 6 in. in diameter by 4 ft. in depth, whereby 390 tons of sands were treated by canide for 66 oz. of melted gold. During the year 1905, 887 tons of ore yielded 848 oz., valued at £12,286. The total dividends paid amount to £3,341 13s. 4d., and during 1905 shareholders received £750, while the total capital actually called up is £1,933, and the total expenditure up to December, 1905, was £11,131. Twelve miners and two surface hands are employed.

Red Queen Quartz-mine has a mining-area of 25 acres, situate at Seatonville, Mokihinui. The reef operated on is 6 in. in width, opened by five tunnels, which give an aggregate length of 600 ft. The stone is crushed by a two-stamp mill, driven by water-power, each stamp giving an average duty of 2 tons per day, while the gold is saved on copper plates. In 1905, 118 tons of ore yielded 281 oz. of gold, valued at £1,099. Approximate value of mining plant, reduction-works, &c., estimated at £1,000. Worked by a party of tributers. Secretary, A. W. Mills, Westport.

REEFTON.

Keep-it-Dark Mine.—The area held by the Keep-it-Dark Quartz-mining Company comprises 118 acres and 6 perches, situate at Crushington, about three miles east of the Town of Reefton. The winding-shaft, 10 ft. by 4 ft., divided into three compartments, is 1,100 ft. in depth and 245 ft. below sea-level, the mine-water being baled in same shaft. Regarding the future prospects of the mine, development has received special and careful attention, both with respect to the surface and underground workings, and it is satisfactory to note that the efficiency of plant, &c., gives the property very exceptional promise. So far as explorations have been extended, two payable reefs are exploited, which vary in width from 2 ft. to 12 ft., while the stone in sight is computed at 30,000 tons. For several years the whole output of ore has been extracted from a recent find of stone located between the shaft and the Inangahua River, the reef continuing to show a favourable increase in value at depth. The reduction-works are fitted with twenty stamps, capable of maintaining an average duty of 2 tons per stamp per day of twenty-four hours. Gold-saving is effected by amalgamation on outside copper plates, concentration by Frue vanners, and cyanidation of the coarse sands, the fine pyritic slimes being treated over canvas tables. These concentrates are afterwards sold to the smelters. The cyanide plant comprises six leaching-vats, 60 ft. in diameter by 5 ft. deep, fitted with automatic distributers, &c. The ore crushed during the year 1905 was 12,730 tons, yielding 3,391 oz. of gold, valued at £13,653; and during the whole period of operations 206,431 tons of ore has been crushed and 58,099 tons of sands treated by cyanide, giving a gross value of £380,429, at an average of £4 0s. 6d. for battery and £3 11s. per ounce for cyanide. The dividends paid for 1905 were £6,750, and the total dividends paid to shareholders have amounted to £145,666 13s. 4d., or £7 5s. 8d. per share. The capital called up to date amounts to £6,208 6s. 8d., or 6s. 2½d. per share; and in connection with mining operations the total expenditure up to the 31st December, 1905, was £251,236. Average number of men employed in the mine, thirty; reduction-works, ten; surface hands, six. Water-power is used in all departments of the reduction-works, but for several years past a pair of double-cylinder steam-engines (British manufacture) has taken the place of the old winding water-wheel, which is now a thing of the past in mining. The approximate value of mining plant, reduction-works, &c., is estimated at £20,000. Mine-manager, B. Sutherland; metallurgist, R. Aitken; legal manager, W. Hindmarsh, Reefton.

Capleston.

Italian Creek.—This old abandoned property, in the Capleston district, was recently opened by John Knight and party, who have effected considerable development in crosscutting and driving. Of the work done 369 ft. has been driven on a line of reef 8 in. wide, from which 74 tons were crushed, yielding 36 oz. of gold, valued at £130.

Murray Creek.

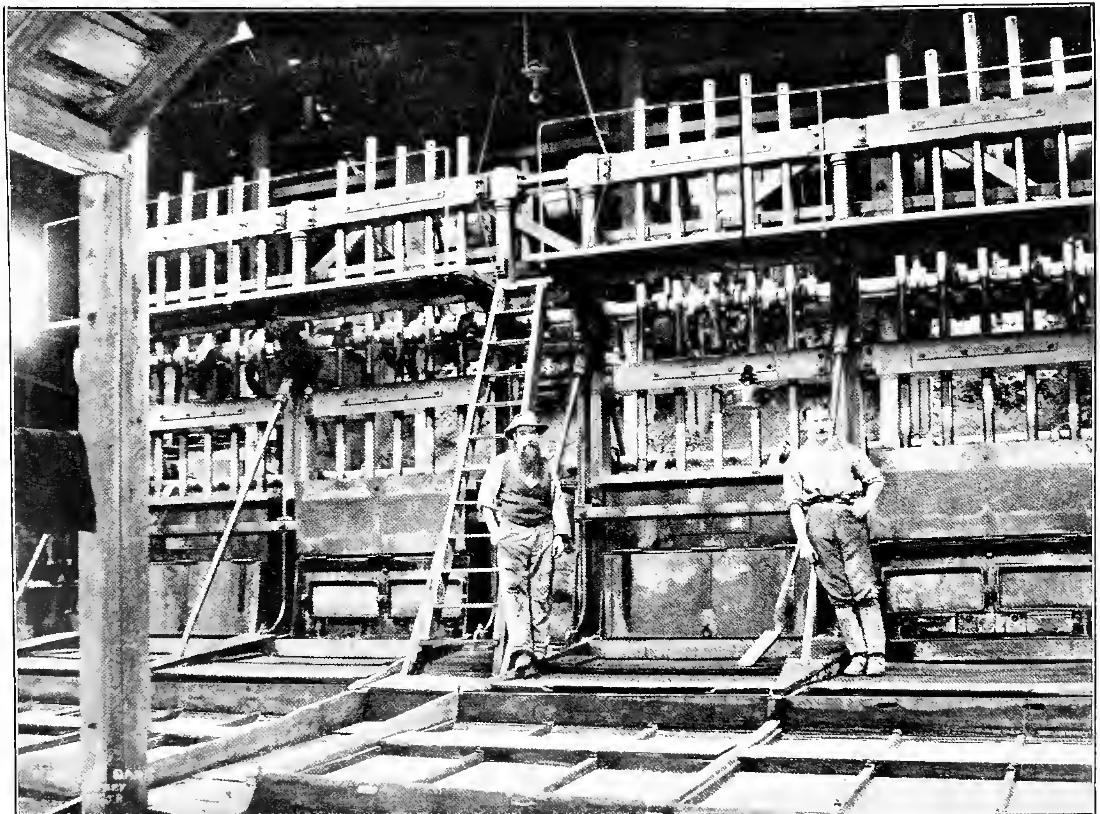
Inglewood-Victoria Mines.—The mining-areas held under lease comprise 100 acres, situate on the Murray Creek, near Reefton. The property is opened by three tunnels, which are driven a total distance of 4,850 ft., and intersect three lines of reef varying in width from 1 ft. to 5 ft., while the quantity of ore in sight is computed at 3,000 tons. Developments comprise 2,050 ft. of crosscuts; rising and sinking, 440 ft.; and 3,250 ft. driven on course of lodes. In connection with the reduction-works a ten-head stamp mill (steam-driven) is employed, the average duty per stamp per day of twenty-four hours being $1\frac{3}{4}$ tons. The gold is saved by amalgamation and cyanidation of the coarse sands, for which purpose three tailings-vats, 22 ft. 6 in. inside diameter by 5 ft. in depth, are in use. The average number of men employed underground is thirty-three, and on surface works nine. Since mining operations were commenced the gross expenditure incurred up to the 31st December, 1905, was about £16,000. Approximate value of the mining plant, reduction-works, &c., £5,000. Owner, P. N. Kingswell.

Painkiller District.

Ulster Mine has an area of 100 acres, situate in the Painkiller district, Section 13, Block X, Reefton Survey District, and is owned by the Ulster Gold-mining Company. Works are simply confined to prospecting, there being no permanent buildings erected on the property. Exploitations comprise two tunnels with an aggregate driven distance of 600 ft., winzes 205 ft., together with 150 ft. driven on one lode, which maintains an average width of 1 ft., while the ore in sight is estimated at 350 tons. Up to the 31st December, 1905, the total expenditure incurred has amounted to £1,963 19s. 7d., and the capital called up to £1,948 19s. 4d. Mine-manager, Alexander McCloy; legal manager, T. Hubert Lee, Reefton.

Merrijigs.

New Inkerman Mines (Limited).—On the 1st August, 1896, the New Inkerman Mines (Limited) commenced work on a mining-area of 406 acres 2 roods 5 perches, situate between the Rainy Creek and Merrijigs, and, after very considerable expenditure in fruitless development, operations were suspended in May, 1905. Nothing further was done on the property until July of same year, when the Consolidated Goldfields of New Zealand (Limited) purchased all mining privi-



Keep-it-Dark Battery, Reefton.

leges and plant for the sum of £750. On this change of ownership several test crushings were taken from various parts of the property, but the values thus obtained proved absolute failures, consequently abandonment was declared, and the plant is being withdrawn as required at the Consolidated properties. The reduction-works (steam-driven) comprise twenty stamps of 950 lb. each; three Joshua Hendy (San Francisco) C.J. mortar-boxes, 7,000 lb. each; and one C.J. mortar-box made by J. Anderson, Christchurch; while one 14 in. by 18 in. Blake rock-breaker was employed. Gold-saving by amalgamation was effected on outside copper plates, concentration by Frue vanners, and cyanidation of the coarse sands, while the fine pyritic sands were treated over a series of canvas tables. The cyanide plant comprised four white-pine leaching-vats, 18 in. inside diameter by 6 ft. deep, fitted with automatic distributers, slime-gates, and overflow launders, cocoanut-matting filters, and bottom-discharge doors, 12 in. diameter. The approximate drivings amounted to 6,252 ft., and sinkings and risings 1,313 ft. Regarding the prospects of the property, the late mine-manager states that, taking the whole of the stone from the "Big Blow" to the low-level tunnel on the Rainy Creek, and assuming that all the gold contained in the stone was saved, it would not pay, as a large percentage of the stone only gives an assay value of 1½ dwt. and 3½ dwt. to the ton. He further states that there is a speculative chance of success by sinking a shaft to a greater depth west of the bottom workings. The tonnage crushed during the year 1905 was 3,455 tons, yielding 549·32 oz., valued at £2,290 7s. 4d., and 1,132 tons of sands were treated by cyanide for 136 oz. 1 dwt. 18 gr., valued at £405 14s. 10d.; and for the whole period of operations 18,837 tons yielded 5,633 oz. 15 dwt. 16 gr., valued at £21,418. The London office accounts in the company's books at Reefton show the gross expenditure by the New Inkerman Mines (Limited) to be £80,419, including £19,960 as cost of flotation from the Inkerman Combined to the New Inkerman Mines Company; and debenture-holders received £1,827. Whilst the mine was in full work there were forty to fifty underground hands employed; five on the surface, including contractors for getting coal and timber; and nine in the reduction-works.

New Scotia Mine, covering a mining-area of 100 acres, situate in the Merrijigs district, about ten miles by road from the Town of Reefton, was originally opened and operated by the Sir Francis Drake and Gallant Gold-mining Companies. In connection with the development of the separate properties, the Sir Francis Drake was opened by a vertical shaft, 10 ft. by 4 ft., to a total depth of 400 ft., divided into two winding and one ladder-way compartment, the winding being actuated by coupled horizontal steam-engines; and the Gallant, which comprised the lower levels of the field, was opened by level adits. The New Scotia Gold-mining Company, on acquiring possession, carried out extensive exploitations on No. 1 level eastward, off the Sir Francis Drake shaft, which was afterwards connected by rising on line of reef from the Gallant adits; but, so far as these exploratory works were effected, they proved the auriferous values unremunerative. At this period of operations the winding plant was removed from the Sir Francis Drake shaft and rebuilt at No. 1 Gallant, to sink a shaft, 7 ft. by 4 ft., on the underlie of a reef 3 ft. in width, which was continued to a total depth of 150 ft., from whence driving was extended north and south on the lode for 100 ft. Probably the most lucrative proposition in connection with the venture was the cyanidation of an old tailings-heap, which contained 5,350 tons of rich auriferous sands, and yielded 1,107 oz., valued at £3,470. The cyanide plant comprised three leaching-vats, 22 ft. 6 in. diameter by 4 ft. 6 in. deep, and two sumps, 12 ft. diameter by 4 ft. deep. In 1905, 250 tons of ore yielded by amalgamation 35 oz. 5 dwt., valued at £137 9s. 6d., while 150 tons of sands treated by cyanide yielded 11 oz. 10 dwt., valued at £39 13s. 6d.; and the total ore crushed amounted to 1,424 tons for a yield of 303 oz., valued at £1,164, and by cyanide 972 tons of sands yielded 113 oz., valued at £303. In connection with mining operations up to the 31st December, 1905, the total expenditure amounted to £1,406 2s. 2d., and capital called up £1,150. The property has been abandoned, and all mining plant and reduction-works were sold for £500. Late mine-manager, John McMasters; legal manager, T. Hubert Lee, Reefton.

Big River.

Big River Mine, owned by the Big River Gold-mining Company, covers an area of 54 acres 1 rood 6 perches, and the seat of operations is located on the Big River, about nineteen miles by road from the Town of Reefton. The property is opened by a vertical shaft 1,200 ft. in depth, with a capacity of 10 ft. by 4 ft., divided into two winding and one ladder-way compartment. Winding is actuated by steam-engines, having coupled horizontal cylinders. The reefs worked vary from 2 ft. to 12 ft. in width, and according to present development 800 tons of ore is in sight. Exploitation includes 2,000 ft. of crosscutting, 150 ft. driven on course of lodes, and winzes 120 ft. The reduction-works comprise ten head of stamps, capable of giving an average duty per stamp per diem of 1¼ tons, while the gold is saved by amalgamation on the ordinary copper plates. During 1905, 920 tons of ore yielded 879 oz., valued at £3,514 8s. 3d., the total yield being 25,854 oz., valued at £103,940 4s. 2d., an average rate of £4 4s. 4¾d. per ounce. In connection with mining operations, the total expenditure up to the 31st December, 1905, amounted to £69,904 11s. 4d.; dividends paid to shareholders, £47,366 5s.; and the capital actually called up, £11,475 2s. 6d. On an average, there are twenty men employed in the mine, four in the battery, and eight in various surface works. Winding at the mine is actuated by steam-power. The approximate value of mining plant, reduction-works, &c., is computed at £3,000. Mine-manager, John H. McMahon; battery superintendent, P. N. Rodden; legal manager, T. Hubert Lee, Reefton.

Victoria Range.

Kirwan's Reward Gold-mining Company has an area of 93 acres 2 roods 4 perches on the Victoria Range, near Caplestone, in the Reefton district. During 1905 the company's fifteen-stamp mill, which is worked by water-power, crushed

7,584 tons for 1,683 oz. 18 dwt. 6 gr. of gold, value £6,699 13s. 11d., the average duty per stamp being about 1½ tons. The total quantity crushed has been 25,956 tons, which yielded 12,171 oz. 13 dwt. of gold, valued at £48,500 18s. 2d. (at the rate of £3 19s. 9d. per ounce for melted gold). The total expenditure up to the 31st December, 1905, amounted to £32,692 11s. 6d.; total dividends paid, £18,900, including £2,100 disbursed last year; capital actually called up, £3,091 13s. 4d. Twenty-two men employed. The peculiarity of this property is that no true reef has yet been found. The crushed ore is picked from a large body of loose stone lying on the surface.

PAPAROA RANGE AND TEN-MILE CREEK.

Paparoa Range Mine was originally equipped with an aerial tram-line and a ten-stamp mill, but, after considerable expenditure, operations were finally abandoned, and the plant sold two years ago.

Taffy Gold-mining Syndicate, with a called-up capital of £100, holds an open-face auriferous area of 2 acres, situate on the Ten-mile Creek. The formation worked is a broken irregular slate, intermixed with quartz stringers, which are crushed by a five-stamp mill, and the sands treated over the ordinary amalgam-tables. For the year 1905 the gold won amounted to 31 oz., valued at £120.

Some Particulars of Hydraulic Sluicing Claims.

Addison's Long Tunnel Gold-mining Company was registered and work commenced on the 24th September, 1898, in a claim of 19 acres and 20 perches, the wash being a marine deposit 10 ft. in thickness. The company's dams, covering an area of 50 acres, maintain an average water-supply of eight heads over four miles of water-races, 300 ft. of fluming, and 10 in. pipe-line, at an average head pressure of 20 ft. The gold, being fine, is treated over a series of plush-laid tables, 80 ft. by 12 ft., whilst the tailings are discharged through a tail-race a mile and a half in length. For the year 1905 the gold won was 326 oz., valued at £1,289, and since registration 1,824 oz., valued at £7,204 (average value £3 19s. per ounce).

Manzoni and Party's Claim, Callaghan's, Kumara.

Capital has been called up to the amount of £1,500, and £723 14s. paid in dividends. Four men employed. Mine-manager, P. Sullivan; secretary, A. W. Mills, Westport.

Barrytown Sluicing and Elevating Claim has an area of 65 acres, situate on the Barrytown Flat, which was formerly owned and worked by the Barrytown Company, but about seven years ago the plant and property were purchased by Mr. A. McKay, of Greymouth. The wash consists of sand and gravels, which are sluiced from a false bottom to a depth of 12 ft. and elevated 65 ft., thence distributed and treated over a table-surface 212 ft. in length by 12 ft. in breadth. During 1905 the yield of gold was 700 oz., valued at £2,730, and since work first commenced 3,000 oz. has been obtained, valued at £11,700. The capital expended on development has amounted to £20,000; dividends, 6 per cent. on capital; value of property, including plant, water-races, &c., computed at £20,000. The claim includes three miles and a half of water-races, together with four miles of pipe-line, varying in diameter from 7 in. to 20 in., which discharge from twelve to twenty heads of water on two nozzles at a head pressure of 615 ft. From sixteen to twenty men are employed. Mine-manager, W. White.

Bell Hill Sluicing Claim.—This party commenced work in the year 1900 on an auriferous area of 50 acres, of which 4 acres have been since worked, the wash operated on consisting of 130 ft. of heavy alluvial gravel and pug. In connection with the water-supply the company's dams occupy 5 acres, from which the water is passed through four miles of water-races, three-quarters of a mile of fluming, and 100 yards of 18 in. pipes, which maintain an average supply of 100 heads on three nozzles, under a head pressure of 150 ft. The sample of gold is coarse, medium, and fine, and is therefore treated over a series of twenty gold-saving tables comprising an area of 968 square yards, together with 400 yards of tail-race blocks. The plant, races, dams, &c., have an approximate value of £10,000. During the year 1905 the gold won was 250 oz., valued at £968 15s., and since commencement of operations the total gold obtained amounts to 1,000 oz., valued at £3,875 (an average value of £3 17s. 6d. per ounce). The amount of called-up capital is £6,000, and up to date all profits have been absorbed in extending the water-supply. Owners, William J. McIlroy and party; secretary, T. R. Byrne, Kumara.

Charleston Beach Sluicing Company holds an auriferous area of 16 acres at Charleston. The gravels, 7 ft. in depth, consist of sand and stony wash overlying the true bottom. In May, 1905, the company commenced to open up the claim, and was registered on the 13th June, 1905. The dams owned by the company cover an area of 3 acres, from which the water is conveyed through five miles of water-races and 600 ft. of 8 in. and 10 in. pipes, which maintain a supply of eight heads on one nozzle, at an average pressure of 50 ft. The gold is fine, and saved over baize-covered tables, 57 ft. by 18 ft., and the tailings carried over 400 ft. of tail-races, including 200 ft. of tunnel. The capital actually called up is £445 10s. 6d., and the approximate value of plant, races, dams, &c., £650. Five men are employed. Mine-manager, Thomas Radford, jun.; secretary, Reginald A. Aickin, Auckland.

Grey River Sluicing Claim.—This claim has an alluvial area of 30 acres, of which 4 acres have been worked since operations were commenced. The depth of wash in the face is about 15 ft. Water is supplied from the company's dam (2 acres in area) by a water-race four miles in length, together with 25 chains of fluming and 20 chains of 13 in. and 18 in. pipe-line, and the face operated on by two nozzles, under an average supply of twenty heads, at a head pressure of 60 ft. The gold is medium-sized, and saved on 30 chains of tail-races paved with wooden blocks. During the year 1905 the gold won amounted to 235 oz. 17 dwt. 20 gr., valued at £931 15s. 5d. (an average value of £3 19s. per ounce). Four men employed. Owner and manager, Joseph Shrives, sen.

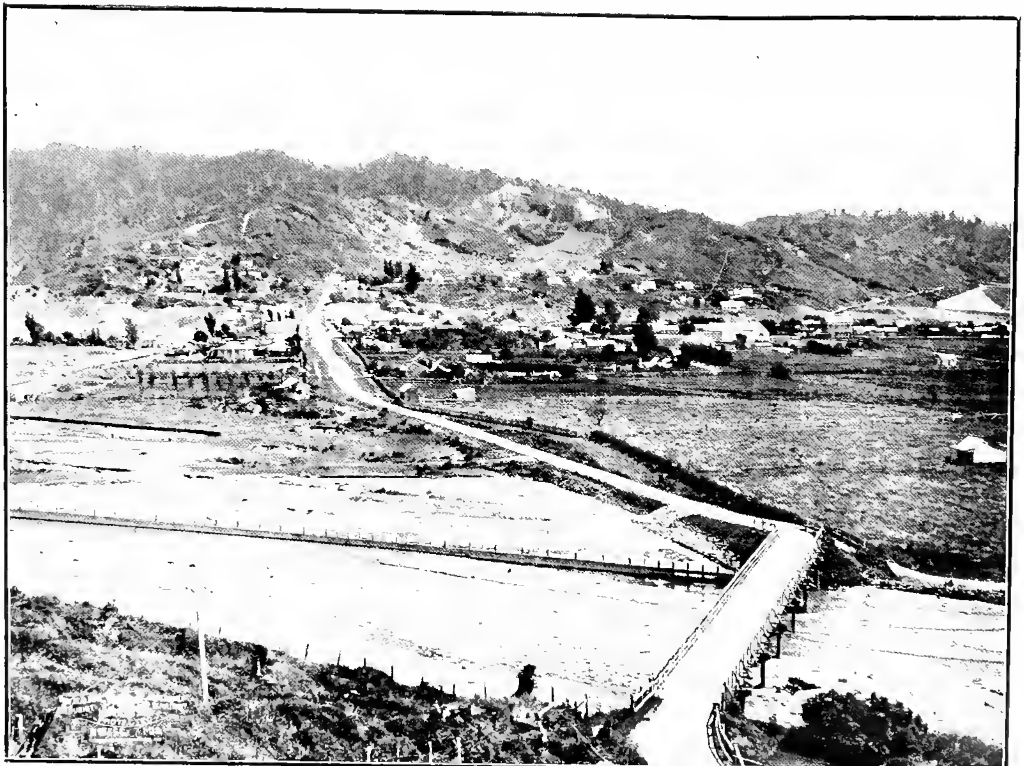
Horse Terrace Sluicing Company was registered on the 2nd August, 1904, and owns an alluvial area of 40 acres on the Horse Terrace, near Murchison, employing eight men. In 1905 the yield of gold was 331 oz. 2 dwt., valued at £1,290. The capital called up has amounted to £5,000, and the approximate value of plant, races, dams, &c., is £4,000. Mine-manager, C. S. Beilby; secretary, H. Gilfillan, jun., Auckland.

Kiri Momona Claim.—The Walker-Maruia Gold-sluicing Company was registered on the 31st May, 1905, and acquired the mining and water rights to work the Kiri Momona Claim, situate at Maruia, in the Burnett Survey District. The auriferous areas now held under lease, for a period of forty years, comprise 172 acres of crushed quartz and slate formation, intermixed with sandstone and granite boulders, resting on the "Old-man bottom," the wash varying in depth from 40 ft. to 120 ft. The company having originally determined to carry out operations on systematic and profitable lines, construction of a water-race is now in active progress, the completed length of which will be seven miles, and will comprise 60 chains of fluming and 100 ft. of 18 in. and 19 in. pipes, with a capacity of sixty heads, under a head pressure of 70 ft. Meantime, the ordinary sluice-box and plush-table will be erected, with an operative surface of 150 ft. by 9 ft. The approximate value of the works, &c., when completed, is computed at £6,000. The called-up capital to date amounts to £2,300. The works employ twenty men, and, according to contract, the water-race should be finished on the 31st August, 1906. A sawmilling plant, driven by the original water-supply, is erected to meet the requirements of the works. Secretary, M. M. Webster, Nelson.

MacLeod's Terrace Sluicing and Water-distributing Company (registered on the 4th April, 1902) owns and works an alluvial area of 100 acres, situated on the Mikonui River, Westland, and employs four men. The wash consists of a glacial sandstone deposit, overlain by a sandstone loam, which is sluiced to a depth of 120 ft. from a false bottom, and the gold saved over 208 ft. of tail-races, paved with wooden blocks. Since work first commenced the total gravels sluiced comprise an area of ¼ acre, for a yield of 26 oz., valued at £101 3s. The dams have an area of 1¼ acres, connected by three miles of water-races, including 8 chains of fluming and 15 in.-diameter pipe-line, which discharge twenty heads on one nozzle, under a head pressure of 120 ft. The approximate value of plant, water-races, &c., is estimated at £10,000, that being the amount of money expended. Mine-manager, Fergus MacLeod; secretary, William Bell, Wanganui.

Minerals (Limited) commenced sluicing operations on the 13th June, 1903, on an alluvial area of 200 acres, situated on the Blue Spur, Arahura. The wash is an auriferous gravel, varying in depth from 1 ft. to 4 ft., and operated on the true bottom. During the year 1905 the materials raised and treated cost 8s. per yard, yielding 393 oz. 15 dwt. of gold, valued at £1,535 13s. 3d., and since work first commenced 10 acres of wash yielded 493 oz. 15 dwt., valued at £1,926 4s. 11d. The capital called up has amounted to £4,917 5s.; approximate value of plant, races, dams, &c., £2,000. There are eight miles of water-races, 3 chains of tail-races, and ½ acre of dam, from which 6 chains of 18 in. pipe convey one head of water on to the face. Five men employed. Mine-manager, R. R. Morrison; secretary, E. Holloway, Auckland.

Mont d'Or Gold-mining and Water-race Company commenced work in June, 1878, on an alluvial area of 163 acres, situate on Sailor's Gully, Ross, and was registered in July, 1882. The ground operated on is an auriferous sandstone-drift deposit, mixed with black manganese stones, and having a varied depth from 180 ft. to 300 ft. During 1905 the area worked (1¼ acres) yielded 789 oz. 17 dwt. 4 gr., valued at £3,080 8s. 9d., and since the claim was first taken up 28 acres worked has yielded 40,672 oz. 11 dwt. 18 gr., valued at £158,623 6s. 10d. (a rate of £3 18s. per ounce). The called-up capital has amounted to £10,800, and the dividends declared to £41,400. As computed by the company, the probable life of the mine will be twenty-five years, and from its earliest history fifty-two years. The water-supply is conserved in dams with an aggregate area of 7 acres, thence over sixteen miles of races, including 1,600 ft. of 22 in. and 1,500 ft. of 15 in. pipe-lines; and the tail-races, which comprise a total length of one mile and a half, are paved with blocks and stones for the purpose of saving the gold (tables



Town of Ross, Westland: Mont d'Or Claim in the Distance.

are not in use). There are three giant nozzles, operated on by twenty heads of water, under a head pressure of 180 ft. For maintenance of water-races the yearly cost is £416. Approximate value of plant, &c., £12,135 14s. 10d. Fourteen men are employed. With the object of working the deeper deposits to the true bottom, which have been proved to contain high auriferous values, a low-level tail-race is now in course of construction. Mine-manager, John McKay; secretary, T. W. Bruce, Ross.

Nine-mile Sluicing Company was registered on the 16th May, 1904, and commenced work in August of the same year. The seat of operations comprises an alluvial area of 69½ acres, situate on a spur 350 ft. from the Ten-mile Creek, at an altitude of 250 ft. above sea-level. The auriferous drift is a sea deposit 60 ft. in depth, overlying the papa-rock formation. In 1905 ¼ acre of gravels was sluiced for 8,000 cubic yards at ½d. per yard, yielding 7 oz. 11 dwt., valued at £30 4s. 9d. The water-supply of ten heads in wet weather and two heads in dry is taken from the company's dam, 200 ft. by 80 ft., over a flume three-quarters of a mile in length, and delivered from the penstock by 12 in.-diameter pipes, at a head pressure of 110 ft. The approximate cost of plant, races, dams, &c., is £3,000; incidental expenses for the year 1905, £150; and called-up capital, £566 15s. Mr. Lemuel McNair, the late manager of the claim, states, "The nature of the country worked was entirely of a prospecting character. The bottom kept rising equal to the surface for 400 ft. up the hill, when it began to dip into the hill, and dipped 13 ft. towards the Ten-mile Creek. The dip proved very poor, and operations had to be abandoned on the 30th December, 1905, for want of funds. There is no reason to doubt that payable gold might be found between the front and back reef, as the back reef was never found. The gutter runs round the hill over three-quarters of a mile, and can be traced by the breakaway of the wash all round the hill and faces standing in the gullies and watercourses. It would have taken six months more to have given the hill a fair trial."

Republic Sluicing Company.—Alluvial mining was commenced in Healey's Gully in 1878, but not until June, 1898, was the Republic Sluicing Company registered as a mining concern, the called-up capital amounting to £3,500. The auriferous areas held under lease comprise 40 acres of hard-cemented gravels, worked to a depth of 70 ft. from the true marine bottom. In 1905, 224,000 cubic yards of gravel were raised and treated from 1 acre of ground, at a cost of 1½d. per cubic yard, yielding 600 oz., valued at £2,400 (£4 per ounce), and since work was first commenced 12 acres have been exhausted for a total yield of 5,000 oz., valued at £20,000. The water-supply of twenty heads is taken from the Roaring Meg, and conveyed to the penstock over two miles of water-race, including 500 yards of flume and 19 in. pipe-line, which maintain two operating nozzles with a pressure of 260 ft. The gold won is of a coarse character, and saved by ordinary ripples, arranged in the tail-race boxes, one mile in length. There are six men employed, and the incidental expenses amount to £300 yearly. The claim has been worked on tribute since February last, and the whole water-supply is sold at Government rates to private claims, and also to the tributers. It is considered that part of the property can be utilised after working for pastoral purposes.

Ross United Claim.—Since the year 1865 the Ross United Claim, an alluvial area of 44 acres, situated in Jones's Flat, had been worked continuously until the year 1905, when the Mont d'Or Gold-mining and Water-race Company purchased all mining privileges and plant. The dams cover an area of 2 acres, connected by five miles of races, including 4,000 ft. of fluming and pipe-line, which varies in diameter from 11 in. to 18 in., and carries eight heads of water at a head pressure of 200 ft. Approximate value of plant and property estimated at £10,000; yearly cost of maintenance, £350. The old company had a capital of £150,000, of which £37,000 was called up. The deposits, which comprise eight layers of highly auriferous wash, were formerly proved to a depth of 392 ft. by sinkings on the Ross Flat; but, in order to develop these deep-level deposits, drainage can only be effected by heavy and expensive pumping plant, at a probable cost of £50,000. Mine-manager, John McKay; secretary, T. W. Bruce, Ross.

THE WEST COAST.

GREYMOUTH WARDEN'S DISTRICT.

By Warden Kenrick.

The Grey, Buller, and Inangahua districts, which were worked as separate districts for over twenty years after the first gold-discoveries on the West Coast, are now administered by one Warden. In dealing with this wide area of auriferous country I shall first deal with

The Grey Subdivision.

The first discovery of gold took place at the Greenstone in 1864, and towards the close of that year at Red Jack's. Then followed the discoveries on the sea-beaches north and south of the Grey River at Marsden, Maori Creek, Arnold, Greymouth, and Moonlight, the most valuable quality of gold being found at the latter diggings. During the first fifteen to twenty years the miners expended about £100,000 in the construction of water-races, tail-races, and dams in different parts of the district. This was supplemented by an outlay of £90,000 on the part of the Government in the construction of the Nelson Creek Water-race. The almost universal method of mining being hydraulic and ground sluicing, a good water-supply was indispensable.

Paroa and Rutherglen.

These mining townships, situate a few miles from Greymouth, are rather quiet, a very small amount of alluvial workings being now carried on. A cement lead runs in a northerly direction from the New River through Rutherglen parallel to the coast-line as far as Nelson Creek. It is about 150 ft. above sea-level, and consists of cemented black sand, which requires to be crushed in order to extract the gold. If worked on a large scale payable returns might be obtained.

Marsden and Dunganville.

This district, not many miles from Greymouth, with a good road to it, takes in the New River Valley, and in the early days produced very rich yields of gold. The left-hand branch of New River and all its tributaries are worked out towards their sources to an elevation of about 400 ft. above sea-level.

The Eight-mile Range rises to a height of 1,200 ft., and there is believed to be payable ground to the very summit. This, however, cannot be worked for the want of water at such a level. A number of miners are still working in this locality, and those who own water-rights do fairly well.

Dredging has been tried in this district, but without any degree of success. Notwithstanding its failure, it is the opinion of some residents that there is payable dredging-ground in the locality which only requires to be prospected for.

It is believed, if a high-level race could be brought to the Eight-mile Terrace from the Eastern Hohonu River, a distance of twelve miles, a considerable area of payable ground could be worked by sluicing.

Maori Gully and Arnold Creek.

Rich gold was formerly obtained from Maori Gully and the surrounding streams, but at present only a few parties are working with catchwater dams and races.

Payable sluicing-ground has been reported on the Arnold banks, Stillwater Creek, and Maori Gully, but it cannot be worked until a high-level water-race is brought in, and it would require considerable expenditure to do this.

Moonlight and District.

This locality, situate on the north bank of the Grey River, and nearly opposite the Township of Ahaura, was noted for its rich gold in early days, and quite recently a 68 oz. nugget was found, with several smaller ones.

The Moonlight Company has let its dredge on tribute, and it is yielding payable returns.

WHEEL OF FORTUNE CLAIM, STAFFORD (KUMARA DISTRICT).

Mining Handbook.

The Shetland Terrace Sluicing Company, in the same locality, has ceased operations for want of sufficient capital to complete its water-race.

The Moonlight district will again undoubtedly be a large gold-producer, but to work its quartz lodes and to bring in water for sluicing the large areas of auriferous ground requires a considerable expenditure of capital.

Most of the nuggets found in this district have quartz attached, and it is firmly believed by all who know the locality that rich reefs do exist. The ranges are high and rough, making prospecting difficult.

Ahaura.

This is another district which, with the expenditure of capital in bringing in water at higher levels, will again become a highly payable alluvial field. Alluvial gold has been found for miles, and large areas in the form of high terraces have been tested and proved to be highly payable. An attempt is now being made by a local syndicate to bring in a water-race from Lake Hochstetter, a distance of six miles, to work the higher terraces.

Two dredges were constructed and worked on Ahaura River some years ago. Both did well, one getting as much as 50 oz. of gold a week; but they were not strong enough, and could not touch the bottom, which in some places is of more than ordinary depth. An up-to-date powerful dredge should pay well, judging by the results obtained by the one which was working. It, however, only worked a small area of ground.

Want of capital in this district, as in nearly all others, is the only drawback to the development of a large gold-producing area.

Reefton District.

Both alluvial and quartz gold has been found for a considerable area around the mining township of Reefton. At the present time very little alluvial work is being done, although rich auriferous ground was worked in the early days. The value of the gold obtained in this district would not be less than £3,000,000.

Quartz claims were taken up first near Reefton in 1870, and since then large dividends have been paid by various companies, notably the Ajax, Golden Fleece, Wealth of Nations, Progress, Keep-it-Dark, and many others. Mining is fairly quiet in Reefton just now, although several mines are still paying good dividends, such as the Keep-it-Dark and Progress Mines and the Consolidated Goldfields. The ore is now successfully treated by battery and cyanide process.

Nearly all the ranges around Reefton are auriferous. What is urgently needed in this district is more prospecting. It has been noticeable that wherever a little prospecting is going on some new finds are made. Quite recently two or three miners, after a few months' prospecting, have discovered a payable, and what appears likely to turn out a rich, quartz reef at Snowy River, about a day's journey from Reefton. Considerable pegging-out has been the result, and in consequence vigorous prospecting has been going on. Other reefs have been found, but it is premature to express an opinion as to their values. This find is about four miles from the Upper Blackwater, where good gold has been obtained, and where alluvial mining still continues.

Keep-it-Dark Quartz-mining Company, Crushington.

This company's property is situated at Crushington, two miles and a half from the Town of Reefton, in the County of Inangahua. The company now holds licensed holdings containing 118 acres and 6 perches. The original claim, from which the company derives its name, was pegged out as eight men's ground under miners' rights in 1873, the company being registered the following year. The extent of ground which each man could hold at that time was 60 ft. along the line of reef, with a width of 150 ft. on each side of the line. The original size of the first claim held by the company was 480 ft. long by 300 ft. wide. The company has since acquired five or six of the original claims which were pegged out on the same line of reef in the vicinity.

The company has now been steadily working the claim for the last thirty-two years. The present depth of the main winding-shaft is 1,100 ft., being about 400 ft. below sea-level.

Two levels of about 150 ft. each were worked from tunnels driven into the hill before any sinking was required. Altogether the company has mined 212,923 tons of quartz up to the 1st June, 1906, which has yielded 101,046 oz. 18 dwt. 11 gr. of melted gold, valued at £389,689 18s. 1d. Dividends amounting to £150,666 13s. 4d. have been distributed, equal to £7 10s. 8d. per share, and £158,672 7s. 3d. paid in miners' wages and contracts.

The output of quartz for a few years was small, as the company was not in possession of a crushing plant for some years after operations were commenced. The plant now consists of a twenty-head stamper-battery; two Wilfley improved concentrators; cyanide plant, consisting of six leaching-vats, each holding 60 tons, two solution-sumps, and two settling-tanks; winding plant, one 25-horse-power double-cylinder engine (makers, Fowler and Son, Leeds). The battery is driven by water-power (Pelton wheel). The water is taken from the Inangahua River, the water-race being a mile and a quarter in length, and the supply never-failing. Water-power was also used for winding by an overshot reversible wheel. It was very economical, and answered admirably until the shaft got down below the 500 ft. level. It was then found to be too slow, and for the past eight years the winding has been by steam-power.

The company's equipment and plant at the present time, including the main shaft, has cost over £20,000, the greatest part of which has been paid out of profits, as the capital called up in cash is only £6,208 6s. 8d., equal to 6s. 2½d. per share, the most of which was expended in prospecting operations.

From small beginnings and by careful management the company has been one of the most successful in the Inangahua district, and the future of the company for a long time to come is also assured, for, in addition to the lode which is now being worked and on which the company has been operating for the last eight years, there are several places within the boundary of the company's holdings where reefs have been profitably worked by other companies from the surface down to 500 ft. in depth. These claims having been purchased, the company is now in a position to prospect these lodes at much deeper levels, and it is anticipated that payable results will be obtained.

Lyell District.

Very little work is being done here at present. The Alpine Mine, which did so well for a considerable time, paying upwards of £70,000 in dividends, has been sold, together with the battery and plant, and it is understood that a syndicate has been formed with the object of giving the mine a further trial.

Many quartz lodes are known to exist near Lyell, but without large capital they cannot be developed. The surrounding country is very mountainous, rough, and heavily timbered. What this district must have before the quartz-mining industry can flourish is large capital; it is, from its roughness and its heavily timbered mountains, difficult to prospect.

There are a number of miners scattered about doing a little alluvial mining.

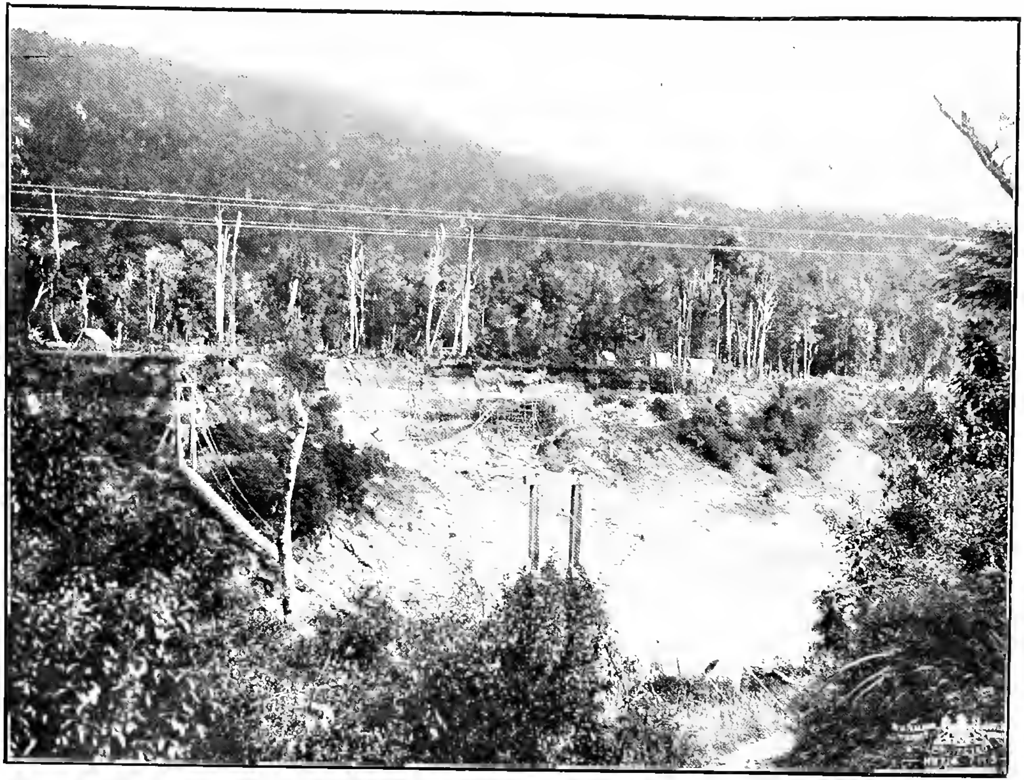
Murchison and Matakitaki.

Murchison (sometimes called Hampden) is a rising township in the Hampden Riding of the Inangahua County. A considerable amount of sluicing has been done on the Matakitaki River banks and terraces, and the operations still continue. Some of the claims have done fairly well, but the want of capital to bring in large races at high levels has prevented wide areas of ground from being worked successfully.

Thompson and party are working a claim on the east side of the Maruia River with a good deal of success, and they are now constructing a four-mile race to work the high terraces.

There is a considerable area of alluvial wash on the banks of the Maruia and Matakitaki Rivers; some of it is rich, but very rough for working.

The dredges in the district have not been a success. There are payable patches, but generally the wash is too heavy and too shallow to be profitably worked.



Gold-workings, Upper Buller River.

A quartz reef was discovered thirty or forty miles from Murchison at Upper Matakitaki, carrying a little gold. There are other indications of the existence of quartz lodes, but further prospecting is required in this district.

Glenroy River.

Alluvial gold has been obtained in this river, but the payable wash is apparently exhausted. The terraces contain payable gold, and only await the judicious expenditure of money in bringing in a race at a high level, when good returns should be obtained.

Westport District.

Westport is a seaport town on the Buller River. To the north and south of it there are many fields which have yielded very rich alluvial gold. In 1886 it was calculated that the value of the gold obtained in the Buller district was about one-twelfth that of the whole colony, or approximately £3,600,000; so that at a moderate computation it may be set down at not less than £4,000,000 to date. Some difficulty was experienced in arriving at anything like exact figures, for, while the bulk of the gold was exported by way of Hokitika, some of it found an outlet from Greymouth, and other parcels went by way of Nelson. The beaches and banks of the Buller River were very rich in deposits of the precious metal, which was for the most part of a flaky description, requiring little apparatus and preliminary labour in winning it.

Charleston and Brighton, to the south of Westport, were perhaps the largest gold-producers in the early days of the Buller district, many thousands of miners doing well for years in these places.

There are several good sluicing claims about Charleston paying well; also one or two cement claims, which are yielding fair profits. Although all the richer ground appears to have been worked out, there is still a considerable area of payable sluicing-ground to be operated on.

The sea-beaches continue to pay fair wages, although they have been worked for forty years. The gold is very fine and the sand heavy; therefore only a small percentage of the gold is saved with the present crude methods. When a process is introduced by which the fine gold can be saved these beaches will yield excellent returns.

Brighton, some miles south of Charleston, has still a considerable area of payable sluicing-ground, which, however, cannot be worked for want of water, and to get this water it will be necessary to expend a large sum of money.

Going north of Westport, much alluvial gold has been secured in the past, and there are now many small claims working profitably. The district about Westport, and well to the north as far as Karamea, should be well worth prospecting for quartz lodes, and in the future quartz-mining will undoubtedly play an important part in Westport's mining industry. Within the last few weeks a large quartz lode, carrying gold, has been discovered in very rough country between Karamea and Little Wanganui. Quartz reefs have been found in Rough-and-Tumble Creek, near Mokihinui. There are several quartz claims being worked near Mokihinui, and also at Birchfield. At the last-named place the Britannia Company, since 1901, has won a fair amount of gold; a cyanide plant has been erected, and it is anticipated very much better returns will be obtained than formerly with the battery only.

Concluding Remarks.

Westport has splendid prospects before it in regard to its coalfields. Up to the present several large coal-mines have been working successfully, the output for each week varying up to 13,000 tons from them. This industry is only in its infancy. Several large coal-areas have been taken up within the last year, and already many splendid seams of coal have been found. Companies have been formed with ample capital to develop these areas, and in a very short time it is expected that the output of coal for this district will be more than doubled.

The coal prospects of Greymouth are also very good, and the output of coal is rapidly increasing. Several new areas have been taken up, and development-work is now progressing.

The West Coast is, indeed, rich in minerals, the development of which is only as yet in its infancy. Coal can be found outcropping almost all over the Coast, and much of it is of the highest quality. There are many other minerals and valuable stones known to exist, but no attempt has been made to prospect for them so far.

Dredging generally has not been a success on the West Coast, but in many instances fair returns would have been obtained if suitable dredges had been put on. On the Buller River a number of dredges obtained very good returns for short periods. A few dredges have done exceedingly well in the Grey district, and several are now paying large dividends, but the greater number have ceased to work.

THE WESTLAND DISTRICT.

By Warden ACHESON.

Kumara District.

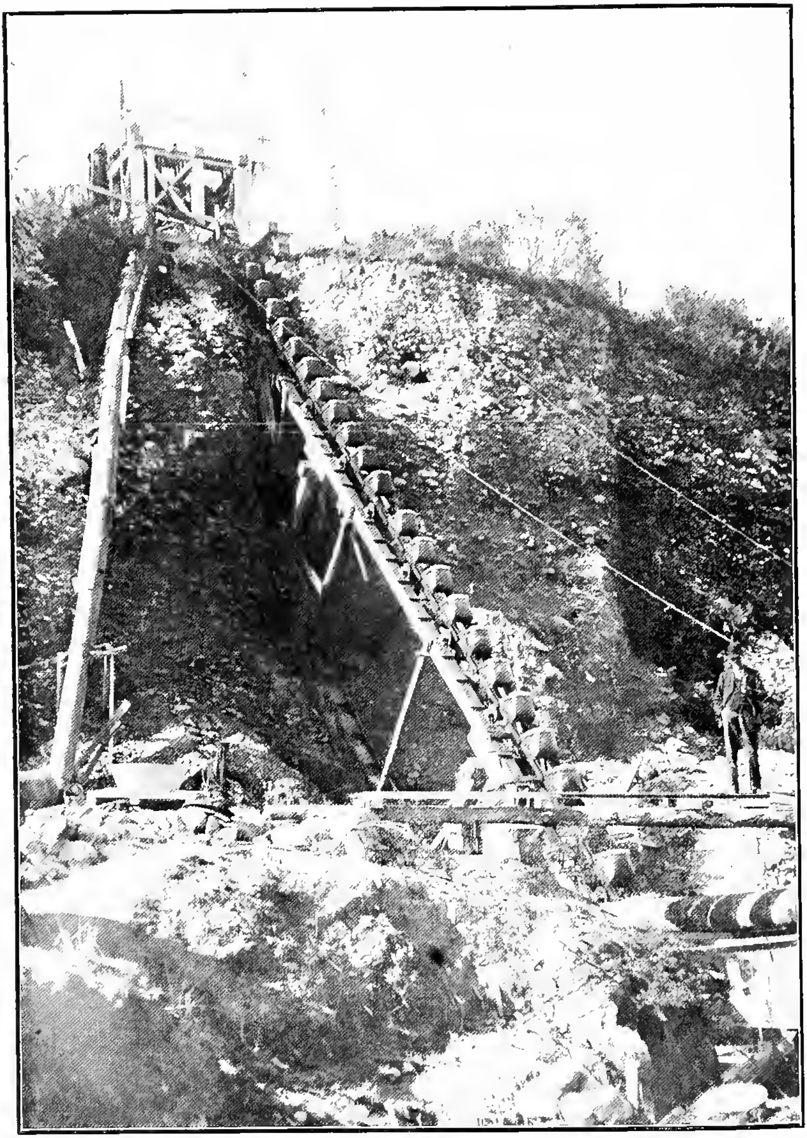
ALL the dredging in the Kumara district is confined to the Greenstone Creek, and in the year 1905 four dredges worked in that locality. The Greenstone Junction dredge averaged 11 oz. per week. During the big flood in June this dredge sank, and a great deal of time was lost in refloating her. She is at present being worked by tributers. The New Greenstone Gold Syndicate's dredge averaged about 18 oz. per week. Messrs. Cowie and Bice, who have the old Bun Tuck dredge, have worked to the Blackwater Creek, and averaged 40 oz. per week. The Three-mile dredge, which is owned by a Dunedin company, obtained on an average 20 oz. a week during the same period. Extensive prospecting operations are now being carried on, which when successful—and the results so far are encouraging—will give a fresh impetus to mining in this locality, where there is a magnificent water-supply for hydraulic sluicing. The extensive terraces lying north of the Teremakau will undoubtedly command the attention of prospectors as soon as the roads now in course of construction are completed.

Alluvial.—Three prospecting shafts were sunk at Larrikin's during the year by a private association without any result. At Dillmanstown three claims are working with success—viz., McGrath's, the Long Tunnel Gold-mining Company, and Cullen and party's. The Long Tunnel Company paid two dividends of 3d. per share. Vocasivich and party worked at Tramway Terrace, but the ground did not turn out to be very rich. At Cape Terrace about five sluicing claims are working with varying success. In some cases a scarcity of water considerably affects the returns. At Hayes's Terrace four claims have been worked by Gilbert and Tomasi, McIlroy and party, Evenden and A'Court, and some Chinese, with fair average results. At the Greenstone, Chinamen have been sluicing along Quinn's Terrace, near the Three-mile, and up Fuchsia Creek with average success, and the same applies to the five claims which are being worked in the same neighbourhood.

Stafford and Goldsborough Districts.

Dredging.—A new company was formed in the place of the Stafford - Waimea Gold - dredging Company, which went into liquidation in 1904. The new company was registered on the 17th May, 1905. It commenced operations immediately after that date, and worked continuously to the end of the year for a return of 511 oz. 10 dwt. of gold, value £1,969 4s. 6d., divisible after paying expenses among seven shareholders.

Alluvial.—At the beginning of the year 1905 there were 377 acres held under license. During that year 48 acres were taken up and 133 acres surrendered. From this it might appear that the area over which operations are being conducted has decreased, but I am quite certain that more work has been done and a greater quantity of gold obtained than during the previous year. The want of water prevents larger and more successful operations being carried on. At Middle Branch Flat, where there is a Government supply of water, most of the claims have been working continuously, and with excellent results, and the locality is regarded as a field for mining operations for some considerable time to come,



Bucket Elevator, Wheel of Fortune Claim, Stafford (Kumara District).

especially when the holdings, several of which are at present locked up owing to want of connection with the Waimea Main Tail-race, become connected with the sludge-channel. At Callaghan's the miners are now getting a supply of water from the Government race, and are in consequence working continuously, and with much better results than hitherto. The Wheel of Fortune Hydraulic Sluicing Claim, which was purchased early in the year by a local syndicate, has been working very steadily, and the new owners are quite satisfied with the result of the year's operations. In other parts of the district miners have to depend to a large extent on the rainfall, and this results in disaster when a dry season occurs. German Gully, Fourth and Fifth Terraces, and Lamplough would, I am confident, with a better supply of water, pay handsomely, and provide employment for a large number of men.

Hokitika District.

Dredging.—There have been only two dredges working in this locality—the Montezuma and the Woodstock. The former has been greatly hampered by the sea breaking into the dam, and either sinking or silting her up. This last disaster happened towards the end of the year, and caused operations to be discontinued. (I may say that since then she has been dismantled.) The Woodstock is working continuously, but, being owned privately, it is impossible to ascertain with what result. Certainly, the fact of constant working would lead to the conclusion that the dredge must be paying the owners well.

Alluvial.—The returns from this source during 1905 have been up to the average of recent years. At Humphrey's Gully the Consolidated Claim is being worked by tributers, and the results, although not great, have been satisfactory. At Blue Spur there are many small claims which appear to provide their owners with a good living, while Minerals (Limited), towards the end of the year, struck a good patch, which realised £1,113, and enabled the company to pay off all liabilities and place £558 to its credit at the bank. About

Kanieri Forks, Woodstock, Arthurstown, and Craig's Freehold small parties appear to be doing fairly well, but the main alluvial field at Woodstock suffers considerably from want of water, which, if obtainable, would doubtless result in far larger and more remunerative mining operations. The various mining privileges at Back Creek, or Seddon's Terrace, now being worked are giving good results for the money invested. The subsidised tunnel of Johnson and party has paid good wages to the workmen since completion. At present two layers of gravel are being turned out, known respectively as the "blue wash" and the "Brighton bottom."

Westland Reefs.—The Westland Reefs, on the Wilberforce River, are about 5,000 ft. above sea-level, and in the range dividing Canterbury and Westland. During the past year several of the prospecting claims have been worked, with a view to defining the quartz reefs which have been proved to exist on all the claims excepting one. In the Wilson's Reward a tunnel has been driven 100 ft. below the surface where the outcrop appears, and the reef has been found at that depth to be over 20 ft. wide, and greater in width than at the outcrop. Tests made have proved the stone to be highly payable. No work has been done on Grey's, Hyndman's, Billett's, McIntosh's, Hutchison's, and McClay's claims, as most of them were only taken up at the end of the year. On Fiddes's Reward, which contains three distinct lines of gold-bearing reefs, a very good lode has been traced to a length of fully 30 chains. Eleven chains of this has been carefully prospected, and the reef proved to be of an average width of over 2 ft. In the 11 chains the reef is exposed in sixteen places, and yields prospects equal to 2 oz. to the ton. Baucke's claim has been well prospected. The reef in Fiddes's Reward continues in this claim, but in addition there are two other outcrops. Samples taken from two of these reefs have yielded from 1 oz. to 2 oz. per ton, but the ore in the other is of lower grade. Considerable prospecting has been done on Pfahlert and party's claim. The reef has been traced a distance of 10 chains, and proved to be of an average thickness of 3½ ft., and highly payable.

Ross District.

There is not much to report as having occurred in this district during the year. In dredging matters the Prince of Wales and the Kohinoor went into liquidation. The former was bought by several persons previously interested in her, and under their management there has been a considerable increase in the returns of gold. The Kohinoor was sold and deported.

In sluicing matters, the evergreen Mont d'Or Claim has continued to declare regular dividends to the fortunate shareholders, and is likely to continue doing so. The MacLeod's Terrace Company has not been so fortunate: the want of an adequate supply of water has been a considerable handicap to mining operations, and the blue clay, or pug, in the claim a great obstacle.

THE POSSIBILITIES OF ROSS FLAT.

At Ross, where the Mont d'Or Sluicing Company has won from "mother earth" 40,700 oz. of gold, and divided in profits £52,200, there exists a large flat known as the Ross Flat. One man named Cassius obtained from this flat over 22,000 oz. of gold in two years, and at the top end, known as Jones's Flat, over 5 tons of gold has been obtained. The old Ross United Company, which worked the Ross Flat until operations were stopped by water, obtained 2,500 oz., and its big shaft (which was sunk to a depth of 392 ft.) passed through eight distinct layers of gold-bearing wash without finding the bottom. How many more layers or levels of payable wash there are below this shaft no one can tell. That such a marvellous deposit is not being exploited to-day is more than remarkable, since the Government is offering the whole of this area (100 acres) and a subsidy of £15,000 to any person or company whose proposed method of working is approved by the Government Engineer. That this flat can be drained to a depth of 500 ft., if necessary, is proved by the Beaconsfield Mine, in Tasmania, where 5,000 gallons of water are lifted per minute from a shaft 2,000 ft. deep in four lifts with plunger pumps, at a cost of £10 per annum per horse-power. The old company failed because it tried to drain this flat with water-power. With the completion of the railway to Ross in about a year's time, coal could be landed at the boilers on this claim for 15s. per ton, and the flat easily drained with an outlay of £50,000.

Okarito District.

Dredging.—During the early part of the year a dredge was worked on tribute on the Saltwater Lagoon, but as sufficient gold was not obtained to pay expenses operations ceased. The Five-mile Company attempted to place a dredge on the Five-mile, but owing to the difficulty of landing the machinery the attempt was abandoned.

Alluvial.—Very little work has been done. The Westland Company and Batson, at the Waiho, have opened up a large block of country on the south side of the Waiho River, but it is impossible to say with what result. The company employs nine men.

Beach Gold.—In the early part of the year a great deal of beach gold was obtained. A Mr. Gibb and his family are credited with getting between eight hundred and a thousand pounds' worth in a few weeks. It was reported at the end of the year that good coarse gold, carrying quartz, had been got at the Omoerua River. A prospecting party of two men are working on Cook's River, but with what result is unknown.

Other Minerals.

Large blocks of greenstone, or jade, are constantly being unearthed at Kumara during sluicing operations. This stone is now very much in demand in Europe, having lately become very fashionable. It is known to exist in many other localities on this coast, but it is not as yet found in any other part of the colony, and as a consequence must in time command a high price.

The existence of coal of a very good quality has been proved at Touchier's Gully, close to Lake Kanieri; at Koiterangi, only fifteen miles from Hokitika; in the Lower Paringa

Hydraulic Sluicing, Ross, Westland.

Mining Handbook.

Valley; at Bullocky Creek, ten miles north of the Haast River; and close to Jackson's Bay.

Copper has been discovered in the Upper Hokitika Valley; the Upper Wanganui Valley; at Copper Creek, in the Matakitaki Range; and near Maori River, South Westland.

Iron has been found close to the terminal of the Fox Glacier; in the Lower Paringa Valley; in the Lower Smoothwater Valley, near Jackson's Bay; and in the Upper Cascade Valley, below Jackson's Bay.

Granite exists in large quantities in the Teremakau Valley; the Island Hill, at the head of the Kawhaka Valley; Mount Tuhua (Lake Kanieri); and in the upper valley of the Hokitika River.

Freestone is abundant in the Otira Valley; at Koiterangi; at Abbey Rocks, six miles south of the Paringa River; and in Smoothwater Valley, near Jackson's Bay.

Silver has been found at Mount Rangitoto.

Westland as a Mining-field.

In addition to the Westland Reefs, now in process of development, gold-bearing quartz has been found at Kelly's Range, and at the Cedar Creek Reefs, at the head of the Totara Valley, near Ross.

Although dredging for gold has not been so successful in this district as in other parts of the colony, I am convinced that the failure to equal the records elsewhere has been caused not by the non-existence of the gold, but because the dredges used have not been sufficiently strong to overcome the obstacles met with in the shape of sunken timber and large boulders, nor been capable of dredging deep enough to obtain the precious metal, which I have no doubt exists almost everywhere on this golden coast.

On the sea-shore, extending for hundreds of miles, are sands laden with fine gold, and being constantly renewed. A fortune awaits the inventor who will discover a process of washing this sand or extracting the gold therefrom so that none may be lost.

BLACK-SAND BEACHES ON THE WEST COAST.

By Robert Tennent and Arthur H. Richards, Inspectors of Mines.

In 1864 a party, consisting of Messrs. Alphonso Barrington, Antonio Laurie, and James Farrell, made several prospecting trips from Queenstown towards Jackson's Bay, and during their travels endured great privations, so much so that when the party arrived at Constable Winter's quarters, at the head of Lake Wakatipu, they presented the appearance of living skeletons. Barrington stated, after their arrival in Queenstown, that he had found some quartz reefs, and in consequence a small vessel was built and fitted to take the party to Jackson's Bay; but, although the Arawata (or Jackson's Bay) River was prospected for a distance of forty-five miles, nothing of importance was found; and on their return they washed some prospects on the beach at Jackson's Bay, which they considered would only give an average return of 7s. 6d. to 10s. per day to each man. In the vicinity of the Teremakau a man named Albert Hunt averaged £2 per day for some time, and was awarded a bonus of £200 by the Canterbury Provincial Government, and in December of the same year about fifty men took up claims on the Saltwater, about sixteen miles from Okarito, where they did remarkably well for a time. At present there are small parties who earn a good average living by what is known as "blacksanding," and between Jackson's Bay and Karamea the most favoured beaches are Bruce Bay, Gillespie's Beach, Sandfly Beach, Five- and Three-mile Beaches, Okarito, Saltwater, Paroa, Barrytown, Brighton, Charleston, and Mormontown. On the Three- and Five-mile and Sandfly Beaches, within a radius of sixteen miles of Okarito, all available labour in the locality has found remunerative employment during the month of May, 1906, the tide being favourable. Probably the most lucrative black-sand claim on the coast is Powell and Sons' sluicing and elevating claim on the Charleston Beach, the sands being treated over a series of outside copper tables. Some years ago the Hon. the Minister of Mines offered a bonus of £2,000 towards the discovery of a process whereby these black-sand deposits could be profitably treated in large quantities, but, notwithstanding that test samples of rich auriferous black sands have been forwarded to Australia and the Continent of Europe for scientific treatment, the solution of the problem still demands further research.

GOLD-MINING IN SOUTH WESTLAND.

By Wm. M. Hitchin, Ross, Westland.

Beach Auriferous-sand Deposits.

Having had a long experience of black-sand workings, I have been requested to give my impressions regarding the deposits and industry as far as my knowledge of the subject goes. It is right, however, in the first instance, to state broadly that the conditions vary very materially in different localities. For instance, north of the Grey River, from the Twelve-mile Creek to Razorback, the gold is made at neap tides, which gently reduce the deposit of gold-bearing sand washed by the spring tides among the boulders forming the rim of the beach, while south of Ross it is the high spring tides during northerly weather which comb down the beaches and deposit the black auriferous sands.

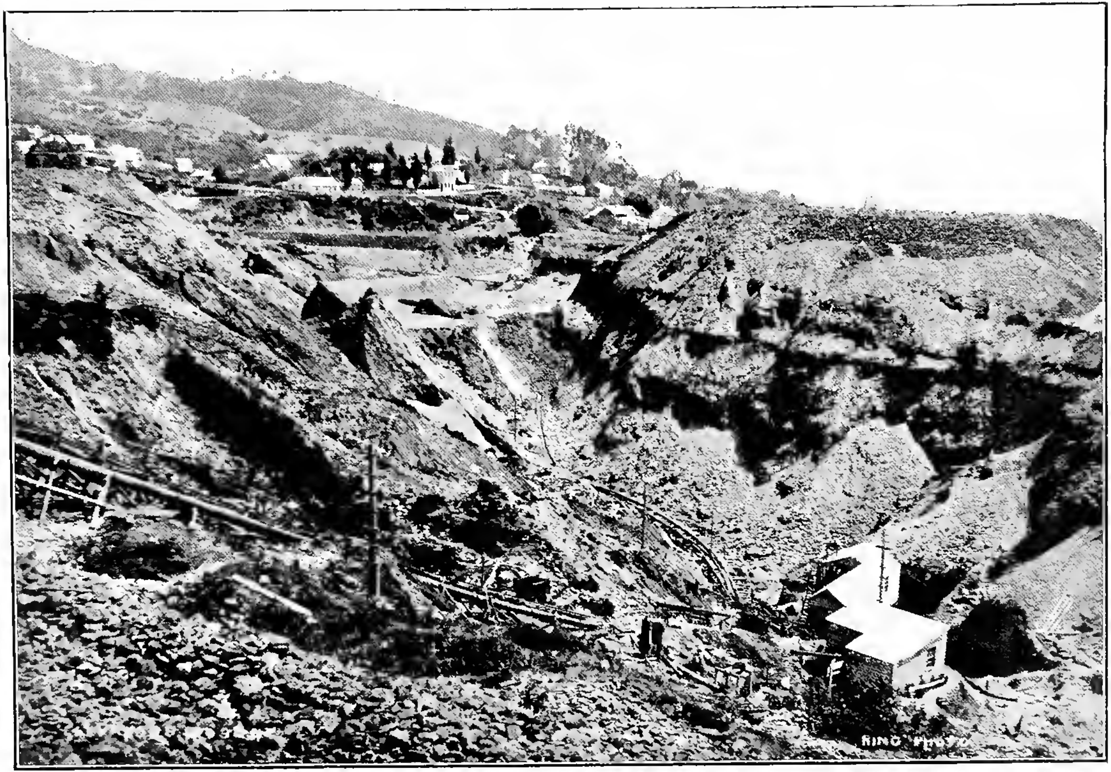
From Hokitika northwards old beach deposits gradually rise from the sea-level, and have been worked in many places to great profit by sluicing. The terraces on which payable gold exists increase in height at an apparently uniform grade from Hokitika to Charleston, where sea-sand is said to be found 500 ft. or 600 ft. above high-water mark. The majority of gold-bearing terraces run from 40 ft. to 150 ft. above the sea, but some that have proved very remunerative are at a still greater altitude above the present ocean-beaches. From Hokitika southward all the ancient deposits (if there were any) dip at the same angle as they rise to the north—a fact which unmistakably shows that at some remote period in the past the Westland beach-line was uplifted to the north and correspondingly depressed to the south. Thus, south of Hokitika there are no marine deposits on higher levels beyond the existing rim of the beaches; the "terrace bottom" (*i.e.*, gravel wash) abuts on the lagoons. Some thirty-odd years ago the beach proper averaged from 5 to 7 chains in width from the lagoon on the Waitaha South Beach (now known as Hitchin's Beach). Since then the sea has gradually encroached, making from time to time sand in places worth washing, until the whole of the old beach was cut away as far back as the lagoons. While this was progressing the "blacksanders" reaped their harvest, which is unlikely ever to recur, for the sea very soon fills up the vacancy made with barren sand or shingle. What old leads there were then were washed out in detail, and most of the gold secured by the busy "blacksanders" in the process.

Further south different conditions exist, the beaches varying much in width and depth, while many of them are still intact, and when the process of denudation by the sea takes place in these localities there will be a rich harvest for the "blacksanders" of that day.

The accepted theory is that the gold obtained has come down the rivers along with the heavy sand in which it is found, and has been gradually deposited on the beaches by the action of the tides and currents during past ages. Consequently, where what is called the "maiden beach" has all been cut away, it is hopeless to expect a repetition of the "good old times," as the travelling deposits are too scanty and poor to deserve attention. Such is the conclusion I have arrived at with respect to those beaches that have been denuded by the sea and re-formed with fresh *débris*, which, for the most part, is practically barren.

Ross Flat and its Possibilities.

The auriferous alluvial deposits of the Ross Flat are perhaps the most remarkably situated gold-bearing gravels in New Zealand or Australasia. Consecutive layers of false bottoms, upon which the more or less rich gravels rest, occur



Hydraulic Sluicing at Ross, Westland, showing Elevators and Pipe-line.

Mining Handbook.

one after the other eight times to a depth of 390 ft., which is as far as the Ross United Company's shaft was sunk, and even at that depth there appeared no indication of a real bottom. Of course, it is apparent that this vast deposit of alluvium must have been formed at a vastly higher level. It seems as if the adjacent mountains had been forced upwards by subterranean causes, and that the normal creeks and terraces of ancient watersheds were sunk in successive stages at different periods, as indicated by the many false bottoms, to the present site, some of which have been found over 300 ft. below sea-level. (I may say, parenthetically, that the fullest information as to the value of the respective layers of wash gone through by the Ross United Company's shaft are available from the books of the company.) The great cost of fuel and the inadequacy of engine-power were the reasons that the work so courageously undertaken by the company had to be abandoned. Old miners who worked in the shaft say it was sunk in the wrong place, and that further down the flat there would be very much less trouble with water. However that may be, there seems to be no insuperable difficulty in working these great deposits, as many mines at Ballarat and elsewhere, under greater difficulties, and at an equal depth, have been successfully explored and made to yield up their riches to the enterprising miners, to the advantage of the country in which they occur. The use of steam-power for haulage purposes, as generally adopted in the past, will, however, always be a source of very great expense, even when railway communication reduces the cost of fuel to less than one-half of what the company had to pay for firewood; while the cost of bringing in sufficient water-power seems impossible, and would, at any rate, be prohibitive; besides, the expense of maintenance of races is always very considerable. It seems, therefore, feasible that, in the case of the Ross Flat, the dynamo should be put in requisition to secure the power running to waste in so many localities in South Westland, and transmit it by cable to where it can be utilised to the great and permanent advantage of the district and the colony at large. I need scarcely point out how electricity is becoming more and more a factor in the world's industries every year—so much so that it seems destined to supersede steam-power altogether. Associated with the late Mr. T. Perham, Water-conservation Engineer, when he was in Ross some years ago, was an electrical expert, who it was reported at the time was well satisfied with the facilities for erecting a powerful dynamo at the gorge of the Mikonui River. It was then said to be his opinion that a head-race, some 15 or 20 chains in length, might be easily constructed to convey thirty-five to forty heads of water to an almost vertical fall of 120 ft., sufficient, as was asserted, to generate 300-horse power, which might be conveyed by cable along the wide river-bed, and along the Main South Road to the point required, a distance of only seven or eight miles. I have been informed by a well-known electrical firm at Dunedin that the initial expense of erecting the dynamo plant and cable is practically all the outlay required, as the upkeep of the plant is comparatively nil. Given the lifting-power, many claims would speedily be taken up on the flat on the old basis of ten to twelve working-men, who would most willingly pay interest on the cost on the same lines as the Kumara miners do for their water-power. How far the deep auriferous gravels of Ross Flat extend is not known; the deep ground, however, is known to continue south as far as Donoghue's, while to the north in all probability it extends beyond the Totara River—a rich gold-bearing stream which must have contributed largely to enrich the deeply buried gravels. Beside the Ross United, there were two other shafts sunk in the Ross Flat—viz., No. 2 shaft, which utilised a horse-whim as far as such limited energy permitted; and the celebrated Cassius Claim, whose prosperous career, before it was cut short by the inrush of water from the older and shallower workings, has become a matter of history in the annals of the district.

Duffer's Creek and Mount Bonar.

Duffer's Creek is situated about twenty miles south of Ross, and is the watershed from Mount Bonar, which spreads its broad base from the Waitaha River to Evans Creek, a distance of some fourteen miles. This beautiful mount rears its lofty wooded cone direct from the shore of Lake Ianthe, and greatly enhances the attractions of that picturesque sheet of water. The steep sides of this mount, so plainly visible to the excursionist afloat upon the lake, are practically a *terra incognita*, although so near to the Main South Road, and in close proximity to the oft-frequented lake; the foot of man has seldom, if ever, climbed its bush-entangled sides—the breeding-place, and hitherto the safe retreat, of the wild pigeon, kaka, weka, kiwi, and many other kinds of native birds. About 300 ft. above the road, and clinging to the side of the mount, are the remains of a terrace, that extends all round as far as Evans Creek, a distance of four or five miles, which in all probability is gold-bearing, for during the construction of the road gold was found by the employees in the *débris* beneath it, and a half-ounce specimen was got from the wash of a small creek which is spanned by a bridge at the top of the zigzag that leads down to the shore of the lake.

Duffer's Creek, the subject of this sketch, takes its source from the heart of the mountain, and crosses the Main South Road several miles to the north of the lake. Its name is a misnomer, given in the early days of the Coast by some disappointed miners, who, after a hasty inspection, departed without giving it a fair trial. Since then considerable gold has been obtained from the upper portion, commencing a mile or so below the road and up the stream and its tributaries and terraces as far as the narrow rock-bound gorge of the mount. Europeans and Chinese in turn more or less successfully worked the gold-deposits of the creek, and nine or ten of the latter, on leaving, went direct home to their "flowery land," the possessors of 10 lb. to 14 lb. of the precious metal per man, which meant, as they stated, a moderate competence in their own country. The district is now practically deserted, but while it was in work many beautiful quartz-specimens were obtained, leading to the general conclusion that a gold-bearing reef permeating the mount was the source of the more or less rich deposits found. Personally, I am able to confirm in some measure that opinion, as on one occasion, while climbing the spur that divides the left branch from the Waitaha Valley, I found a specimen of much-honey-combed gold, weighing 1 dwt., in a small hole of the bare reef nearly at the top of the spur. I mention the matter for the information of any party who may think it worth their while to give the locality a trial, which can easily be done, as the spur at that place is very narrow, and a short tunnel might disclose a very important find.

The country to the south of Duffer's Creek, between the lake and the ocean, I always considered to be well worth prospecting. While seeking straying stock one day I ascended a hill some 500 ft. to 600 ft. high on the south side, and found what seemed payable gold in a small creek running south into an extensive flat country. The result was that some half-dozen parties of Ross miners obtained about 200 oz. of gold by box-sluicing in rainy weather. The flat into which the above creek empties is extensive, and with occasional ridges and terraces continues as far as the Wanganui River, gold-colours being obtainable from every little creek that from time to time I have tried. Within sight from the top of "Hitchin's Hill," as the miners called it, is to be seen the terrace about half a mile distant, bordering Lake Ianthe, where the late Mr. John Allen had a sluicing claim. There are also many other indications that the untried country extending southward from the places named must contain more or less rich leads of gold, which, if discovered, would open up a very large mining district. The probability is, however, that the promising country I have attempted to describe will be left in abeyance until Westland becomes much more populous, and easy access is available by means of a West Coast railway connecting with Otago.

WATAROA RIVER.

By Alexander Gunn, Wataroa, South Westland.

So far as gold-mining is concerned, the Wataroa River has been a very poor one, compared with some of the others

Hydraulic Sluicing at Ross, showing Nozzles at Work.

on the West Coast. The best patches I have known seldom gave more than good wages. The gold that has been got has been technically called "drift"—*i.e.*, simply thrown up on sheltered beaches below a sharp bend. There were over forty men on the river the first winter it was opened, and nearly ever since there has been one or more fossicking on it, and occasionally striking a good-wages patch after a big flood. The main bottom has never been touched, so far as I know, except on one occasion by two mates and myself, about ten miles from here, up the Perth branch. We got colours of gold in a saddle above the snow-level on the main range; it was very fine gold, but the sample varies very much in both branches from fairly coarse to the fineness of flour, mostly the latter kind.

Tin, Antimony, Copper, Scheelite, and Silver.

There are traces of tin, antimony, copper, and scheelite, as well as gold, but whether in payable quantities remains to be proven. I know of a big reef containing copper, but not in payable quantity—at least, not at present; I had some of it tested. The reef also contains traces of gold. There is a small silver leader about 6 in. in width, but I have seen no trace of a golden reef anywhere, and have only heard of two quartz-specimens being found. One I picked up myself in the claim where we worked on the main bottom, weighing over 2¼ dwt.; the other specimen was picked up lower down the same branch, and it weighed just over a pennyweight.

MINING POSSIBILITIES IN SOUTH WESTLAND.

By W. H. Harris, Pakorari, South Westland.

Possibly a brief sketch of the past history of mining affairs in the far south, with a prospect of what is likely to come if followed up with energy and perseverance, may not be out of place. In the early part of the mining rush to the Coast a number of the hardy old sort of diggers—men who would risk their lives and go to strange places for gold—were prospecting and exploring the southern part of the Coast from Riverton to Okarito, principally in search of gold. A number of them came round in surf-boats and small craft prospecting the sounds, beaches, and rivers along the coast-line. They found gold almost everywhere on the sea-coast and in places inland for about two or three miles. Some of this gold was worked with good results—more of it patchy, and known to the digger as "stringing" gold; but, still, the gold was there, as well as other valuable metals, though not in sufficient quantity to pay the ordinary gold-digger. This is left for the present or future generations to exploit, and I have no doubt that it will eventually be well worth it. Through the energy and pluck of these men, this rough and rugged southern coast-line was transformed into busy places.

South of Okarito, the Three-mile, Five-mile, Gillespie's, Hunt's, Bruce Bay, and Haast Beaches, with many small places between, were all rushed and worked, and some of these beaches gave many a digger a fortune. They were all black-sand leads made by the sea, and truly a "golden coast." One may ask, "Where did all this gold come from?" The only solution to this question is that, in the first place, it was washed out by the rivers from the interior, then cast up on the sea-beaches, mixed with tons upon tons of sand and gravel, then combed down by certain winds and ocean currents, till a seam of black sand and gold remained. These, in the course of time, would be covered up with wind-blown sand by the action of the sea and other causes, until some of these leads were deep from the surface, requiring pumps and, in some places, water-wheels to drive them, and then only a portion of the lead—perhaps the best part—was got. The rest—the deeper part—was left, and in some cases is there still, being too deep to work by these means; and there it is likely to remain, as well as other deep and little-known leads, which are waiting for an up-to-date dredge or some other mechanical means to make them pay. Does all this not go to prove that the country inland contains gold somewhere? All the gold in these leads was very fine—as fine as flour; therefore, the only thing to infer is that the coarse gold has been left behind—perhaps deep in the river-beds and gullies, or buried in the sidelings and terraces, and there it has to remain until some fortunate prospector is lucky enough to discover it.

The inland country in the far south is very little known to the prospector. The bulk of the diggers have worked the remains of the beach leads—that is all they could work owing to want of water—and some have worked on the coarser known deposits inland, but very little prospecting has been done in a systematic way. The old-time school of digger has long since left for other golden countries; others have "crossed the border," never to return, and the few that remain are too old and used-up to tackle rough work of this sort. The present generation do not seem inclined to prospect this inland country. To begin with, they do not know how, and they lack the funds. It takes money to prospect deep and difficult country, and that they have not got. They are generally more disposed to take up land, make farms, and raise stock. This will give them bread and butter, and so this inland country is left for speculative men with means at their back to prospect the interior, where, doubtless, there is a good field awaiting them for their pluck and outlay.

In 1873 gold was found in a block, known since as "Bullock Creek country." Here was a splendid sample of coarse gold—some of it up to 5 oz. pieces. I myself had about 50 oz. in one parcel, and, with the exception of about 2 oz. of small gold, the whole lot weighed from ½ dwt. to 4 oz. A rush set in here, but was of little consequence, for the gold was found only in a small area of country. Many of the men who came to this rush had left good claims and homes elsewhere, and when they found the best ground taken up they were eager to return; therefore the surrounding country got very little further prospecting. It was a very rough country, without roads or tracks, and dangerous to travel on account of bad bluffs and rivers. Most of the men came by steamer into the Haast River, and went back the same way. Since then a number of men have been fossicking in the old workings, but they were not exactly the sort to further explore the surrounding country.

Coal was also found in this block, and copper and mica in the range at the back, but these minerals have never been tried or prospected much, owing to the old story—lack of funds.

Later, when the dredging-boom was on throughout New Zealand, a number of areas were taken up here, but they fell through before a trial was made in this direction. Possibly the claimholders had no knowledge at that time how to deal with fine gold on a large scale. They, doubtless, will surmount this difficulty as time rolls on, and then the southern beaches and rivers will be valuable property.

Further south coarse and fine gold has been found, and worked nearly to Milford Sound. This, with a few exceptions, has been entirely along the sea-coast line, and in this block it is still the same old story—very little known of the inland country.

Metals and minerals of value have been found in the Red Hills on the Cascade River, in and on the Gorge River, Big Bay, and many other places that would pay the prospector to look into. It is of little use looking along the coast-line. These places have all been worked, and until a means of saving fine gold on a large scale is discovered there is little there worth attention; but there is room for energetic men with some capital who would systematically prospect the inland country of far South Westland.

These notes, from a man who has spent more than half a lifetime on the South-west Coast, principally in mining, may be of some little assistance to the future prospector in these promising regions.

Hydraulic Sluicing at Ross, showing Pipe-lines and Giant Nozzle.

Mining Handbook.

SOUTH WESTLAND AS A GOLD AND MINERAL COUNTRY.

Notes describing the Auriferous and Mineral Country between Waiho and Cook's Rivers and further South.

By J. RITCHIE, Bruce Bay, South Westland.

OMOEROA Creek is situated within about two miles of the Waiho River at its effluence. Running parallel with the coast-line, three miles inland, is an alluvial lead of cement wash. Fifteen years ago a party of three men obtained gold which gave them £500 each for twelve months' work. The *modus operandi* was by burning the cement. Gold is obtainable in almost any part of this cement lead, and the probabilities are that similar rich patches to the one mentioned exist. The surroundings are rough and heavily timbered, but, nevertheless, are well worthy the attention of persevering and intelligent prospectors.

Concerning the creek, a strange feature exists—viz., at its extreme head no gold is to be obtained. This will be from the south-western slopes of Mount Cook. The stream is about ten miles in length, and flows direct to the ocean. At three miles from the entrance the bed of the stream was worked in the early days at a profit, and gold with quartz attached was often found—in fact, the Omoeroa Creek was a byword for specimen gold. This augurs well as an indication of auriferous-quartz reefs in the near locality, and should also command the attention of prospectors in search of quartz reefs.

The Waikukupa River is two miles south of the Omoeroa Creek, and is similar in character in every respect to the description given above. It may be termed a sister stream. At the extreme mouth payable gold can be obtained, even at the present day, apparently brought down by diluvial action.

Cook's River is a hundred miles from Hokitika. Eight miles from the Main South Road, and up stream, the right-hand branch heading from Mount Cook was worked profitably for some years by wing-damming and other methods. It is rather rough with boulders, but to enterprising men these are to be managed. There is any amount of unworked and available ground to be obtained. These flats would require heavy tail-races and water-wheels. As an instance, twenty years ago a party, from a paddock 40 ft. square and 20 ft. in depth (unbottomed), got 70 oz. of gold. The great difficulty they had to contend with was the water. There was easier ground to work in those days, and the party disbanded; but rich gravels are there in those river flats to reward strong, active, and robust men; or perhaps dredging would be the better plan to deal with these gravels. Wages also can be made in the terraces. The gold is from fine to shotty.

Referring again to the Waikukupa, the country south and towards Cook's River, about four miles inland, is a succession of terraces, worthy also of the attention of prospectors. A little gold was found in the early days, but the difficulties of the dense, impenetrable forests retarded any exploitation, or of such a kind that the locality warrants. If it had been in some more central place, probably something would have been discovered long ago. The country described above appears to be the end, southerly, of the auriferous zone from Ross and the various districts northerly.

Gillespie's and Karangarua River.

The rock formation traversing south from these localities to Oinemaka (or Black) River, five miles south of Bruce Bay, is quartzose schist. In the left-hand branch of the Karangarua River great outcrops of hæmatite are to be seen. These and the quartzose-schist rocks denote the strong probability of cupriferous or other mineral ores. No prospecting has been done by an expert to ascertain the nature of these indications. These hæmatites are useful in the manufacture of paints.

At the Oinemaka River the formation changes to granitic. Here, again, no prospecting has been accomplished. It is on the cards that the granitic country may be stanniferous, and the very high price for tin ought to offer an inducement to the expert tin-prospector to overhaul this country to determine if the oxides exist or not.

Between the Oinemaka and Paringa Rivers the country is elevated, and on the falls south another change in the formation occurs, and you are in a coal-measure; an outcrop of bituminous coal occurs on the surface, but its width and other dimensions are unknown, for, apart from an occasional bag or so being rooted out by one or another, no development has taken place. This coal is pronounced to be of excellent quality.

At Paringa River, ten miles south of Bruce Bay, twenty years ago, a local syndicate found a complex ore containing silver, antimony, and a small percentage of gold. This also has not had sufficient attention devoted to it, and the extent of the deposit, or lode, is undetermined. Being isolated, the affair dropped out of sight.

Abbey Rocks are on the shore five miles south of the Paringa. On a hill facing the ocean the country rock is a calcareous, or limestone, formation, and the indurated portions of it are adaptable for lithographic purposes. At a depth away from the disturbances effected on the surface the stone ought to prove more solid and defined, and proving the stone at depth should have been the procedure of a company who thirty years ago expended £1,000 on the venture. Similar rocks are obtainable in more accessible parts of the world, and the utility of the Abbey Rocks lithographic stone may be recognised in due time.

South of the Abbey Rocks to the Blue River another auriferous belt traverses the country. Twenty years ago, and subsequently, several parties of diggers averaged wages, and sometimes smaller returns. Odd parties at times have even done better; for instance, a party of three men made £1,000 between them in a comparatively short time in working a terrace, and two others got 80 oz. of gold in working a small creek running into the river. Gold can be found all over the surrounding country, but it was, and is still, very rough, and difficult to obtain supplies; hence this part of the West Coast has not had sufficient attention paid to it by prospectors.

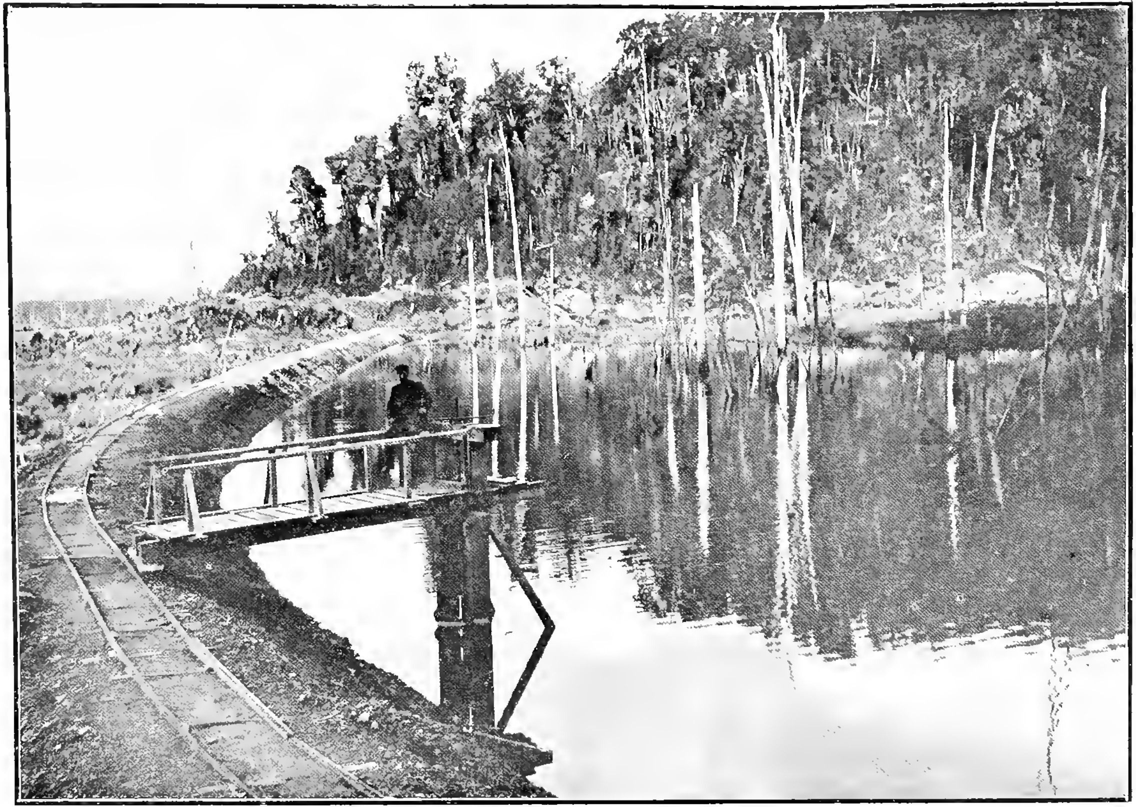
Eight miles further south of the Bluo River there is a succession of terraces and gullies, similar to Omoeroa Creek, described above. Twenty-five years ago a rush set in at a place called Bullock Creek, and some thousands arrived there. Although several hundred ounces of gold was obtained, there was not inducement enough for a large population in such an isolated locality. The ground worked was shallow, and the gold was of a coarse character.

Immediately near the coast is a cement wash, at what is called the Sardine Terrace. Gold is known to exist in this formation, and is pronounced to be payable. Six years ago a syndicate secured the ground, and partially constructed a water-race. The isolated position, again, similar to other worthy mining projects in far South Westland, deterred them from further operations; but the locality will have its day in the near future.

Copper Creek is five miles further south. For years past cupriferous ores have been known to exist in this locality, but no systematic search or development has ever been undertaken by an expert in mineral ores to test the dimensions, conditions, and value of such deposits as to whether they are good, bad, or indifferent, or whether they occur in veins, lodes, or deposits. The high prices ruling at present for copper and tin will, no doubt, stimulate prospecting around this district.

The Auriferous Black-sand Industry.

Apart from other mining pursuits and their future prospects, and the probabilities of new discoveries in gold and mineral ores, is the black-sand industry. All along the coastline described from the Waiho to the Haast Rivers this mode of gold-winning has been a source of considerable profit for many years. Of course, the first working would be the accumulated deposits of gold-dust from time immemorial by the ravages of tempests, but, nevertheless, even at the present day scattered parties here and there along the coast beaches, after heavy surf beatings, get nice patches of the precious metal. Some maintain that the gold-dust is due to marine agencies, ground from the ocean bottom, while others contend that the heavy surfs beating on the beach-washes inland is



Government Dam, Middle Branch, Kumara Water-race.

the cause. Both theories are, apparently, feasible, and perhaps both actions are independently responsible for the black-sand deposits.

When the dredging boom was on, these auriferous beaches were all taken up, and at Gillespie's Beach a suction dredge was erected, but this proved a failure, owing to its inability to profitably raise sufficient wash. Bucket dredges must be the mode of working. This industry will last for many years, and if proper appliances are adopted there is no fear of the result. At times dredges would have to cope with stones and timber, but these would not prove such a drawback as in many other places.

Every heavy storm adds its ounces of gold to reward the beachcomber, and the heavier the surf the better for him.

In conclusion, I desire to acknowledge Mr. A. McPherson's valuable aid in the compilation of this short paper, which I trust will be the means of attracting public attention to a part of New Zealand that is too little known to the general public.

THE GOLD AND MINERAL WEALTH OF THE WEST COAST.

By J. Bevan, Merchant, Hokitika.

In a paper read at the Town Hall, Hokitika, on the 27th August, 1895, by Mr. J. Bevan, formerly member of the House of Representatives, reference was made to the fact that from Cape Farewell to the confines of Otago there is a stretch of mineral country, hundreds of miles in extent, with indications of immense wealth, extending from the sea-coast to the dividing-range. Nearly every river and its tributaries bears evidence of this fact—apart from the gold-deposits existing on the ocean-beaches, held in the black sand in a finely divided state—and is always suggestive of the great main sources from whence it is derived. This West Coast forms one of the most interesting and extensive fields for research. It is rich in the possession of untold wealth, as evidenced from its discoveries and its steady output of gold. It is figuratively, and in some places quite, an unexplored portion of New Zealand, capable of absorbing an enormous population, and with salubrious climatic advantages.

After referring to the marvellous results obtained from fissure-lodes in the granite formation in Montana, where the Great Granite Mountain Mine paid £3,000,000 in dividends in ten years, and to the Alaska-Treadwell Mine, which paid £80,000 annually in dividends from low-grade ore only worth 13s. 9d. per ton, Mr. Bevan referred to the discoveries of quartz veins in the main belt of granite at Mount Wills, Victoria, embracing an area of forty square miles, and pointed out that similar granite formations are the leading features observable for hundreds of miles in the great auriferous belts of the West Coast; gold had been proved to exist in these formations, scattered over an immense area, and was obtainable in any of the granitic formations.

Amongst other discoveries on the West Coast, Mr. Bevan referred to that at Langdon's, in the Grey district, the ore from which had given phenomenal assay returns; to the surface reefs at the Taipo, rich in the precious metal; to the coal-deposits at Gentle Annie and Camelback; to the rich and promising reefs at Cedar Creek; to the auriferous and argentiferous lodes at Mount Rangitoto; to the argentiferous galenas found in the Totara and in the neighbourhood of Mount Bonar; to the splendid coal and rich carbonates of copper found at the Haast River; and to many other discoveries of tin, nickel, &c., all object-lessons of great value and importance. Unhappily, development had not succeeded discovery—not on account of the want of enterprise on the part of individuals, but to want of necessary capital and lack of the scientific and technical skill to cope with such undertakings.

As to deep sinking, nothing of importance had yet been accomplished, beyond what was done in Reefton in quartz-mining, and at Ross in alluvial workings. In the latter place, the Cassius Claim was an example of what might be expected if deep sinking was proceeded with on systematic lines.

The operations of the late Mr. Cassius, who was one of the most enterprising men in Westland (commercial and otherwise), solved, in his mining venture at Ross, a most interesting problem in the development of the rich auriferous deposits of the Ross Flat. He proved the existence of gold at deeper levels than were ever worked before, the wash being much richer than in the upper workings, which were all on false bottoms, even to the bottom worked in the Cassius Claim, which was also a false bottom; nevertheless, in eleven months' working on that bottom gold was obtained to the value of £18,726. It was no unusual circumstance to get from 30 oz. to 50 oz. per day. The work was carried on under exceptional difficulties, having to combat a heavy body of water with inadequate machinery at a period when everything was of a costly nature and wages abnormally high. The Ross Flat has always been looked upon as a basin of gold, and, should a proper and efficient system of drainage be adopted, no finer field for mining enterprise exists in the colony. The Ross Flat is surrounded by gold-bearing belts of country, indicating great possibilities when work is scientifically and economically undertaken.

WAITAHA RIVER TO BIG BAY.

By G. J. Roberts, Commissioner of Crown Lands, Westland.

The following notes as to metals, minerals, &c., occurring between the Waitaha River and Big Bay may be of some value to prospectors and investors:—

Gold-bearing Gravels, &c.—These occur on banks and bars of nearly every river, and also fringing the terraces and plateaux between the foothills and the sea. If water were brought in, undoubtedly remunerative sluicing would ensue. Best localities: Omoeroa, Cook River, Paringa, Abbey Rocks, Bald Hill, Bullock Creek, Sardine Terrace, Stafford River, Gorge River, &c.

Surface prospecting has overtaken the greater portion of the country, but there are still many square miles of virgin areas; and it must be especially emphasized that none of the deeper ground has been tested at all, because the water has always prevented the ordinarily equipped digger from sinking any moderately deep shafts.

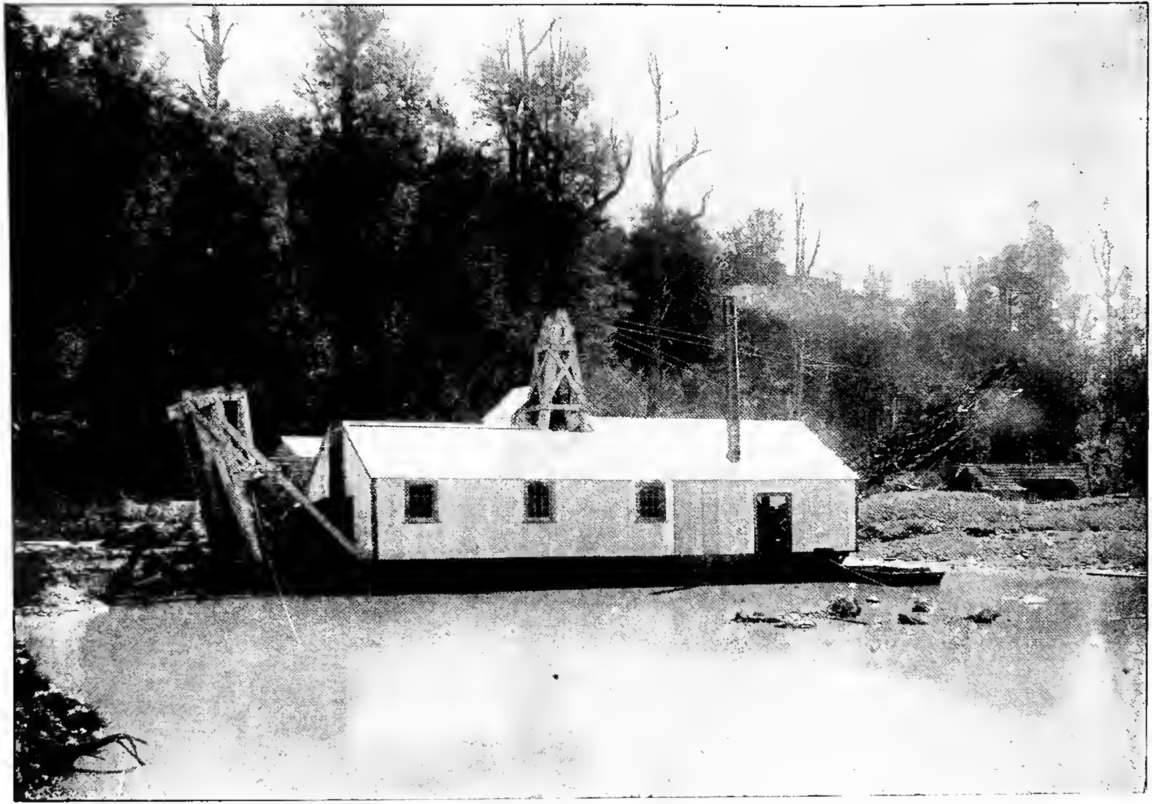
Auriferous Sands occur all along the sea-beaches, not only on the open shore, but also in "leads" more or less parallel with the present seaboard. These "leads" are ancient sea-deposits, and indicate former shore-lines. Despite the continuous workings for forty years, many of these beaches still yield small wages to the individual miner, and after heavy weather really good returns are made, owing to the sea cutting down the beaches and concentrating the gold which occurs throughout the immense sand-dunes. Much fine gold is also thrown up on the beaches by the surf, and this induces the belief that payable gold may exist on the outside bank which everywhere runs parallel with the shore. This sea-covered bank could only be worked by dredges. Many ancient beaches also occur in the swamps along the seaboard, and as these are in waterlogged country they can only be worked by dredges. I consider these would be found very rich in several localities. "Raised" beaches also occur all along the seaward slopes; these are gold-bearing cements, and though their continuity is much broken by the erosion of the rivers and streams, yet many strips of these rich deposits remain undisturbed.

Auriferous Quartz has been found at Evans Creek, and in the valleys of the Wanganui, Callary, Cook, Paringa, Jackson, Cascade, and Gorge Valleys, but as yet no payable reefs have been exploited.

Silver-ores.—Galena has been found at Evans Creek, Cook River, Mount Argentine, Blue River, and Jackson Valley.

Copper occurs at Wanganui River, Paringa, Matakitaki Range, and on the Red Hills behind Big Bay.

Iron-ore (*Chrome*).—This occurs at Fox River, and on the Red Hills in large quantities.



Mining Handbook. RED JACK'S DREDGE, NEAR NGAHERE, WEST COAST.

Coal occurs in patches, more or less extensive, from Paringa to Smoothwater—close to the coast.

Limestone accompanies the above coal-measures.

Millstone Grits occur at Smoothwater Bay; also good freestone around Jackson's Bay.

Building-granite is found at Mount Bonar, &c.

Asbestos is found on the Red Hill country near the Cascade River.

NOTE.—Westland is just about dead for want of prospectors.

GOLD-DREDGING ON THE WEST COAST.

By ROBERT TENNENT, Inspector of Mines, and ARTHUR H. RICHARDS, Assistant Inspector of Mines, for Marlborough, Nelson, and the West Coast.

ALTHOUGH gold-dredging on the West Coast has not of late years favoured the anticipations so strongly announced by the original promoters in the early history of the industry, the fact remains that, where care and ordinary skill were exercised in the selection of dredging-areas, and the affairs of the company were directed under the auspices of honest and judicious management towards the interests of the shareholders, the claims still continue to give satisfaction, and even on areas which, according to public opinion, were the reverse of favourable, success has seldom failed to reward honest effort when combined with common-sense methods.

It would serve no useful purpose now to enumerate the advantages and disadvantages as related to the probable success and failure of the industry, since we must be more concerned with the future, and take profit from the disappointing experiences of the past. It must be admitted that when the boom was pushed to fever-height there was extraordinary pressure on the physical capacity of the consulting engineer, while there was excessive employment of unskilled labour. These factors of rashness had not only a tendency to increase the ruinous breakdowns of machinery, but also resulted in an extravagant loss of time in effecting repairs. In fact, the cry was, "Get the dredge on the water, whether suitable or otherwise"; and, as a consequence, success was a financial virtue sure to be fettered with the inevitable breakdown.

In reviewing the general operations so far effected throughout the different auriferous areas operated on, it is noticeable that the beds of the Buller, Grey, Teremakau, and Hokitika Rivers, which drain the more important alluvial watersheds of Westland, and the Aorere River in Collingwood, have practically failed to maintain profitable investment; whilst, on the other hand, the tributaries have given, and continue to give, lucrative and payable returns—viz., the Nelson, No Town, Callaghan's, Blackwater, and Slab Hut Creeks, on the Grey River; Greenstone Creek, on the Teremakau River; and Boatman's Creek, on the Inangahua River (a tributary of the Buller River). In short, with the exception of the Old Diggings, New Buller Junction, and the old Premier (Three-channel Flat), now operating on the Lower Buller, dredging is practically confined to the tributaries above mentioned.

Some Particulars of Dredging Operations.

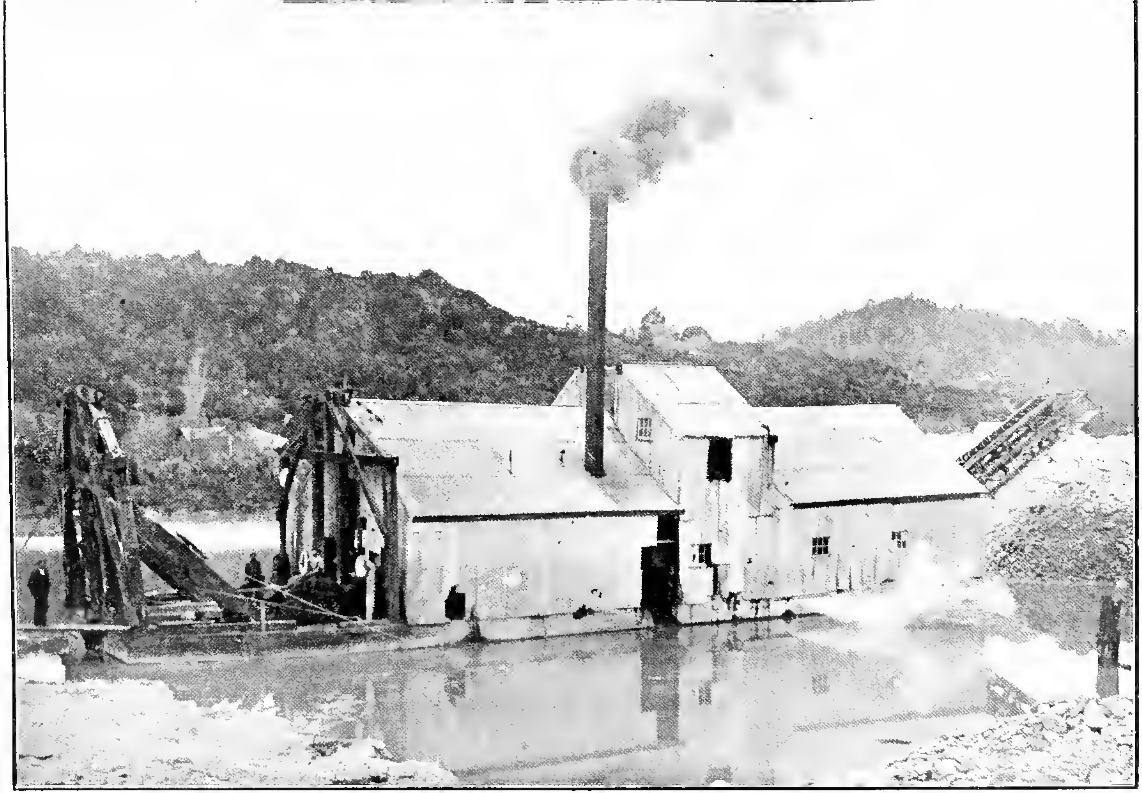
Blackwater River Dredge, Grey Valley.—The Blackwater River Gold-dredging Company was registered in April, 1900, with an area of 106 acres and 36 perches. The nature of the material operated upon consists of free wash without boulders; depth, 13 ft. from water-level; quantity raised per hour, 100 yards. During 1905 an area of 7½ acres was worked, the quantity treated being 516,000 cubic yards, and the yield of gold 2,030 oz. 16 dwt. 22 gr., value £8,058 16s. 3d. The total quantity of gold obtained since the dredge first commenced work has been 5,065 oz. 1 dwt. 18 gr., value £20,229 1s. Dividends paid amount to £6,395 12s. 6d. Cost of dredge, £5,060 13s. 2d.; property, £3,157 12s. 3d.; other plant, £351 17s. 6d The capital actually called up amounts to £8,891 18s. Average weekly cost of working, £75 to £80; average weekly cost of repairs, about £600. Length of pontoons, 90 ft. 6 in.; depth, 6 ft.; beam, 24 ft.; ladders capable of dredging 32 ft.; capacity of buckets (thirty-five), 4 ft.; rate of discharge per minute, twelve buckets. Length of elevator, 45 ft. Average number of weeks worked, thirty-three. Average number of men employed, eleven. Dredgemaster, M. C. Cuff; secretary, A. J. C. Brown, Dunedin.

Callaghan's Creek Gold-dredging Company has an area of 39 acres 3 roods 2 perches at Callaghan's Creek, about five miles from Ahaura. The company was registered on the 25th May, 1900, and commenced work on the 12th March, 1902. During the year 1905 the dredge won 1,324 oz. 3 dwt. of gold, value £5,264 0s. 10d., making a total of 4,296 oz. 13 dwt., value £17,097 19s. 9d., from which dividends were disbursed amounting to £5,750, while the total capital actually called up was £5,750, and the dredge cost £5,394. The pontoons are 60 ft. in length, 6½ ft. deep, 25 ft. beam; and elevator 36 ft. in length. There are thirty-six buckets, each with a capacity of 4 cubic feet, and capable of discharging at the rate of ten to twelve per minute from a depth of 22 ft. to 30 ft., the average quantity raised per hour being about 2,200 cubic feet of wash. The weekly cost of working (including fuel, &c.) was £110, and the yearly cost of repairs £300. The number of hours worked during the year was 6,406. Seven men employed. Dredgemaster, David Clark; secretary, Bernard P. McMahon, Reefton.

Greymouth South Beach Dredging Company (not registered), with a called-up capital of £1,287, commenced work on the 15th May, 1905, on a black-sand auriferous area of 70 acres, situated about three miles south from the Township of Greymouth. During the year 1905 there were 4½ acres of ground operated on, which yielded 170 oz. of gold, valued at £656. This dredge was originally named the "Stony Mosquito," and was repurchased, with other plant, water-races, dams, &c., for £1,550. The time worked during ten months and a half was thirty weeks, the average yearly cost for repairs being £800, while the working-cost per week was £38. The pontoons are 96 ft. in length, 8 ft. in depth, and beam 24 ft., equipped with a ladder, carrying thirty-eight buckets of 5 ft. capacity each, capable of discharging eight per minute from a depth of 26 ft. The sands, comprising one-fifth of the material lifted, are treated over plush-laid tables, 36 ft. by 8 ft., and the washed gravels elevated and discharged 55 ft. Average number of men employed, seven. Dredgemaster, George Vick; secretary, G. Perotti, Greymouth.

A1 Gold-dredging Company was registered in 1899, and the dredge commenced work in June, 1901, on a creek-bed area of 68 acres, situated on the Redman's Creek, Cronadon, and adjoining the areas dredged and owned by the Reeves Proprietary. The material dredged is an ordinary wash 15 ft. in depth. In 1905 9 acres of ground were worked and treated for a yield of 931 oz., valued at £3,440, and since work first commenced 3,800 oz. of gold won gave a cash value of £14,981. The capital called up has amounted to £8,500; dividends, £2,125; cost of dredge, £8,887; other plant, water-races, dams, &c., £1,659. Average weekly cost of work, including fuel, water, &c., £46; yearly cost of repairs, £198; cost of coal per year, £292; number of weeks worked per year, forty-seven, or 5,680 hours. Length of pontoons (wood) 95 ft., depth 6 ft., beam 30 ft.; fitted with ladders carrying thirty-five buckets of 4½ ft. capacity, of which nine to ten buckets are discharged per minute, and the sands distributed over a table-surface 12 ft. by 12 ft., while the gravels can be elevated to a distance of 70 ft. Seven men employed. Dredgemaster, Alfred Thomson; secretary, E. Walker, Christchurch.

Belle Vue Gold-dredging Company was registered on the 17th October, 1902, and dredging was first commenced on an area of 75 acres, situate on the Matakitaki River, near Murchison, in August of 1904. The wash operated on is sand and ordinary gravels, occasionally mixed with clay, the depth varying from 6 ft. to 23 ft., and the quantity of gravels raised and treated per hour gives an average of 90 to 140



Stafford-Waimea Dredge (Kumara District).

cubic yards. In 1905 29,040 cubic yards was raised from 13½ acres, and treated over a table-surface 18 ft. by 4 ft. 6 in., and ten tables 9 ft. by 2 ft., for a yield of 489 oz., valued at £1,924. Since dredging first commenced, 851 oz. 13 dwt., valued at £3,339, has been won, while the capital called up has amounted to £3,400, and the cost of dredge was £3,586 9s. 11d. Including fuel, water, &c., the average weekly cost of working is £51; yearly cost of repairs, £273; and yearly cost of fuel, water, light, &c., £480. In 1905 the dredge worked twenty-four weeks, at the rate of 120 hours per week, and during the year 2,561 hours, with seven men employed. The pontoons are 110 ft. in length, depth 7 ft., and beam 30 ft.; fitted with forty-two buckets having a capacity of 6 cubic feet each, able to discharge 60 cubic feet per minute and elevate 28 ft. The depth of auriferous gravels below water-line is 18 ft., with an overburden of 2 ft. above water-line. Dredgemaster, C. G. Morel; secretary, E. MacRae, Christchurch.

Jamieson's Reward Gold-dredging Company was registered in 1901, and commenced work in August, 1902, on an alluvial dredging-area of 112 acres, situate in Nelson Creek. The material operated on comprises one-fourth sand and three-fourths gravels, about 1,500 cubic yards per hour being treated at an average cost of 1½d. per yard. In 1905 11 acres of ground operated upon yielded 2,322 oz. of gold, valued at £8,625, and since dredging commenced 3,312 oz., valued at £12,782. Capital actually called up, £6,500; total dividends declared, 16s. per share; and cost of dredge, £3,500. The pontoons (wood), built to a total length of 90 ft., depth 6 ft., and beam 29 ft., are fitted with ladders carrying thirty-three buckets of 4½ cubic feet capacity, of which nine buckets are discharged per minute, and the sands distributed over a table-surface 12 ft. in length by 14 ft. in width. The average weekly cost of working is £80, and per year of forty-eight weeks worked, £466 14s. 9d.; during same period general repairs cost £1,500. Seven men are employed. Dredgemaster, A. Dalzell; secretary, E. A. Wicks, Greymouth.

New Feddersen Gold-dredging Company commenced work on the 2nd June, 1904 (registered 1st August, 1904), on an alluvial river-bed area of 10 acres, situate in the Buller River, near Lyell. The material operated on includes fine sand and gravels, with about 15 per cent. of large stones, some 1,800 cubic yards per hour being lifted from a depth of 35 ft. In 1905 the gravels raised and treated from 3 acres yielded 742 oz. 16 dwt. of gold, valued at £2,899 10s. 11d., and since work first commenced 1,654 oz., valued at £6,472 16s. 5d. The first cost of dredge was £10,400, the repurchase price being £2,000. The capital actually called up has amounted to £2,312 10s., and the total dividends declared to £1,271 17s. 6d. The pontoons (wood) are built to a length of 90 ft., depth 8 ft., and beam 30 ft., fitted with ladders carrying twenty-seven buckets of 6 cubic feet capacity, and discharging at the rate of nine per minute, while the sands are distributed over a table-surface of 12 ft. by 12 ft. The average weekly cost of working was £63; for the year of forty-one weeks, £590 9s. 9d.; and during the same period repairs cost £600. Eight men employed. Dredgemaster, Andrew Carnegie; secretary, Joseph Steele, Reefton.

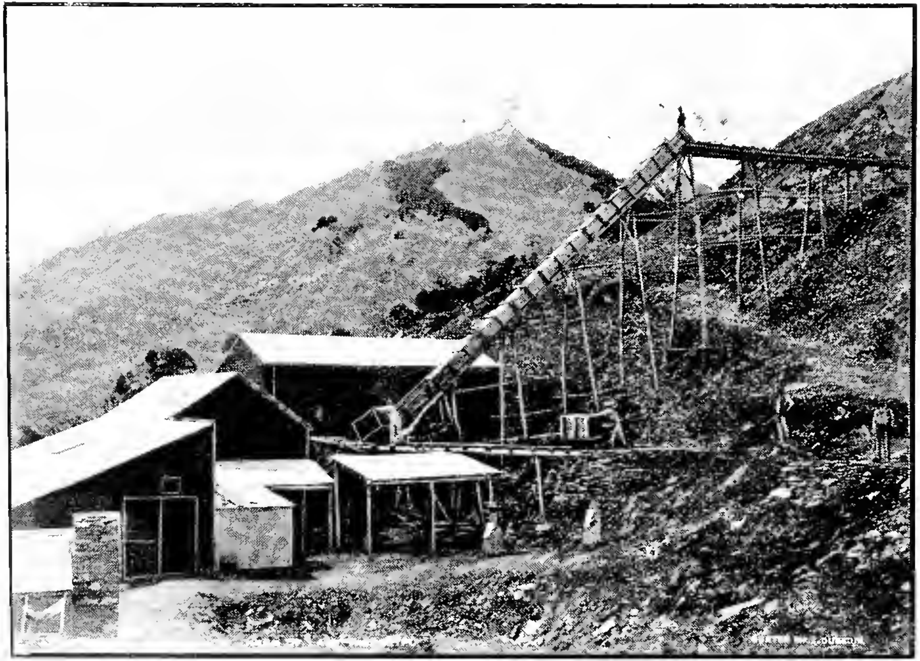
Old Diggings Dredge, Buller River.—Hansen and party, having repurchased the Old Diggings dredge for £400, commenced work on a river-bed claim of 4½ acres, near Berlin's, on the 9th February, 1903. The gold won in 1905 was 368 oz. 17 dwt. 22 gr., valued at £1,467 6s. 8d., and the total yield 1,101 oz. 8 dwt. 22 gr., valued at £4,479 2s. 1d. Two sets of ordinary tables are in use, with respective areas of 16 ft. by 12 ft. and 15 ft. by 7 ft. The pontoons are built of steel plate to a total length of 101 ft., depth 5 ft., and beam 20 ft. 6 in.; equipped with ladders which carry thirty-two buckets of 4 ft. capacity, and discharge nine buckets per minute from a depth of 25 ft. The elevator, 49 ft. in length, is set with trays at 6 in. centres. For wages and coal only the average weekly cost is £32; cost of fuel for year, £218 6s. 9d.; and repairs for same period, £450. Five men employed. Dredgemaster, A. Gillstrom.

Pactolus Gold-dredging Company has an area of 168 acres

1 rood 9 perches at Nelson Creek, situate about nineteen miles from the Town of Greymouth, on which two dredges are at work, both being capable of raising 6,750 cubic feet of wash per hour. The company was registered on the 30th August, 1899; No. 1 dredge commenced to work on the 14th March, 1901, and the No. 2 on the 10th September, 1902. Their united yields amount to 14,678 oz. 2 dwt. 3 gr., value £57,985 19s. 2d., and shareholders have received dividends amounting to £20,937 10s.; while No. 1 dredge cost £7,122 17s. 7d. and No. 2 £8,342 1s. 9d., the capital actually called up being only £8,125. During the year 1905 the two dredges won 5,863 oz. 3 dwt., value £23,179 12s. 9d. There are seventy-six buckets working on both dredges, with a capacity of 4½ cubic feet on one and 5½ cubic feet on the other, the rate of discharge from a depth of 25 ft. to 30 ft. being ten to twelve buckets per minute. The weekly cost of working both dredges, on which there are eighteen men employed, is £131 5s., and the yearly cost of repairs £1,500, the aggregate number of hours worked during the year on both dredges being 11,781. It is estimated that the claim will last five to six years, or about ten years from the date of commencing work. Dredgemaster, James Cowan; secretary, Bernard P. McMahon, Reefton.

Prince of Wales Dredge is operating on an area of 9 acres at Robinson's Creek, Donoghue's, near Ross, where work was first begun on the 13th October, 1903, the owners being a private syndicate. The wash operated on consists of auriferous sandstone intermixed with black manganese stones, and is dredged from a depth of about 30 ft. Since then the dredge has worked 2 acres of ground for a yield of 2,735 oz. 15 dwt. 4 gr. of gold, valued at £10,670, including 669 oz. 17 dwt. 18 gr., valued at £2,610, the result of dredging for the year 1905. The cost of the dredge has been £10,155 14s. 8d.; weekly cost of working, £50; fuel annually cost £1,098, and repairs £1,480. It is surmised that the claim will last twelve years, or fifteen years from date of commencing work, and that the land can afterwards be utilised for grazing purposes. Dredgemaster, David Graham; secretary, T. W. Bruce, Ross.

Stafford Gold-dredging Company (formerly Stafford-Waimea) was registered on the 17th May, 1905, and on the 5th June commenced dredging operations on an alluvial creek-bed area of 60 acres 1 rood 26 perches, situate on the Waimea Creek, Stafford, Westland. The gravels operated on, 25 ft. in depth, are heavily intermixed with submerged timber; the bucket-ladder can lift from a total depth of 32 ft. From the 5th June, 1905, to the 31st May, 1906, the gravels raised and treated from 5½ acres yielded 933 oz. 9 dwt. of gold, valued at £3,608 13s. 1d., and during operations by the Stafford-Waimea Dredging Company on the same creek the gold won amounted to 1,379 oz. 9 dwt. 23 gr., valued at £5,326 5s. 3d. The repurchase cost of the dredge, including claim and freehold land, was £1,734. Since registration the capital actually called up was £1 on 289 contributing shares, and the dividends £202 6s., being 2s. per share on 1,734 vendors and 289 contributing shares. The pontoons are built to a length of 110 ft., depth 6½ ft., and beam 31 ft., fitted with ladders carrying twenty-seven buckets of 4¾ cubic feet capacity, capable of discharging 1,710 cubic yards per hour, at the rate of twelve buckets a minute, while the sands are distributed over a table-surface 21 ft. by 21 ft. Including fuel, &c., the average weekly working-cost is £57, the cost of fuel alone for forty-four working-weeks being £535. It is considered probable that the ground can be afterwards used for fruit-culture. Dredgemaster, George Wilson; secretary, C. E. Richards, Alexandra, Otago.



Invincible Quartz-mine, head of Lake Wakatipu, Otago.

Mining Handbook.

OTAGO AND SOUTHLAND.

QUARTZ-MINING.

By Robert McIntosh, A.O.S.M., Assistant Inspector of Mines for the Southern Mining District.

Head of Lake Wakatipu.

It is recorded in the "Handbook of New Zealand Mines, 1887," that the Invincible Mine, Rees Valley, was opened out in November, 1882, and from that month until December, 1885, 7,755 tons of quartz yielded 3,828 oz. of gold, or an average of 9 dwt. 21 gr. per ton. To this must be added 108½ oz. recovered from 11 tons of pyrites ground in a berdan. For the twelve months ending March, 1886, 2,682 tons of quartz yielded 1,100 oz. 13 dwt. of gold, and the tailings yielded an additional 108 oz. 10 dwt., making a total of 1,209 oz. for that period. Again, during 1896 the company crushed a total of 2,167 tons of quartz for a yield of 1,517 oz. of retorted gold, equal to 14 dwt. per ton. The mine was profitably worked until August, 1887, when it was found, after careful prospecting, that the quartz had run out. The mine was then let on tribute in February, 1888, and in March the tributers were reported to be on payable gold. During 1887 the tributers crushed 1,361 tons of quartz for a yield of 500 oz. of gold. The payable stone was again lost in 1888, and the company went into liquidation. The mine was then sold to the Rees Valley Quartz-mining Company, which prospected it thoroughly until 1892, but without success, the license being eventually cancelled.

In 1904 a Greymouth syndicate sent two prospectors to prospect a reef at Mopoke Creek, Lake Wakatipu; but the assays of the quartz did not come up to expectations.

Mr. George Reid, of Queenstown, acquired a prospecting license in 1904 over a large area in Caples' Valley, Greenstone, Wakatipu district.

Shotover District.

The Phœnix Mine was originally prospected about the year 1862, when it was purchased by Messrs. Bullen Bros., who are said to have expended £50,000 in developing the property. During the early stages of development some good returns were obtained, but the work undertaken was mainly of a prospecting and opening-up nature, and the mine did not become a paying concern until about the year 1884. It was recorded that from February, 1884, to November, 1885, 6,400 oz. of gold was taken from the mine, the total yield up to 1887 being about 15,500 oz. In 1888 a poor block of stone was being worked, the yield being as low as 3 dwt. per ton, and this continued during 1889, when the owners purchased the Phœnix Extended. In 1891, 4,835 tons of quartz was crushed for a return of 3,197 oz. of gold. The property was floated on the London market in 1892, and the new proprietary took possession on the 31st March, 1893. During 1892, 5,457 tons yielded 1,920 oz. of gold; all the quartz was taken from the Phœnix Extended section. Operations were continued by the new company, called the "Achilles Gold-mining Company," and good returns were obtained from time to time. In 1896 the quartz in the lode then being worked averaged 1½ oz. to the ton, and since the date of registration, in 1893, 7,181 oz. of gold has been produced, valued at £27,500. The mine continued to be worked until 1901, but not with the success attending its former operations. Owing to the capital of the company being then exhausted, and no payable stone in sight, the mine was permanently closed down in May, 1901 The property was purchased in 1903 by the Mount Aurum Gold-mining Company, and operations were resumed in 1904 on the British-American line of reef. An aerial tramway connects the mine with the battery. The deep workings have not been unwatered.

The Gallant Tipperary Mine was first opened about 1867, but without success until 1884, during which year it was worked on tribute. In the early years of its existence this mine was known as the Nugget. Some of the stone worked in 1888 averaged from 11 dwt. to 18 dwt. per ton. 1,500 tons was crushed in 1889 for a yield of 961 oz. of gold. From 1885 to 1895, 11,490 tons of stone was crushed, yielding 4,392 oz. 11 dwt. of gold. In 1897 this company went into liquidation, and the property was purchased by the Shotover Quartz-mining Company. A low level was driven, which was completed in 1900, and stoping operations were commenced. The stone mined of late years has not been rich, and calls have been made on the shareholders from time to time for capital to enable operations to be carried on. It is the intention of the company to spend a considerable sum during 1906 in development-work.

This district abounds in reefs, many of which have been worked from time to time; but none of these mines can be said to have been developed to a paying stage. In common with other districts, many of these leases have been held, apparently, with a view to disposing of them should an impetus be given to quartz-mining; thus development is retarded Other reefs known to be payable only await the capital to provide the necessary machinery. Among those which have been worked at various times may be mentioned the Maori Point, Leviathan, Crystal, Cornubia, Chorazin (or Reefton United), Aspinall's, and Alpine Reefs.

Macetown.

Warden Stratford states that reefs were first practically tested here about the year 1876. Three lines of reef were first worked—(1) the Homeward Bound line, (2) the Maryborough line, (3) the Advance Peak line. The Homeward Bound line was opened in 1876 by Messrs. Raven and Barclay, who won 551 oz. of gold from 542 tons of stone while opening up. On the same line, to the north-west, were situated the Lady Fayre, Gladstone, Mackay's, and Premier Claims. The Defiance line runs parallel to the Homeward Bound, and on the east side. The Maryborough was opened up in February, 1876, by the Maryborough Company, and from 5 tons of stone crushed from a footwall leader 23½ oz. of gold was obtained. On this line were situated the leases of the Garibaldi Company, Duke of

Wellington No. 2 South, Victor Emmanuel No. 3 South, and Finn's lease, No. 4. The All Nations line is parallel to the Maryborough, about 5 chains to the southward. From a leader between these two lines 345 tons of quartz yielded 39 oz. of gold. The Tipperary, Geraldine, and Caledonian leases were continuations of the All Nations line, while the Canton and Ancient Briton claims were branches trending south. With regard to the Advance Peak, or Main Lode line, there appears to be three parallel lodes here trending north-west. Several rich leaders radiate from these lodes, as high as 5 oz. of gold per ton having been obtained from them. The Katherine was a rich leader from the north-east lode of this parallel. Development-work was carried on, and in 1878 a public crushing plant was erected and quartz crushed from various reefs. Some of these parcels, which were said to be well representative of the quartz in the mines, gave rich yields. Eighty tons of quartz from the Gladstone Mine yielded 304 oz. of retorted gold; 50 tons from the Tipperary yielded 127 oz For some time the stone from the Tipperary Mine yielded nearly 1 oz. 8 dwt. of gold per ton. It would be impossible in this short sketch to detail the history of this district during the next few years. Numerous leases were taken up, but operations were not successful in all cases. Capital was required, as the district for some years was only provided with a pack-track. In 1884 the main road from Arrowtown was opened for traffic. Warden Hawkins, reporting in 1886, says, "Of all the numerous gold-mining companies that were called into existence on the discovery of payable quartz at Macetown only two remain, of which the Premier Mine has been the most successful." During 1886 the Sunrise Lease Gold-mining Company struck good stone, and was the only mine at work during 1888 and 1889. In the latter year an endeavour was made to float a company on the London market to work the Premier and Tipperary mines. This flotation was completed, and British capital was introduced into the district in 1890. About this time prospects became brighter. The Sunrise struck good stone, and erected a new battery. Unfortunately, in 1891, expectations were not realised. Poor results were

Bridge over Clutha River, Clyde. Otago.

obtained from the Sunrise and Premier mines, while operations were not commenced at the Tipperary Mine. During 1892 the Sunrise Company sold its plant and claim to the Premier Consolidated Company, which carried on continuous operations during the year for a return of 945 oz. of gold from 957 tons of quartz crushed. The Tipperary Company was re-formed in London in 1892 with an available capital of £10,000, so that in this mine, as also in the Premier, development-work was carried on during 1893. In that year the Premier Company crushed 3,163 tons of quartz for a yield of 1,985 oz. The Glenrock Consolidated Company purchased the Premier and Sunrise mines in 1895, and preparations were made to work these properties on a more extensive scale. The Tipperary Gold-mines Company was reconstructed in 1896, and a new company called the Westralia and New Zealand Gold Explorers (Limited) took possession of the property. Work was continued along the usual lines for the next few years. In 1898 several well-known mines—the Victor Emmanuel, Morning Star, Black Angel, Garibaldi, Maryborough, Homeward Bound, Lady Fayre, and Golden Treasure—were consolidated into one holding as "Farrell's Consolidated Mines." The intention was to place these properties on the London market. Operations in the Tipperary and Sunrise mines were not very successful, and the mines were closed down in 1899, but the Premier continued to be worked, 2,825 tons of quartz being treated for a yield of 1,661 oz. of gold during the year 1899. The Indian Glenrock (Wynaad) Company continued operations in the Premier Mine during 1902, in which year 2,178 tons of quartz yielded 1,752 oz. of gold. In 1903 the Premier-Sunrise (New Zealand) Gold-mining Company purchased the Premier Mine from the Indian Glenrock Company. The mine was worked continuously during the year with fair results. Work was resumed in the Tipperary Mine in 1903, but, as the further development of the mine included the installation of expensive machinery, operations have since been at a standstill. The Premier-Sunrise Company continued operations during 1904 and 1905. In the latter year the available stone was stoped out, and considerable prospecting-work failed to open up a new ore-body. In consequence instructions were received from the home office to suspend operations early in 1906.

Some attention was given to prospecting in 1904, and reefs were opened up in Caledonian Gully by Richard Balch, Anderson and party, and Beale and party; 25 tons crushed from Balch's lease yielded 52 oz. of retorted gold. Information was received in 1904 that the flotation of the New Zealand Consolidated Gold-mines was completed, and a few weeks' work was done on the property. Owing, it is stated, to some hitch in financial arrangements, the transfer was not completed, and operations were discontinued. No work has been done on that property since.

The reefs in Caledonian Gully were worked during 1905 with more or less success, the quartz being crushed in the Tipperary battery, purchased by McKay and party, who hold the lease adjoining Balch's. The closing-down of the Premier Mine was due to the lack of capital to further develop the property. The fortunes of this mine were involved with others in India, and further capital was not available for the New Zealand property. It is confidently asserted by those who have the best knowledge of the district that the mines will prove their value in the future, when the necessary capital becomes available for their development.

Mount Pisa.

There is a line of reef on the face of Mount Pisa, opposite Gibbston, which has received some attention from time to time, but no development-work has been done on it. Quartz reefs have also been found at the head of the Gentle Annie and Roaring Meg Creeks. There is an extensive field on Mount Pisa practically unprospected for quartz reefs or mineral lodes. Further on a large quantity of gold has been found on the slopes of the Crown Range, and a quartz-mine is now being opened out on the Crown Terrace.

Native silver has been found on the western slopes of the Crown Range, in the Matatapu Valley.

Carrick Range.

The Star of the East Company commenced operations in 1870, and for a few years there was considerable activity in quartz-mining in this district. During 1877 quartz-mining took a retrograde movement, due to the absence of new finds. Warden Simpson drew attention to the necessity for prospecting for main reefs on the tops of the ranges instead of the slopes and spurs, and expressed his confidence that the quartz reefs in the district, which are very numerous, would excite considerable attention at no very distant date. Warden Keddell, reporting in 1881, indicated that an important discovery had taken place in the Carrick Range, but recorded in 1882 that after a trial crushing from one or two of the pioneer claims, which resulted in a yield not worth recording, the new quartz claims on the Carrick were abandoned. It appears that the character of the quartz reefs here is entirely different from those found in any other district. They are mixed with a red-clay substance, and the stone is of a loose, broken nature, and can easily be taken out. About this time an antimony-lode was opened out by Messrs. Buchanan and Watson, of Dunedin, but the ore, although of good quality, was not found then in quantity. Mr. H. A. Gordon, Inspecting Engineer, Mines Department, writing in 1885, states of this locality: "Very rich quartz lodes have been worked on the surface, one of the companies (the Royal Oak) having paid about £14,000 in dividends to the shareholders, but after going down about 70 ft. in the lode it commenced to get of too poor a nature to work. On the Royal Oak line of reefs shafts have been put down 150 ft., but at this depth the lode seemed to run out." The ground was abandoned for several years, when a company again took it up, and was in 1885 driving a tunnel from the face of the hill at the head of Smith's Gully to try and find the reef at a greater depth. This tunnel is now in nearly 1,100 ft., but the present company has not yet been successful in finding any stone of a payable nature. There are several lines of reef on this range, but none of them are being worked to any extent. The Star of the East Company has driven a tunnel at a low level for over 500 ft. to prospect the ground. All the work being done in 1885 was of a prospecting nature. During the next four years operations were mainly of a prospecting nature. In 1889 Warden Hickson reported: "Very little activity is noticeable. A special claim, embracing the ground formerly held by the Star of the East Company and the Elizabeth Company, has been granted, and prospecting is being carried on, but the result is not ascertainable. Lawrence and party are getting good payable stone from the line of reef formerly held by the Caledonian Company, and on the same line Watson and Ridland are getting good prospects, and have erected a small crushing plant." In 1890 Lawrence and party, working on a lease on the old Caledonian Reef, were said to have a very valuable property. They succeeded in tracing the reef for a considerable distance, with a body of stone 2 ft. to 4 ft. in width, carrying very payable gold. The Star of the East Company abandoned its claim, and the license was cancelled, but several parties set in to further prospect the ground. In 1891 there was little quartz-mining in the district. Some rich stone was got in the early days, but the Carrick Range was at this period nearly deserted, with the exception of about two parties. Eighty tons were taken from the ground formerly held by the Elizabeth Company, which was said to have yielded about 1 oz. of gold per ton. E. Lawrence was carrying on constant operations in his mine, but the quartz, being low-grade, required a cheap method of crushing to make it pay. Very little mining was done for the next four years. In 1895 Messrs. Lawrence Bros., in the Day Dawn Mine, were working on a lode about 14 in. wide. The reef averaged this width for a distance of 280 ft., and was enclosed between well-defined solid walls. During the year 1895 some 350 tons of quartz was crushed, yielding 230 oz. of gold, an average yield of 13·31 dwt. per ton. Evan Jones and party and McCabe and party also had good prospects. During 1896 Messrs. Lawrence Bros. crushed 876 tons of stone for a return of 346 oz. of gold, valued at £3 17s. per ounce. In the same year McCabe and Sons drove a tunnel 600 ft. in length to cut the Young Australia Reef, which yielded good returns about the year 1876,

BRIDGE OVER CLUTHA RIVER, ALEXANDRA, OTAGO.

but which was then abandoned through a large influx of water. During 1897 the Golden Gate Quartz-mining Company held a claim of 100 acres, upon which an adit was opened out from Pipeclay Gully. The quartz was partly oxidized and partly of a more refractory character, the average width being about 16 in. From a trial crushing the yield was 12½ dwt. of gold per ton. McCabe and Sons continued to work the Young Australia Mine. James Lawrence crushed 782 tons from the Day Dawn Mine for a yield of 143 oz. of gold. Lawrence Bros. crushed 170 tons of quartz from the Star of the East Mine for a return of 57 oz. of gold. In 1898 there was little alteration to note. Four hundred and fifty tons of quartz was crushed from the Star of the East, yielding 107 oz. of gold. Prospecting operations were carried on by J. Holliday for the extension of the Star of the East Reef, known as the Go-by. During 1899 Lawrence Bros. took out small blocks of stone from the Gympie, Heart of Oak, Star of the East, and Day Dawn reefs. Holliday's prospecting-tunnel on the Go-by Claim was in 440 ft.

Renewed interest was taken in the Carrick Range reefs in 1902, as it was expected that the application of the cyanide process would render the refractory ore payable. Unfortunately the parcels of ore sent for treatment to the School of Mines, Dunedin, were too poor to pay for treatment either by amalgamation or cyanide process; but it was considered that the samples were not representative of the quartz in the district. In 1904 a battery was erected on Watson and Holliday's claim, as the owners were confident that the large body of quartz available would be payable if efficiently treated. Unfortunately, the battery results were poor. Exhaustive tests of the stone made at the Colonial Laboratory, Wellington, proved that the values could not be saved by plate amalgamation or the chlorination process; but the cyanide treatment, followed by amalgamation, gave excellent results.* As an alternative method, the suggestion was made that the concentrates could be saved and shipped to Dapto, New South Wales.

* See *New Zealand Mines Record* of the 16th April, 1906, pages 378 and 379, for recent analyses.

Mining in the past has been devoted entirely to the oxidized stone, and very rich yields havo been obtained from time to time. It was not possible to deal with the refractory ores, and consequently these portions of the lodes lie undisturbed. Hence there is a large field here which only awaits the outlay of capital in the necessary appliances and works to render it productive.

Bendigo, near Cromwell.

The Bendigo Reef was first opened out in 1865 by Logan and party, and worked by them until 1876, when the Cromwell Company was formed to work the mine. The "New Zealand Handbook of Mines, 1887," records that gold to the value of £500,000 was obtained by Logan and party, and, from 1876 to the end of 1883, 26,000 oz. of gold was obtained. In 1884 the company was wound up, and the mine and plant were purchased by the New Cromwell Gold-mining Company (Limited). During 1886 this company erected expensive winding, air-compressing, and pumping machinery. In 1887 the company's property was purchased by a London syndicate, and a new proprietary formed with a capital of £100,000. It was intended to sink the shaft to a depth of 600 ft. In March, 1889, the shaft had been sunk 330 ft. Previous to the old company suspending operations a winze was sunk for 27 ft. below the 420 ft. level, and at 20 ft. down the winze stone was struck which yielded nearly 3 oz. to the ton, the reef being from 2 ft. to 2 ft. 6 in. wide, following an east-and-west course, with underlie to north. On the 31st May, 1890, the shaft was down 430 ft. In the same year McLoughlin and party erected a five-head battery on tho Eureka Reef. The Cromwell Company's shaft reached a depth of 520 ft. in 1891, and a level was driven westward to command good stone said to be left underfoot in the 420 ft. level, but the search was not successful. The number of hands employed about the mine was diminished in 1892, and proposals were made to the English shareholders to raise sufficient capital to sink the main shaft 600 ft. The only other work in the neighbourhood was at the Rise-and-Shine (Old Eureka), where crushing was being carried on. In 1893 the Cromwell Company succeeded in raising £12,500 in England, and intended to use £500 in prospecting the old workings; the shoot of gold formerly worked pinched out in depth. There were several claims worked on this line of reef to the westward of the Cromwell Company's ground, and some fair auriferous stone was found. During 1895 the Cromwell Mine was let on tribute to a party of miners, and excellent results were obtained from above the 150 ft. level. The battery returns for 1894 show that 542 tons of quartz was crushed, which yielded 451 oz. of gold, valued at £1,759. The tributers continued to obtain such good results that during 1896 the company was reorganized, and arrangements were made to spend a very considerable sum in further developing the ground. During 1895, 532 tons was crushed, yielding at the rate of 19 dwt. of gold per ton. Operations were resumed by the company during 1896, nearly all the work done being of a prospecting nature; 650 tons of stone was crushed, yielding 262 oz. of gold. In 1898 the mine was again let on tribute. The tributers worked on the northern division of the reef where it splits between the winding and the pumping shafts; the average yield from this block was 2½ oz. to the ton. It was considered that an adit driven from the valley would crosscut the whole system of reefs, and obviate the necessity for pumping and haulage. Early in 1899 the Cromwell Proprietary Company resumed operations in the mine. Work done included the sinking of a shaft in the eastern section of the mine. During the year 1,264 tons of stone was treated for a yield of 827 oz. 5 dwt. The mine was closed down the whole of the year 1900, but in 1901 it was anticipated that the necessary capital to drive the low-level tunnel would be forthcoming. Operations were conducted during 1902, but not in the direction intended, work being mainly confined to taking out stone from surface workings. The company carrying on operations at this period was known as the Bendigo Gold-mining Company (Limited), which worked the mine on tribute from the Cromwell Proprietary. The proposal to drive the low-level adit received consideration from the London board of directors, but the capital was not forthcoming. During 1903 the property was sold to Messrs. Waters and Talboys, trustees for a purchasing company. Operations have not been continued since, but endeavours are being made to raise the necessary capital to further develop the mine. The Alta Reef has also received attention from time to time, and there are several reefs in the locality worthy of attention. Search for the extension of the Bendigo Reef east and west should be conducted, while there is also a large field for prospecting over the Leaning Rock Range.

Scheelite has also been found on this range in the quartz lode at the Alta Mine.

Obelisk (or Old-man Range).

Warden Keddell, in 1883, intimated that new discoveries of quartz claims had been made on the Obelisk Range. These were found by a miner named White, while sluicing operations were in progress on the hill-slopes. In 1883 a company was formed to work White's Reef, and sixteen other leases were granted. Work was continued during 1884, and stone of good quality was taken out. About 600 tons of quartz was taken out in 1886, yielding 520 oz. of retorted gold—an average of slightly under 18 dwt. to the ton. During 1888, 820 tons of stone yielded 829 oz. 17 dwt. of gold, valued at £3 17s. 10d. per ounce. Two other claims were also working, but no machinery was erected thereon. From one claim three crushings averaged over 3 oz. to the ton. An old miner said of the Obelisk Range, "A rabbit cannot burrow without disclosing payable stone." The range is a network of quartz reefs. White's Reef changed hands during 1890, the purchaser being Robert Symes, who has continued to profitably work the mine. Crossan and party and Baker and others were also doing well about this time. Symes Bros. continued to work during 1892, and Crossan and Gray developed a rich reef on Coal Creek spur. During the year they netted 880 oz. of gold—114 oz. by sluicing, and 766 oz. from 315 tons of quartz crushed. Messrs. Symes only crushed 57 tons during 1893 for a yield of 40 oz. of gold, while Crossan and Gray crushed 279 tons of quartz from the Excelsior Reef for a yield of 589 oz. of

Waipori Falls Electric-power Project: Waipori River, below Power-house.

gold, valued at £2,360. Operations were carried on at both these mines during 1894, but results were not so good. The work done during 1895 was, however, attended with more success, 270 oz. being obtained from 236 tons from Symes's mine in a few months. About this time the Conroy's Gully reefs commanded some attention; these reefs were successfully worked many years ago. In 1898, 40 tons of stone from the Excelsior Reef yielded 52 oz. 18 dwt. of gold. During the past few years these two mines have been worked as formerly, but, unfortunately, not with the same amount of success. Both parties, however, continue in the expectation of again striking payable stone. This face of the range is much disturbed, and prospecting is best carried on by surface sluicing. As all the water is now held for sluicing on the Bald Hill Flat, prospecting has been practically at a standstill for many years. There are many known reefs in the Obelisk Range, which can, however, only be worked by companies having the necessary capital. Several reefs abound at the head of Fraser basin and Campbell's Gully, but as the season in this locality is short very little prospecting is ever done. There are several lines of reef crossing the foothills of the Obelisk Range. Among those worked in former times may be mentioned the Conroy's Gully and Day Dawn reefs. Want of capital to provide the necessary pumping and winding machinery is said to have caused discontinuance of operations on these reefs. Recently a reef in Conroy's Gully was taken up, but the owners could not procure the capital to sink the shaft and erect the plant necessary to develop the mine. A battery was erected, and stone carrying payable gold was taken out above water-level, but a slide was met with, and operations were discontinued.

Nevis and Nokomai.

Beyond the Carrick Range, in the Nevis district, quartz-mining has never been prosecuted, although specimen-stone has been found in the alluvial claims. Hitherto alluvial workings have been paramount in this district, but with the decline in that industry more attention will, no doubt, be paid to prospecting for quartz reefs and mineral lodes in this extensive tract of mountainous country.

Cinnabar is known to exist, but little prospecting has been done to locate the lode.

A quartz reef exists in Victoria Gully, Nokomai, but it has not been prospected to any extent.

A large auriferous-lode formation is known to traverse the Garvie Mountain, but owing to its general inaccessibility very little endeavour has been made to locate the value and permanency of this reef, or to prospect for other reefs in this mountain.

Tuapeka.

In 1882 the Gabriel's Gully Quartz-mining Company drove a tunnel 380 ft. into the spur lying between Gabriel's Gully and Weatherstone's. A fine body of quartz was met with, but it was not sufficiently payable for working. The Gabriel's Gully Prospecting Association resumed operations on this reef in 1897. Some years before a reef, varying from 2 ft. to 9 ft. in width, was worked, but it pinched out in depth. Operations were continued during 1898, when a considerable amount of prospecting was undertaken, but the work was not successful, and was abandoned during the following year.

Some specimens of quartz containing gold were found in Grey's Gully, above Evans Flat, and search was made in 1901 for the reef. A level was driven and crosscuts put in without meeting with success, and the mine was abandoned.

A reef outcrops on the Weatherstone's Commonage, near O'Brien's Hill, upon which a limited amount of surface prospecting has been done. This locality is well worthy of systematic prospecting.

Waitahuna.

Quartz-mining is confined to the range known as the Waitahuna Heights, and lying between Waitahuna and Waipori. The Waitahuna Quartz Company was in operation in 1890, but the results were not payable, and in 1892 this company ceased operations. Arnold Sturm continued to prospect about this old mine during 1895 in the hopes of striking a good reef, but these hopes were not realised, and of late years nothing has been done around this district.

Waipori.

Situated in the Tuapeka district, this goldfield was opened up in 1862, and quartz reefs were discovered in 1864. The oldest quartz workings in Otago were opened on the Shetland Reef, which was worked by the Pioneer Company. Several quartz reefs were taken up in these early days, but owing to the lack of capital, in most cases, the mines were not developed in depth, operations ceasing while the workings were yet comparatively shallow. Among the early claims were the Pioneer, Maori and Maud, Devil's Creek, Cosmopolitan, and Canton. The majority of the reefs prospected well, and during their period of working prior to 1873 there was a fair yield of gold in the aggregate. During the next ten years the progress of the industry was slow, and in 1882 Warden Wood expressed the opinion that no reef in the district could be called thoroughly opened out with the exception of the O.P.Q. Reef. This remark equally applies in 1906. In 1882 slightly more attention was given to the quartz reefs. Prospecting was carried on at the Nil Desperandum—a continuation of the O.P.Q. line of reef; also at Cox's, Lammerlaw Reef, and Esson and party's Nuggety Reef. In 1883 there were three batteries at work—namely, the Victory, 10 stamps; the Undaunted, 10 stamps; and the Modern Maori, 5 stamps. About fifty men were engaged working for the above companies. Several new areas were taken up in 1883, and the industry went along quietly for a few years. Reporting in 1886, Warden Revell stated, "At Waipori eight old quartz gold-mining leases were cancelled either for abandonment or non-payment of rent. Two quartz leases and two ordinary quartz claims are now being worked in this part of the district, the quartz being estimated to yield from 18 dwt. to 1 oz. 4 dwt. per ton." Forty miners were engaged in quartz-mining in 1887, in which year Long and party reopened the Canton Claim, and Porter and party took up the O.P.Q. Claim again. This latter party crushed 700 to 800 tons, yielding from 3 dwt. to 14 dwt. per ton. It was estimated that 1,000 tons of quartz was crushed during 1887, yielding 350 oz. of gold. In 1889 Gare and party (Bella Reef), Lawson and party, Robertson and party, and Knight and party were granted licensed holdings. Gare and party's reef, on the Lammerlaw, averaged 5 ft. to 6 ft. in width, and gave a steady return of half an ounce of gold to the ton. The Maori, or Cox's Reef, was reopened in 1890. This reef was only 6 in. in width, but yielded at the rate of 1 oz. to the ton. Gare and party's reef was the only one in operation during 1891. A large body of stone was opened out, and was expected to give an average yield of 15 dwt. per ton. Ritchie and party started work on the O.P.Q. line in 1891, and continued until 1893.

In 1894 Warden Hawkins said of the Waipori district, "Although high hopes were entertained for some time as to the prospects of quartz reefs here, and the existence of reefs has been amply demonstrated, yet at present quartz-mining is in complete abeyance. F. W. Knight intends to further prospect the Bella Quartz-mine, which he purchased, as he believes that good stone will be found to remunerate him amply for his outlay."

The Canton Reef was again taken up in 1896 by several parties, by whom it was to be thoroughly prospected. In this year also the O.P.Q. Reef was in the hands of a party who were endeavouring to float it on the London market. The endeavour was successful and the flotation completed. Warden Hawkins states, "The New Zealand Minerals Company have purchased several claims and water-races, the O.P.Q. and Canton reefing claims, and a right to take eighty heads of water from the Chrystall Falls, on the Waipori River, being among the principal purchases. With the Chrystall Falls water it is the intention of the company to generate electrical power for the purpose of working the two reefing claims Charles Todd took up three special claims on the Bella Reef in 1896, with the intention of floating a company on the English market." The O.P.Q. Gold-mines Company (Limited) was floated on the London market in 1897. This com-

Waipori Falls Electric-power Project. About Three-quarters of a Mile of Flume.

Mining Handbook.

pany took over the O.P.Q. reefing claim from the New Zealand Minerals Company. About thirty men were employed during the year in sinking a shaft, erecting a battery, and opening up the reef. By the end of the year there were about 400 tons of stone at grass, giving an assay value of 14 dwt. Speaking of this company's operations during 1899, Warden Stratford says, "The O.P.Q. Gold-mines Company (Limited) employed a large number of men, and had done a good deal in opening up the reef during the last twelve months. The company has completed and erected a good deal of expensive machinery, and the mine has been yielding good returns; 851 oz. were won for 1899."

The Bella Reef was reopened in 1899 by Robert McKeitch* and party, of Lawrence. There is a percentage of scheelite in the stone, which was not saved. The gold-saving appliances consisted of quicksilvered plates without blanket strakes. The quartz in this reef has been proved to be rich, but the ore requires chemical treatment in addition to amalgamation. The mine was closed down in 1900, and a parcel of concentrates forwarded to New South Wales for treatment. Unfortunately, the parcel was lost in transit, so that no results are available.

During 1900 development and stoping operations were carried on at the O.P.Q. Mine. Gold to the value of £9,000 was obtained for twelve months, and concentrates were on hand for shipment to New South Wales for treatment. The average yield of gold is given as 8½ dwt. to the ton. The best crushing the company had realised 190 oz. 11 dwt. of gold from 193 tons of quartz. Occasional patches assayed as high as 5 oz. to the ton.

Reporting for 1901, Warden Cruickshank says, "The O.P.Q. reefing claim is owned by a London syndicate, and they have spent an enormous amount of money in developing the mine and procuring very costly machinery, and in doing so have just about exhausted their capital; but, of course, they expected the returns from the mine would be sufficient to carry

* McKeitch was the last man killed by the Boers during the late war, or rather after the war, as he was knocked over after the proclamation of peace.

on, as the claim was in working-order and yielding good returns, with about seventy hands employed. Unfortunately, very severe winter weather set in with heavy falls of snow, said to be the severest winter experienced in the district for twenty-four years, and it continued several months, entirely stopping all work at the mine, and all hands were thrown out of employment. As good yields were obtained while the mine was being worked, it is to be hoped that satisfactory financial arrangements will be made to carry on the work again."

For several months after closing down, the mine was kept unwatered, and the levels were kept open in anticipation of instructions to resume operations. As these instructions were not received the mine was closed down permanently, and since then the machinery has been partially dismantled. In sympathy with the non-working of the O.P.Q. Mine, all quartz-mining is at a standstill in the Waipori district. It is unfortunate that this should be so, as a great number of reefs occur in the district, many of which are known to be valuable. The drawback is the want of capital to properly prospect and develop them. The district is an outlying one, and the carriage of fuel, timber, and mining requisites is costly, so that private parties are prevented from developing the reefs to that degree upon which the permanency of the mines depends. It cannot be denied that the district abounds in quartz reefs, and that the many reefs now lying unproductive in the Lammerlaw Ranges and adjoining foothills are worthy of the attention of the investing capitalist. That the country is rich in minerals is proved by the existence of copper, antimony, and scheelite lodes, while cinnabar and manganese have also been found.

Canada Reef, near Milton.

Work was carried on here prior to 1875. A shaft was sunk 80 ft. in depth, and the reef was driven on east and west. The average yield in these days from the quartz crushed was about 5 dwt. per ton. It is recorded in Hutton and Ulrich's "Geology of Otago" that in an adit from a steep slope facing the Tokomairiro River a patch of stone was found yielding

5 oz. of gold per ton. The Table Hill Company also worked a reef running parallel to the Canada Reef, the top stone from which averaged 5 dwt. to 6 dwt. of gold per ton. After a depth of 150 ft. had been passed the yield became poorer.

Renewed attention was given to this district in 1887, when several quartz claims were taken up. Gillon and Murphy obtained prospects of from 5 dwt. to 6 dwt. per ton. McLean and Kerr re-erected a battery which had been idle for about twelve years. Murphy, Gillon, and Thompson worked the quartz claim for some time during 1888, but closed down, as it did not turn out payable, and the battery was removed to Nenthorn. Very little work was done on Kerr and McLean's area.

Two quartz claims were taken up at Table Hill in 1889, and fair prospects obtained. A little excitement was caused in this district about 1891, but it died away, and in that year Kerr and party abandoned their enterprise. Nothing more was done until 1897, when John Lawson and party, of Berwick, took up a claim at Table Hill, and erected a ten-head battery. Lawson, Ritchie, and Andrew's mine was let on tribute to W. G. Mouatt in 1898. There were three lines of reef, known as Ocean View, Canada, and Lawson's. Eight hundred and thirty tons crushed in 1898 yielded 103 oz. of gold; 1,297 tons of quartz was crushed during 1898 from the Burnt Creek Company's mine for a total yield of 95 oz. Three lines of reef were prospected, but the quartz presented a glassy appearance, and was very poor. The company went into liquidation in 1899. Work was continued during 1899 on the lines of reef known as Lawson's and the Canada. Two hundred tons was crushed from the Canada line for a yield of 5 dwt. per ton. Several crushings from Lawson's reef yielded from 8 dwt. to 21 dwt. per ton.

During 1901 the Table Hill Quartz-mining Company re-opened the old workings of the Burnt Creek Company, and in the same year Mr. Lawson was engaged in opening out on the Canada Reef, to reach the solid reef beyond the old workings, but he died in 1901, and no further development took place at the Canada Reef in that year. The Table Hill

Quartz-mining Company also ceased operations in that year Sutherland and party did some prospecting on the Burnt Creek line of reef in 1902. Thomas Park and party, known as the Last Chance Quartz-mining Company, reopened the Canada Reef in 1903. Thirty-five tons of quartz was taken out and crushed for a return of 16 dwt. per ton. The workings were about a mile to the east of those formerly worked by Mr. Lawson. During 1904, 226 tons was crushed for gold valued at £1,097. The mine continued to be profitably worked during 1905, in which year 1,967 tons was crushed for a yield of 876 oz. of gold. In this year also prospecting was carried on in various places in the district. The Ocean View Reef was opened up in proximity to Park's workings, and several parcels of stone were crushed at Park's battery.

The Last Chance Company continues to work in 1906, but there is little development in the other mines. Park's battery, being the only one in the district, is working full time when water is available, and thus is unable to crush for other parties.

Saddle Hill Reef, Green Island, near Dunedin.

According to Hutton and Ulrich's "Geology of Otago," this is a true reef. It strikes E. 14° S. and dips northward at an angle of about 55°. The mine was worked prior to 1875. Two shafts were put down 49 ft. and 125 ft. in depth. and the reef widened out to 12 ft. in places in the lower workings. About 2,000 tons of stone was taken out and crushed for a yield of 5 dwt. per ton. The auriferous stone would average 14 dwt. if selected. Three other well-defined reefs occur between the first reef and the main road. Work was resumed about 1884, but was again stopped; the yield per ton was not sufficient to pay expenses as work was then being carried on. During the time of working 5 tons of stone was forwarded to Ballarat, and from two trial crushings the yields were 14½ dwt. and 16 dwt. per ton. The return from similar stone crushed at the company's battery was only 3½ dwt., showing a big loss somewhere. In 1896 about 2½ tons was sent to the Dunedin School of Mines battery, but nothing

Clarendon Rock-phosphate Deposits: Stack of Rock-phosphate ready for burning.

further was done in connection with the lode. The reef is favourably situated as regards coal-supplies and railway facilities.

In 1899 Adam Harris prospected the locality for some scheelite which he knew to exist, but the results were not satisfactory, and the work was discontinued. The reefs have been idle ever since.

Hyde and Macrae's.

Three prospectors discovered a reef in the Mareburn Creek in June, 1887. The outcrop was traced nearly two miles on the surface, and two trial crushings yielded nearly 2 oz. of gold per ton. The reef is 5 ft. between the hanging and foot walls, and auriferous from wall to wall. A company was floated in 1888 to develop the Mareburn, or Mount Highlay Reef. A ten-head battery was erected, and the quartz delivered to it by an aerial tramway from the mine. Operations during 1889 proved the reef to be about 7 ft. wide at the 150 ft. level, and to average 10 dwt. to the ton; but shortage of water hindered the company's progress, and this was also the case during 1890; the average yield from stone crushed during that year was 5 dwt. The Bonanza Mine was opened out in 1890 in a small creek running into the Stoneburn, about twelve miles from Macrae's; 600 tons of stone treated yielded 638 oz. of gold. The Golden Point Mine, situated in Deepdell Creek, near Macrae's, was the property of the Golden Point Gold-mining Company; but the company went into liquidation in 1890, and the property was sold to Messrs. Donaldson Bros. During 1891 operations were carried on at the Bonanza, Mount Highlay, and Golden Point mines. From this latter mine 6½ tons of scheelite was sent as a trial shipment to London, and the result showed a small profit. The Highlay Company ceased operations in 1892, but the Bonanza and Golden Point mines worked profitably during that year, and were likewise engaged in 1894. In that year the Mount Highlay Reef was reopened. The Bonanza and Golden Point were stated to have had a good year during 1895. Owing to the interest taken in quartz-mining on the

West Coast and Auckland, increased attention was paid to the reefs of this district, and there was a likelihood of capital being invested. Messrs. Donaldson Bros.' mine and the Bonanza Mine continued to get satisfactory returns during 1896. A number of holdings was granted in the district and near Dunback.

The Donaldsons erected an aerial tramway in 1897, but scarcity of water retarded crushing operations. Sutherland and Glover took 250 tons out of the Dunback Reef. From Cunningham and party's claim trial crushings gave an average of 1 oz. to the ton. In 1898 Mills and Sons removed their five-head battery from Nenthorn and erected it on Macrae's Flat. That year they crushed stone from the Golden Bar Reef, yielding 5 dwt. per ton. Cunningham Bros. and Ross erected a five-head battery. Fifteen men were employed about the Bonanza Mine during 1898. The low-level adit had been driven 1,550 ft. in length, and the quartz was conveyed to the battery by an aerial tramway.

Messrs. Donaldson had a successful year during 1899. Their scheelite workings were said to have been highly remunerative. The scheelite occurs associated with the quartz in the Golden Point Reef. Mills and party crushed a lot of stone averaging 7 dwt. per ton. Other reefs at work in the district were the Ounce Reef, Mareburn Reef (quartz and scheelite), Mount Highlay, and Bonanza mines. Cockerell and party reopened the Mount Highlay Mine in 1899. C. Nunn was in charge of this mine the following year, and stone was stoped out from the 100 ft. level to the surface. Donaldson Bros. worked their reef by the opencast system, obtaining a considerable percentage of high-grade scheelite. Mills and Sons continued to crush stone from the Mount Highlay line of reef. From sixteen to twenty men were employed about the Mount Highlay Mine in 1900. During that year the Golden Bell battery (H. Mills and Sons) crushed 2,290 tons of stone for a yield of 431 oz. of gold, and Cunningham, Griffin, and Spears crushed 447 tons for a yield of 188½ oz. of gold from the Ounce Mine. In 1900 the Golden Bar Mine was taken up by a party of working shareholders. This reef was tried from time to time and pronounced unpayable, but several crushings taken out that year yielded from 5 dwt. to 15 dwt. per ton.

During the year 1900 the Bonanza Mine was continuously worked, the approximate yield being 15 dwt. per ton. During 1901 Mills and Sons crushed 2,000 tons of stone for a yield of 327 oz., and Donaldson Bros. obtained good returns of gold and scheelite, while the Bonanza and Ounce mines were said to have done well. The Golden Bar Company crushed 900 tons of stone during 1901 for a yield of 5½ dwt. per ton. This company in 1902 secured some good returns, yielding from £10 to £14 per man per week above working-expenses. The Ounce Reef was let on tribute to Lidstone and party, but the Bonanza Mine did not do much during 1902. C. McGill opened the Maritana Mine, in Deepdell Creek, during the year, and erected a battery. Donaldson Bros. erected a new ten-head battery and a Woodbury shaking-table for saving scheelite. At Mount Highlay a little was being done in connection with quartz-mining. The same number of mines continued to be worked during 1903 with more or less success, but there were no fresh developments to record.

During 1904 quartz-mining progressed steadily around the Macrae's district. This progressive movement was assisted to a great degree by the high price ruling for scheelite. This mineral is associated in payable quantity with the quartz at various points on this line of reef. Attention was also given in a few instances to saving the tailings for future treatment by cyanide, and during 1905 a cyanide plant treated a quantity of tailings at the Golden Bar Mine. This plant has now been removed to the Golden Point Mine, where several thousand tons of tailings await treatment.

Donaldson Bros. opened up a large reef near Mount Highlay in 1906, and erected a Huntingdon mill and concentrating appliances. There is a percentage of scheelite in the stone. The Golden Bar and Ounce mines closed down in 1906. A large quantity of gold has been taken out of these mines; but, principally owing to lack of capital to carry on further development-work, these mines have been closed down. In order to establish the permanency of a reef, capital must be expended in opening it up, and in keeping development-work in advance of stoping.

Nenthorn.

McMillan and party discovered a reef at the head of Nenthorn Creek in November, 1888, and prospecting revealed the existence of other reefs. Sixteen licensed holdings were granted in 1889. The richest reef was the Crœsus, which was 2 ft. in width. The Victoria Company's reef was said to be a valuable one, as from $2\frac{3}{4}$ tons of stone nearly 3 oz. of gold was obtained; at a depth of 30 ft. the reef was 2 ft. in thickness. McMillan and party sent a test crushing to McQueen's battery, Dunedin, and obtained a yield of 3 oz. to the ton. The Nenthorn Consolidated Company sent several tons to the Footscray Works, near Melbourne, which resulted in a yield of from 2 oz. to 3 oz. per ton.

A fresh reef was discovered in 1889, two miles south of the Crœsus, and on which the Eureka was the richest claim. Warden Dalgliesh, in 1890, stated, "This last acquisition in the way of a quartz-mining field, about which such very extravagant hopes were entertained last year, has not realised those hopes. At the outset the management of many of the claims fell into inexperienced hands, and the work was carried on without system, and in a very costly manner." The operations of the various companies on this field have been minutely described by Warden Dalgliesh in his report for the year 1890. The collapse of mining at Nenthorn had a depressing influence on mining generally. Only the Crœsus, Eureka, and Surprise Claims were worked on a small scale during 1891. Sheppard and party were working on the field in 1892, and they crushed 100 tons of quartz for a yield of 12 dwt. per ton, but the other mines were idle. The Crœsus, Surprise, Eureka, Jacob, and Daddy Reefs were also worked a little during the year 1893, but the results were not worth recording. There were a few men employed in a desultory manner during 1894. The Crœsus battery crushed small parcels of quartz, amounting to 200 tons, for a return of about

130 oz. During 1895 the Surprise, Victoria, and Eureka Claims were at work, about twenty men being employed. The stone raised was found to run about 15 dwt. to the ton, but this was not sufficiently payable. Negotiations were going on during 1896 with a London company, with a view to working some of the claims on a large scale. A few of the claims were worked in a small way that year. Nenthorn remained quiet during 1897. Messrs. Mills continued working on the Surprise Reef, and succeeded in getting two crushings valued at 2 oz. per ton. Messrs. Sligo Bros. were working the Blue Slate Reef and crushing in the Crœsus battery. The Consolidated Claim was worked by Eggers and Peddie, and 70 tons is said to have yielded 80 oz. McConnell and Wright attempted to work the Jacob Reef, but owing to the smallness of the lode gave it up; the return for 8 tons is stated to have been 20 oz. From Kitchener's Fortune, Callery and McConnell crushed 63 tons for a yield of 70 oz. Scarcity of water retarded continuous working on these reefs. Messrs. Sligo Bros. had a good crushing in 1898, and were said to have struck a block of stone supposed to yield 5 oz. to 6 oz. per ton. They crushed 500 tons for themselves for a yield of 339 oz., and for small parties they crushed 169 tons for a total yield of 263 oz. Callery and Son and Connell and party also had good crushings.

Nenthorn was pretty well deserted in 1900, and very little work has been done since that year. A few leases are still held by those who know the value of the field, in anticipation of a revival of interest in this locality. As at Hindon, the best results would be procured from this field by a company holding an extensive area, and having sufficient capital to develop the reefs and to provide the plant necessary to treat the stone in a scientific manner. Good yields were obtained by the old-fashioned plate amalgamation, but the mineralised nature of the stone prevented any possibility of a high extraction.

Hindon.

Some well-defined reefs were prospected in 1877 in Mullocky Gully, Hindon, and there was reason to believe that the reef would be payably auriferous. Warden Maitland reported that the New Caledonia Quartz-mining Company, operating at the Game Hen Reef, Hindon, erected machinery in 1878; Messrs. W. and A. T. Kenny were also erecting machinery. As there are numerous outcrops of quartz reefs, more or less auriferous, throughout the district, it was confidently expected that they would turn out satisfactorily. During 1879 the expectations regarding these reefs were not realised; the failure is attributed not only to the want of capital, but also to the scarcity of water in the summer months. Two companies erected machinery—namely, the New Caledonia Company and the Hindon Company (late Kenny and party). About 1,000 tons was crushed, yielding at the rate of 15 dwt. per ton. There was no improvement in the district during 1880, the absence of water and cheap fuel proving too great a drawback to success; the stone crushed during the year yielded from 5 dwt. to 17 dwt. per ton. An abundant supply of water would have been beneficial both for quartz and alluvial mining. The Just-in-Time Quartz-mining Company erected a battery during that year. With the exception of 50 tons, chiefly test crushings by the Just-in-Time Company, no stone had been crushed during 1881; the stone crushed by the Just-in-Time yielded 10 dwt. per ton. In the Zealandia Company's lease the reef had been traced to a considerable depth, while Harrison and Marriott had a well-defined reef in the lease known as the Gladstone. The Gladstone Company crushed 100 tons during 1882, which yielded 15 dwt. to the ton. The Game Hen and Zealandia properties also received further prospecting. No stone was crushed in 1883. About 730 tons of quartz was crushed in 1884 by the Don Quartz-mining Company, the yield being a little over 5 dwt. per ton. Lyders and party, who owned the crushing plant of the Don Company, crushed several hundred tons of stone, which yielded from 4 dwt. to 15 dwt. per ton.

Warden Carew predicted a prospect of renewed enterprise in this district in 1888. Lyders and party crushed at their battery during 1887 the following parcels of stone: Lyders and Hilgendorf, 350 tons, yielding 6 dwt. per ton; P. A.

Lyders, 150 tons, yielding 5 dwt. per ton; A. T. Kenny, 70 tons, yielding 4 dwt. per ton; A S. F. Parker, 30 tons, yielding 7 dwt. per ton. A Melbourne company was formed during 1888 to provide capital to develop these reefs, and machinery was being erected in 1889. Lyders and party put through 200 tons, which yielded an average of 8 dwt. per ton. The Mount Hyde Company, mentioned as erecting machinery in 1889, was unfortunate, and the property fell into the hands of Begg and Co. At a small battery in Machine Creek about 200 tons of stone was crushed, yielding an average of 7½ dwt. per ton. Begg and Co. crushed 250 tons of stone in 1890 for a yield of 7 dwt. per ton; Kenny and party crushed 30 tons from the Zealandia Reef and obtained 1 oz. per ton. Begg and party's operations were a failure in 1891, chiefly owing to the stone requiring special treatment. The quartz was found to be highly pyritiferous. Sheppard and party crushed a quantity of stone from the Gladstone Reef, and this yielded from 6 dwt. to 11 dwt. per ton. They continued to work for a few years, as they were able to make small wages.

Very little was done here during 1895, and the district has been practically deserted ever since. The reefs in this locality would be best worked by a powerful company holding an extensive area, and having large crushing plant and reduction-works, in order to gain as high an extraction of gold as possible.

This district is reached by way of the Otago Central Railway from Dunedin.

Barewood.

On Barewood Run, the property of the Otago University Council, several promising reefs were opened up in 1890, and satisfactory trial crushings obtained. Portion of this endowment was brought under the operation of the Mining Act in 1890. Six hundred and fifty tons of stone was conveyed to the Saddle Hill battery during that year, and yielded at the rate of 14 dwt. per ton. A number of the holdings were abandoned in 1891, but Porter and Hocking and Wolters and party carried on active operations during that year. The former party had sunk to a depth of 100 ft., and crushed 500 tons for a yield of 280 oz. of gold. Wolters and party erected a five-head battery, and crushed 540 tons for an average yield of 10 dwt. Quartz crushed by Wolters and party in 1892 yielded from 10 dwt. to 17 dwt. per ton; while Porter and Hocking (tributers to the Barewood Company) crushed 250 tons for a yield of 115 oz. Porter and party abandoned the Barewood Company's mine in 1893, but the company prepared to further develop the property. On the foot-wall side the lode intermixed with scheelite, which was to be saved. In Donald Reid's mine the shaft was sunk to a depth of 150 ft., and 1,447 tons of stone crushed for a yield of 549 oz. of gold. Wolters and party and the Barewood Company worked throughout the year 1894, and in the same year P. A. Lyders opened up a reef on the opposite side of the Taieri, on the Otago Museum Endowment Reserve, where he erected a battery and crushed 90 tons of stone for a yield of 7 dwt. per ton. During 1895 interest was renewed in this field. The party known as Wolters and party was formed into a registered company, known as the Barewood Quartz-mining Company, and this company, from 380 tons of stone, obtained 330 oz. of gold. As the result of prospecting by Lyders and party, several licensed holdings were taken up on the Museum Endowment.

In 1896 two companies, with large capital, completed arrangements for further prospecting and opening out the reefs, preliminary to erecting powerful machinery. During 1897 Lyders and party, of the Golden Burn Company, continued to work; the stone was found to be charged with arsenical pyrites. In the same year prospecting operations were being conducted in the Barewood Mine by the Anglo-Continental Gold Syndicate and the London and New Zealand Exploration Company, who were jointly interested in the venture. Three shafts were sunk. Warden Carew, reporting for 1898, stated that quartz-reefing was at a standstill, the Barewood reefs being apparently too low-grade to be profitably worked under existing circumstances. Owing to litigation the Barewood Company did no work during 1899. In 1900 Alexander

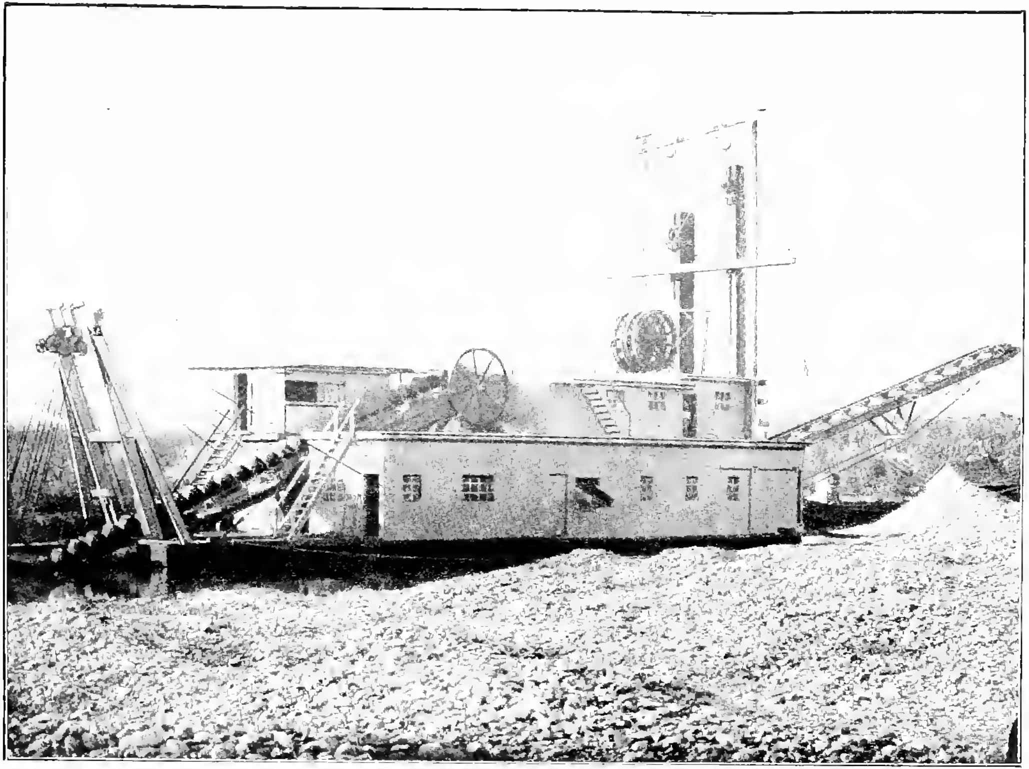


FIG. 1. TYPICAL OROVILLE DREDGE, WITH BELT STACKER AND SLUICES FOR DISPOSAL OF COARSE AND FINE TAILINGS.

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Gibson's claim employed eleven men; the yield of gold for the twelve months was valued at £885. There was nothing else done during 1900.

During 1901 the water was pumped out of the Anglo-Continental Company's No. 3 shaft, and the west level was continued. This was done by Mr. Wolters, acting for the Barewood Gold-mining Company. The stone on the foot-wall was found to be payable, thus giving the mine a new lease of life.

James Hunter sunk a shaft on a reef 4 ft. wide at Sutton. Stone tested at the Dunedin School of Mines returned at the rate of 13 dwt. to 18 dwt. per ton.

During 1902 the Barewood Gold-mining Company extended the 125 ft. level and stoped out to the rise; the stone yielded about 12 dwt. in the crushing. The tunnel on the Sutton Reef was in a total distance of 350 ft. to the face. Operations in the Barewood Mine were extended to the 188 ft. level during 1903, and stoping was conducted to the rise; 2,083 tons of stone was crushed for a return of 1,691 oz. retorted gold, and 100 oz. additional was obtained by treating the tailings with cyanide.

Operations were continued during 1904. 2,209 tons of quartz yielded gold to the value of £3,370. The mine continued to be worked during 1905, and a large battery was erected, driven by an oil-engine. Two cyanide plants were also erected to treat the large amount of tailings saved. The concentrates were shipped to Australia for treatment. The mine still continues in operation in 1906.

The Sutton Reef was further developed in 1905, and preparations were made to develop it on a large scale, but the quartz did not turn out according to expectations. The mine is still being prospected in 1906.

This district is reached by the Otago Central Railway from Dunedin.

Serpentine.

Prior to 1876 quartz veins were prospected in this locality, but with no particular success. Some promising discoveries were made in 1877, and a company erected machinery, other leases being taken up in the locality. The Serpentine Company obtained good prospects in 1878 from the German Jack's Reef, but the intrusion of a large mass of mullock in the reef baffled their efforts. Other reefs were discovered in Scandinavian Gully and Golden Gully, which showed fair prospects. The Serpentine Quartz-mining Company ceased working during 1879; but, in spite of this fact, several new leases were applied for in 1880. Warden Robinson reported in 1882 that the industry was developing into importance here, and some very encouraging trial crushings were made. Several fresh leases were granted in 1883, but operations were at a standstill at the end of that year, sufficient capital not being available to develop the reefs. A company was formed in 1886, called the Golden Gully Quartz-mining Company, to work Turnbull's old reef, which gave good results a few years previously. The Golden Gully's crushings were a disappointment, as a lot of casing and mullock, which it was thought would pay more than expenses, was crushed. The reef was fair-sized, and showed gold. The Golden Gully continued to carry on operations during 1889. A main adit was driven 1,354 ft., and connected with the surface by a pass 230 ft. One hundred and thirty tons of stone was crushed, yielding 221 oz. of gold, being at the rate of 1 oz. 15 dwt. per ton. Work was carried on at the Golden Gully Mine for some time during 1890, that being the only work carried on in the locality.

All work ceased in this district in 1891, and very little was done on these reefs until 1899, when J. Cogan opened up a quartz reef estimated to yield from 10 dwt. to 15 dwt. per ton. This venture was not, however, a success, and mining has latterly been confined to alluvial workings. Cogan's battery is still on the ground, and there is here an extensive field for prospecting. There can be little doubt but that up-to-date methods of mining and scientific treatment of the quartz will enable many of the reefs in the Serpentine district, as well as at Rough Ridge and elsewhere, to be worked profitably.

Entrance to this district is by way of the Otago Central Railway to Waipiata; thence about thirty miles inland.

Otago Central: Rough Ridge and Ophir (or Black's).

Quartz-mining was first started at Rough Ridge about 1868, and carried on for some time. The Ida Valley Quartz-mining Company and the Great Eastern Company were in operation about 1872. The mines at Rough Ridge ceased working in 1879, and very little more was done until 1884, in which year a small company, named the Otago Central Gold-mining Company, was formed for the purpose of working quartz reefs at Rough Ridge. For the last twenty years attempts had been made to work these reefs, as high as 3 oz. per ton having been obtained in some cases. The Ridge is described by Warden Hawkins as a perfect network of reefs, leaders, and lodes, ranging in size from 10 in. to 5 ft. The yields averaged from 10 dwt. to 3 oz. per ton. A large quantity of sulphide mineral was found in the stone; this had a considerable effect on the saving of the gold. The Otago Central Company, formed in 1884, was not successful, and went into liquidation in 1887. The Progress Gold-mining Company was registered in 1886. The Great Eastern Company was very successful, and for eight months, prior to May, 1888, produced 820 oz. of gold from 400 tons of quartz. The company was working in the 420 ft. level. There were several different lodes on the property, and the one then being worked was heavily impregnated with iron-pyrites and zinc-blende, both of which minerals were auriferous. Chemical tests made of the tailings proved that the Great Eastern Company lost nearly 2 oz. of gold for every ounce saved by the battery, and it was proposed to erect chlorination works on the mine. The Progress Company did a good deal of development-work during the year 1888. The Great Eastern obtained fair returns during that year, but the mine was handed over to a London syndicate, which purchased that and other mines on the Ridge, and machinery of the most approved type was to be erected. Unfortunately, the negotiations with the London syndicate fell through in 1890. An expert inspected the properties during 1890 on behalf of the

London syndicate, but the negotiations were not successful, and the mines were closed down. Perry and party did some work on these reefs, with good results, in 1892, and purchased the Progress and Great Eastern mines the following year, and continued to work upon them. They crushed 200 to 300 tons of stone during 1894, but the yield was only equal to 8 dwt. per ton. Latterly their attention had been devoted to the Otago Central Reef, from which the quartz was expected to yield 15 dwt. per ton. In 1895 some special claims were taken up, including those known as the Progress, Central, Great Eastern, &c. It was proposed to form a company, with a large capital, to be floated on the London market. The yield in 1888 and 1889 showed an average of over 1 oz. to the ton; but samples sent Home for treatment gave returns up to 9 oz. per ton. Nothing practical came of the long-pending negotiations between the local company and the London company in 1896; no progress was made in 1897, and very little has been done during the past nine years. Perry had a few crushings from time to time of stone taken out from surface workings. With the advance in the scientific treatment of complex ores, such as exist here and elsewhere, it may be confidently expected that these reefs will be profitably worked at some future date, should sufficient capital be expended in reopening the mines and equipping them with the most improved appliances. The locality is reached by the Otago Central Railway from Dunedin.

During 1887 a company, calling itself "Green's Reef and Seam Workings Company," was floated to work the holding of a miner named Green, who in 1885 found gold in an extensive seam of decomposed schist on a spur above Black's Township. The seam was very rich in places, but the operations of the company were not successful; it had a little over a year of existence, and was wound up in 1889. The company treated the material at first by Wall rolls, but this machine was not suitable. Then a puddling-machine was erected, but 200 tons of stuff only yielded at the rate of 3 gr. of gold per ton. Next, a line of sluice-boxes was laid down, and 597 tons was treated by sluicing for a total return of 2 oz. 1 dwt. In 1889

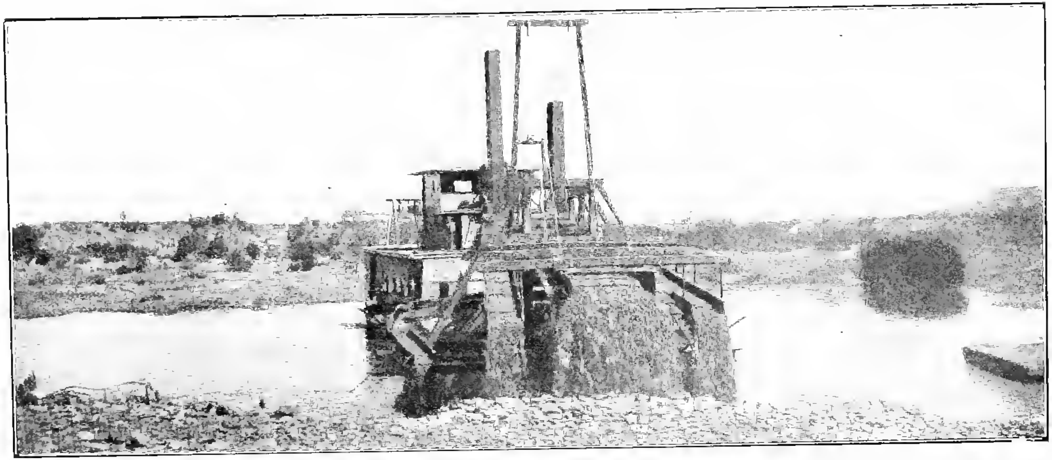


Fig. 2. Oroville (California) Dredge, showing Tailings-shoots.

Mining Handbook.

Mr. Green, the discoverer of the above seam, found a new reef to the north of the reef called Corrigall's. On this latter reef he erected a battery of eight heads to crush the materials, which could not be classed as quartz, being more of a ferruginous quartz conglomerate, without defined walls. A miner named Burren was also sluicing similar material, and saved the quartz which contained gold. The prospects on these properties were not very encouraging, and but little work was done during the next few years. In 1891 a reef called Ryan's, at Black's, was prospected, and a shaft 45 ft. in depth was sunk, but the venture was not successful. Several claims were held in 1892 in the vicinity of Green's seam workings, but no work was done owing to the absence of crushing-power. In 1895 Mr. Green returned and took up his original claim; he did a lot of preparatory work, and was sanguine of the results, but no good results were achieved. Considerable excitement was caused in 1896 by the discovery of what promised to be a highly payable quartz reef some two miles and a half from Ophir, in a south-easterly direction on the range dividing the Manuherikia Valley and Ida Valley. Gold showed freely in the stone. The discoverer, Mr. Green, sent a small quantity to the School of Mines, Dunedin, and the return was at the rate of 7 oz. per ton. A further lot of 30 cwt. yielded on rough treatment a return equal to 2 oz. per ton. The reef was acquired by a small local syndicate, but for various reasons the venture was not a success, although a considerable amount of money was expended in prospecting it. In 1900 this quartz claim was again taken up. In 1901 the Clyde Enterprise Quartz Prospecting Company took up 50 acres under a prospecting license over the area formerly held by the Green's Reef and Seam Workings Company. The old shaft was put in repair and a level started off at the 70 ft. level to search for a quartz reef, but payable results were not obtained, and the venture was abandoned. Since 1901 quartz-mining in this district has been practically at a standstill, although the opinion is held that payable reefs will yet be found on the Raggedy Range and Blackstone Hill. Very rich alluvial diggings have been worked on these ranges.

Southland: Longwood and Waiau.

Warden Wood reported that in 1887 prospecting for quartz reefs was being prosecuted on the eastern side of the Longwood Range, Southland. A well-defined reef, running north-west and south-east, was discovered, and found to be rich to a depth of 30 ft., at which depth it was 2 ft. in width. Owing to a partnership dispute this reef was not worked during 1878, but operations were continued in 1879, when an adit level was driven. At that time the want of capital to develop these reefs was felt, and the thickly timbered and broken nature of the country rendered prospecting a slow process. There was a depressing lull in this district for some time, but renewed activity was displayed during 1879. In several of the claims leaders were found carrying gold, but large reefs had not been found. The Longwood Reefing Company was crushing in 1880; the stone was said to be of good quality. The Longwood Reefing Company and the Geelong Company suspended operations in 1884, as the stone was then too poor to pay for extraction and treatment. Further to the east, in the neighbourhood of Specimen Gully, good samples of stone were taken from the Arethusa and Pioneer Claims; the latter, from a sample of 19 cwt. of stone sent to the Ballarat School of Mines, obtained a return of 19 dwt. of gold to the ton. A battery was erected at Riverton about this period for testing parcels of stone. Warden McCulloch, reporting in 1882, described the industry in this district as being in a state of stagnation; none of the mines was worked during that year. Nothing was done here in connection with the reefs until 1895, when the Riverton Mining Association sent out two parties of prospectors in February, and within two months two reefs were reported to have been discovered. The long-looked-for reefs were not, however, found in 1896, but prospecting operations were still being carried on. In 1897 a subsidised prospecting-tunnel was driven 950 ft. by the Longwood Quartz-mining Company, but the reef was not struck at that distance.

A trial shaft was put down 32 ft. at South Riverton to prove a reef found on the surface. The work was undertaken by the Riverton Prospecting Association.

The Longwood prospecting-tunnel cut a reef in 1898, at a distance of 994 ft. The reef was 2 ft. wide. Some work was done upon it, but unfortunately nothing payable was found. Operations were suspended in 1899, and very little attention has been paid to the quartz reefs since.

Reports have been made from time to time of the discovery of quartz reefs in the dense bush country across the Waiau River, but no definite information has so far been received of any finds.

Preservation Inlet.

The discovery in 1892 of a rich auriferous lode, crossing the bed of Wilson's River, gave an impetus to prospecting for reefs at the Inlet. The first claim was called the Prospectors', and four other holdings were taken up on the northern extension; three were granted on the southern end Another quartz reef was found near Cuttle Cove, on the opposite side of Preservation Inlet. Other prospecting was being carried on in 1892, but the country was rough and covered with dense, swampy moss and forest. Very little development took place during 1893. The Golden Site Company acquired the Prospectors' Claim, and sunk a shaft and constructed an adit. Arrangements were made to erect a battery to be driven by water-power. The Hesperides, Surprise, Lucky Shot, and Rata Claims were prospected with little or no success during that year. Very rich gold-bearing lumps of quartz were found in Cuttle Cove, but the solid lode was not discovered.

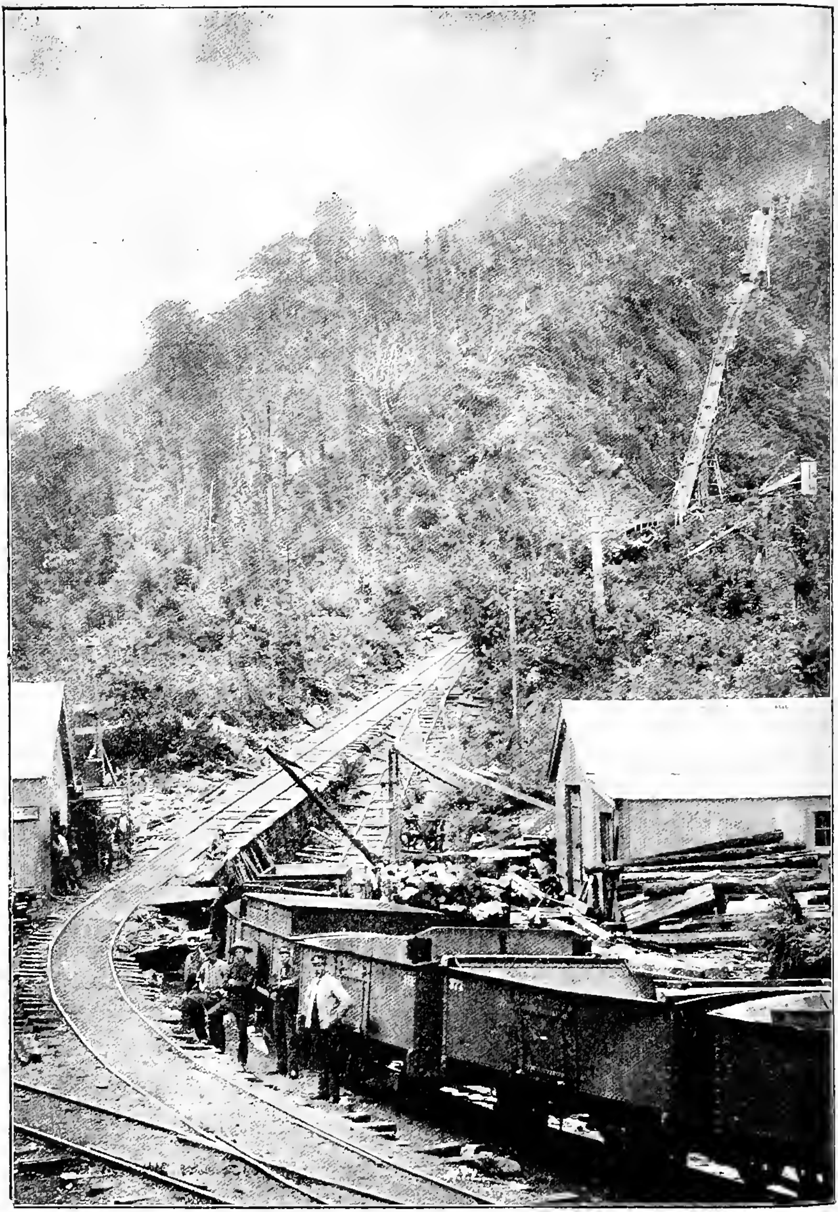
During 1894 the Golden Site Company erected a battery, and between August and October crushed 640 tons of quartz for a yield of 666 oz. of gold. This quartz was all taken from the south side of Wilson's River, where the reef averaged 8 ft. in width. The battery returns for 1894 showed that 1,155 tons of stone was crushed for a total yield of 875 oz. of gold, but only the Hesperides and Triangle Extended mines, on the south side of the Golden Site, were developed, very little being done towards working the quartz lodes in the district, and operations were suspended in the holding on the north side.

The Morning Star Company was formed in 1894, with a capital of £12,000, to work a mine on the mainland, facing Longbeach. A ton of stone sent from this mine to Messrs. Wylie and Scott's battery at Invercargill yielded 9 oz. 14 dwt. A rich auriferous lode was found on Crayfish Island, in the Nugget Claim, where 95 oz. of gold was broken out by hand. A trial crushing from the St. George and Crown Claims, at Cuttle Cove, is said to have yielded 1 oz. 7 dwt. per ton.

"Rocks of the Lower Silurian formation abound in this locality, and three distinct lines of reef-bearing rock are traceable within the bounds of this formation. (1.) That of the Golden Site, in the middle of Wilson's River Gorge, and extending south to the coast-line at the mouth of Kiwi Stream. (2.) That beginning at Cuttle Cove, and extending through Steep-to Island (Crayfish) to the Longbeach and Morning Star line of reef. This line extends south across Sealers' Creek to Wilson's River, two miles below the Golden Site Claim, and has been cut in the road formed to that claim. (3.) This line of reef-bearing country begins between Cuttle Cove and Southport, and forms a very considerable display of reefs and leaders on Cavern Head, and thence extends through Coal Island to Observation Point, on the mainland opposite. Below Sealers' Creek this line is lost in the disappearance of the Silurian rocks below the coal-bearing rocks of the coast-line." The foregoing description is by Mr. Alexander McKay, F.G.S., Government Geologist, who visited the district in 1895. Quartz lodes are rare in the granite formation to the eastward of the Silurian rocks.

One lode was being prospected in Isthmus Sound in 1895. The ore was a strange admixture of iron, copper, lead, zinc, gold, and silver. When comparatively pure or dressed to a high percentage the galena was said to yield 100 oz. to 120 oz. of silver to the ton, and as much as 7 dwt. of gold.

The Golden Site Mine made little progress during 1895, and was closed down towards the end of that year, pending the raising of further capital to develop the lodes; 111 oz. of gold was obtained from 454 tons of stone. The Morning Star Mine continued to work with vigour, and the battery-power was



THE LOWER INCLINE, DENNISTON (WESTPORT COAL COMPANY, LIMITED).
Mining Handbook.

doubled during that year; 1,335 tons of quartz yielded 728 oz. of gold.

Several reefs were found at Sealers' Creek, but they were not opened out. A good deal of prospecting was done on Steep-to (or Crayfish) Island for a rich reef supposed to exist, but this had proved a vain endeavour. Sufficient prospecting had not been done to prove the value of the reef at Cuttle Cove, near Cavern Head. Mr. McKay examined several outcrops in Cuttle Cove, but pronounced them to be too thin for profitable working, unless very rich. Samples yielded only traces of gold. At Cavern Head there is a regular network of reefs and quartz leaders.

The Morning Star Mine continued to work during 1896. The total yield of gold since commencement of operations was valued at £20,000. The returns for the year ending the 31st March, 1897, showed that 3,140 tons of stone was crushed for a yield of 3,420 oz. 14 dwt. of gold, valued at £4 2s. per ounce. The Alpha Gold-mining Company was formed in 1896 to work Longney's Claim, Sealers' Creek, but very little work had been done. A well-defined reef was traced in the Golden Site Extended Company's claim, and a trial crushing gave favourable results. All the claims were held under protection in 1896. At Isthmus Sound the stone taken from Bradshaw's Reef was highly mineralised, and it was proposed to ship a parcel of ore to England for treatment.

The Morning Star was the only mine producing gold in 1897, in which year 139 oz. of gold was obtained. The Alpha Mine was being developed, awaiting the erection of the battery. The Golden Site Mine was being further developed, but no crushing was done. Other mines in the district were doing very little, except the Golden Site Extended, at which mine a shaft 210 ft. in depth was sunk and levels driven.

In 1898, 3,733 tons of quartz was crushed in the Morning Star battery for a yield of 2,060 oz. of gold, valued at over £8,000, and a further yield of 93 oz. was obtained by amalgamation of the tailings. The Golden Site Extended also started crushing, and obtained 301 oz. of gold from 1,107 tons of quartz; while the Alpha Company crushed 338 tons of quartz

for a yield of 93 oz. The Sunrise Company started driving tunnels on property adjoining the Morning Star, and a reef 6 ft. in width was cut in No. 1 tunnel.

During 1899 the Morning Star Company crushed 1,033 tons for a yield of 432 oz. of gold, valued at £1,770. The resources of the mine were approaching exhaustion at the end of that year, in consequence of the little development-work that was carried out. A good deal of work was done on the Alpha Mine, but only 22 oz. of gold was obtained from 446 tons of quartz. The stone was low-grade, as the best crushing only returned 5 dwt. per ton. The Golden Site Extended Company's holding comprised five claims—viz., Break of Day, 30 acres; Heather Bell, 30 acres; Golden Site, 30 acres; Christmas Eve, 30 acres; Hesperides, 24 acres. A lot of work was done on the property, but only 274 tons of stone was crushed, yielding 55 oz.

A shaft 80 ft. deep was sunk on the Tarawera Gold-mining Company's property, Isthmus Sound, but the stone would require to be shipped to a reduction-works for treatment. While prospecting by surface trenching Messrs. Robinson and Williams unearthed a reef 18 in. wide, and showing gold freely. A trial crushing from a reef at Cuttle Cove yielded 1 oz. of gold per ton.

The returns from the Inlet mines were not very large during 1900. The Morning Star crushed 776 tons for 365 oz. of gold, valued at £1,496. The Golden Site Extended crushed 5 tons for 1 oz. 18 dwt., and the Alpha Quartz-mining Company secured 264 oz. 17 dwt. from 1,364 tons of quartz. There were no developments to record during that year, but in the year 1901 the New Star Company's tributers, operating on the Morning Star Claim, crushed 15 tons for 11 oz. of gold. The Golden Site Extended recovered 9 oz. from 42½ tons, and the Alpha Mining Company crushed 770 tons of quartz for a yield of over 163 oz. Three tons of stone was taken from the Venus Claim (late Mavourneen), Crayfish Island, and crushed at the Morning Star battery, for a return at the rate of 16 dwt. per ton. In June, 1901, the Cuttle Cove Gold-mining Company's mine was let on tribute to two miners, who took out a trial crushing of 15½ tons of stone; this was crushed at the Morning Star battery for a yield of 11 oz. 13 dwt. retorted gold McQueen and party extended an adit through hard country to intercept the main reef in the New Venus (or Monte Christo) Claim in 1902, but without success.

In the year 1902 the New Star Company secured 113 oz. 15 dwt. retorted gold from 178 tons of quartz, and from the Alpha Mine 306 tons were crushed for a yield of 25 oz. retorted gold. Matters were very quiet on the Preservation field during 1903. The New Star Company had an unfortunate year, and was compelled to go into liquidation; 99 tons of quartz was crushed for a return of 26 oz. of gold. The mine was worked on tribute during that year by Hawkins, Juncker, and party.

All work in connection with quartz-mining was stationary throughout 1904, although efforts were made to resume work in the Morning Star Mine. This state of inactivity continued throughout 1905, but in 1906 some prospecting was undertaken, and rich stone was reported to have been found, taken, it was said, from the newly discovered extension of the Morning Star Reef. There is an extensive field here yet unprospected owing to the difficult nature of the country.

Access may be had by steamer from Invercargill, or by several difficult overland routes.

[The early information in these notes is mainly culled from reports by Wardens and officials published in the annual reports issued by the Mines Department.—AUTHOR.]

MOUNT IDA DISTRICT.

By Warden McENNIS.

GOLD was discovered in the Hogburn Gully, on the present site of the Town of Naseby, in June, 1863, by a miner named William Parker and his mates. The Hogburn is a small stream which takes its rise in Mount Ida, and joins the Taieri River above the lake. Soon after gold was found at Hamilton's, followed by fresh discoveries at Hyde, Sowburn, Kyeburn, and Fullerton's. The following year gold was discovered at Blackstone Hill and Dunstan Creek (or St. Bathan's), and shortly after at Cambrian's. The Mount Ida Goldfield embraces within its area a large number of streams, all of which have been proved to be auriferous. A few months after the first discovery, when it was estimated there were five thousand people on the field, the escort brought to Dunedin 4,320 oz. of gold. The field has been continuously worked since then, and sluicing has been very extensively carried on.*

The operations at some of the principal mines in the district during the past year may be briefly summarised as follows:—

Macrae's Flat.

Gold and Scheelite.

The usual amount of mining has been carried on during the year ended the 31st December, 1905. There has been more activity than usual in quartz-mining, and several fresh areas have been taken up, but in most cases not much has been done, as a want of capital hinders efficient work.

The Golden Bar Mine has been very successful during the year, and has paid handsome dividends to the owners. Towards the end of the year the good stone gave out, but a fresh make was discovered.

The Ounce Claim has been worked by W. Lidstone, and a small quantity of stone treated, which, it is stated, has left very little margin of profit.

The Maritana Claim, owned by C. McGill, has done a considerable amount of work, and produced a small quantity of scheelite, but the gold-returns are rather small. The mine has been connected with the battery by a three-rail tramway, and an oil-engine put in to augment the water-power.

The Golden Point Mine, owned and worked by W. and G. Donaldson, has been in regular operation during the year, and employed an average of twenty-five men at mine and battery.

* "Handbook of New Zealand Mines, 1887," p. 68.

The low level has been extended, and is now following the reef to the dip, which contains very good gold-bearing stone. The yield of gold has been satisfactory, and 60 to 70 tons of scheelite has been produced during 1905, of an average value of about £80 per ton.

The Mount Highlay Mine changed hands during the year, and the purchasers have done a considerable amount of work. They put in a concentrator and saved some scheelite with it. Four or five men are employed, but the battery has not been kept constantly going, although there is a prospect of more vigorous work being undertaken.

The Gold and Tungsten Mine, near Mount Highlay, is one of the most recently taken up properties, and, although it at first consisted of six parties, it is now entirely in the hands of Messrs. W. and G. Donaldson, who have spent £1,500 on a plant, which is situated on a branch of the Mareburn Creek, and within 500 yards of the mine. The plant consists of a receiving bin and screen, a coarse rock-breaker, a fine crusher (Blake and Marsden), ore-feeder (Challenge), a 5 ft. Huntington roller mill, copper plates, and a Wilfley concentrator (latest pattern). An oil-engine will be used to actuate the plant till a large steam boiler and engine are put in. The engine will have ample power to drive an enlarged plant. The reefs contain very fair gold, and one has a good percentage of scheelite in it. Messrs. Donaldson believe in the Huntington mill for crushing scheelite-ore, as their experience has shown them that there is nothing like the loss in slimes (and scheelite is very apt to slime) with the mill as with modern stamps. The plant will employ ten or twelve men.

The Burster Sluicing Claim, situate on Mount Burster, Mount Ida Range, was a notable claim, considering it was at an elevation of 4,000 ft. above sea-level. This, I understand, was at the highest elevation (save Mount Criffel workings) of any gold-sluicing in New Zealand. The water was obtained by several races, circling round the mountains, catching the snow-water. The claim is now practically worked out, but the owners have men on tribute clearing up small patches and prospecting.

Matakanui.

The Undaunted Gold-mining Company has paid in dividends £1,125 for the year 1905, and won 618 oz. of gold, the number of men employed on an average being nine. This company has the electric light installed. The face operated upon is 43 ft. deep. The water-supply was very slack from March to end of August, 1905, the autumn being the driest ever experienced, and the winter the mildest, with scarcely any snow or frost; but fair rain fell during the last four months of the year. The company holds 114 acres, hydraulic elevating being the method employed in working the claim. This company has paid £11,250 in dividends, and expended £16,953, its paid-up capital amounting to £15,000.

The Tinker's Gold-mining Company paid in dividends during the year £1,687 (making a total of £5,438), and won 739 oz. of gold. The company is elevating from a depth of 60 ft. Claim, 87 acres.

The Matakanui Gold-mining Company paid in dividends in 1905 £1,049, and won 538 oz. of gold. It is now working a rich run of gold, and elevating 65 ft. Claim, 45 acres.

St. Bathan's.

The scarcity of water during the past year retarded mining operations considerably, but the returns, nevertheless, were satisfactory, and have given hopes of future permanence.

The United M. and E. Company obtained about 850 oz. for a little more than four months' work. The dry weather and heavy frosts caused the water-supply to be very intermittent and small. This company has struck a good run of gold.

The Scandinavian Company has done but little work on the claim in St. Bathan's basin, owing to protracted litigation. This company intends to erect an up-to-date and powerful plant to elevate from the lowest level—about 160 ft. On its Surface Hill Claim this company is elevating from a depth of 120 ft. The company has the best water-supply in the district.

NASEBY DISTRICT.

By R. MURRAY, Manager Government Water-races.

WITHIN a radius of four miles of the Township of Naseby the principal gold-mining operations in the County of Maniototo have been carried on during the last forty-two years. Until recent times the method of working was by ground-sluicing. The water supplied from private races in the early days being very inadequate and intermittent, the Government had by 1887 constructed the Mount Ida Water-race, thus allowing a large amount of ground, wherever fall could be got, to be sluiced away. This became limited within recent years, and, in order to get at the flat beds of the creeks, a different method of working had to be adopted—that of hydraulic elevating—for which the ground is very suitable, it being principally a quartz wash, and free from any large quantities of boulders. The average depth is about 16 ft., but to get a dump for the tailings the washdirt has to be elevated to a height of about 26 ft., the number of claims at present at work using all the water available. During the dredging boom a good deal of this country was taken up for dredging, but from the consistent nature of the auriferous washdirt this method proved a failure. By the hydraulic-elevating system the wash is completely pulverised, letting the gold free.

In the Kyeburn, Patearoa, and Blackstone Hill districts, with the exception of one elevating claim at Patearoa, gold-mining is carried on by ground-sluicing, all the water being in the hands of private parties. At Patearoa a private party of four, about two years ago, started to construct four miles of a race at a high level to carry ten heads out of the Sow-burn Creek, to work ground in Caledonian Gully, but it is not yet completed; they have had a good deal of rock-cutting to contend with, but evidently have faith in the venture.

The length of the Government main race is 66 miles 65 chains. Besides this, there are about twenty-four miles of distributing races from it. The Blackstone Hill Race, owned by the Government, is sixteen miles in length, making a total length of races of 106 miles. Only twelve miles of the Blackstone Hill Race is in use, supplying R. Johnston and Sons, who are ground-sluicing.

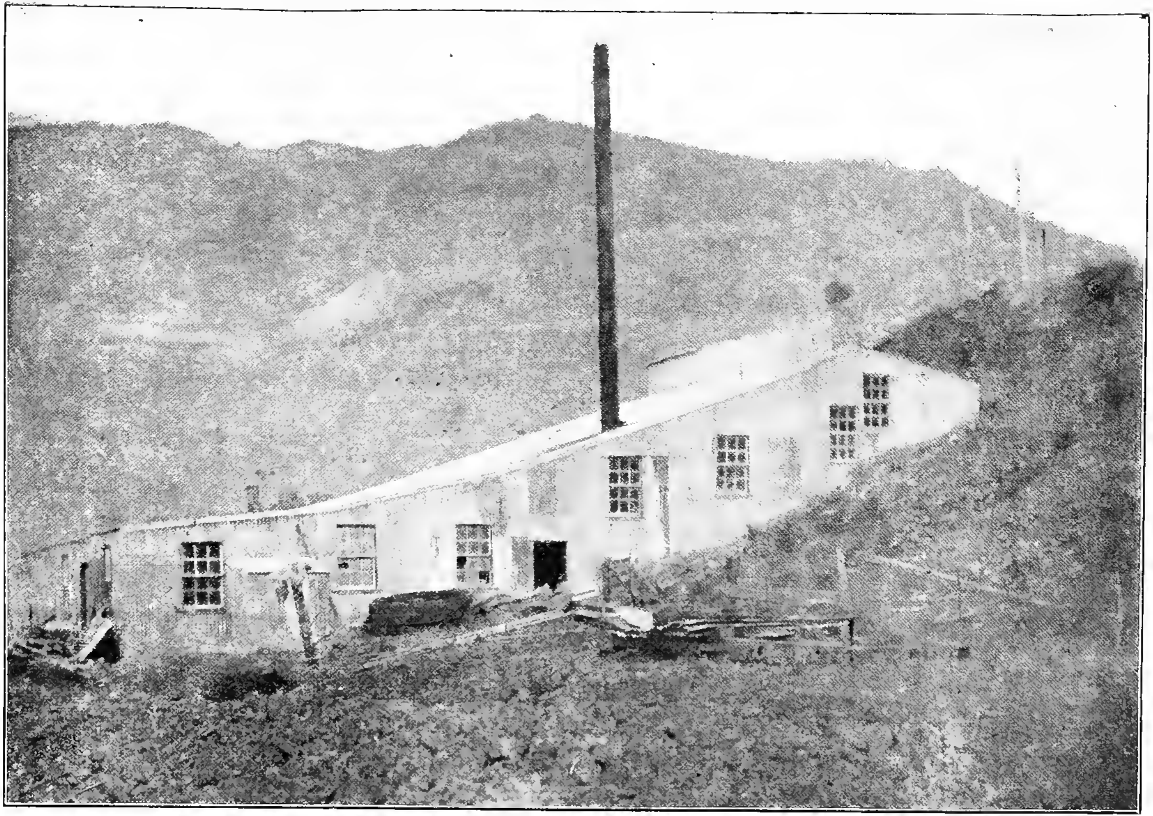
Besides the lignite-beds that are at present being worked in the district, there is a very large area of this coal not generally known at the East Marionburn, a tributary of the Manuherikia River. It is traceable for a distance along the foot of the Hawkdun Range upwards for about twenty miles, where the East Marionburn cuts through it. It is of a much better heating and lasting quality than that of any lignite now being used in the district. It is about seven miles inwards towards the range from Hill's Creek Township.

In connection with mining in this district the principal drawback is the want of water.

MINING AT LITTLE KYEBURN.

By William Smith, Little Kyeburn.

Little Kyeburn, properly speaking, is the right-hand branch of Kyeburn Creek, and at no period of its history has it ever been noted for its large finds of gold, although gold-mining has been carried on in the locality for upwards of forty years. There is a large area of auriferous ground, but most of it is much too poor to pay with present known appliances, and, with the exception of two or three parties of Chinamen fossicking in the bed of the creek, there are only three parties at present carrying on mining operations in the locality. The first and most important of these parties is W. H. George and his two sons, who obtain their supply of water from the Undaunted Creek, a tributary of the Little Kyeburn. The water is conveyed in a water-race about two miles in length to their claim, which is situated on the bank of Deep Creek, about half a mile above its junction with the



Gold and Scheelite Mining at Macrae's, Otago: W. and G. Donaldson's Golden Point

Little Kyeburn. The ground is all river-gravel, and very stony, and is operated on with about 800 ft. of pipes, varying from 15 in. to 7 in., with a $2\frac{1}{4}$ in. jet. Owing to the stony nature of the ground, it just about pays working-expenses.

Philip Brown and W. Smith's claims are about a mile and a half distant from that of W. H. George and Sons, and on a higher elevation. The water-rights of these respective parties are not so good as that of the Georges', but the ground being of a lighter nature, and generally very hard, they can work with a smaller head of water with just about the same results—namely, pays working-expenses.

Some few years ago a dredge was put on to work the bed of the Little Kyeburn, but it turned out a failure, and afterwards a sluicing company tried hydraulic elevating; but, owing to the ground being too stony, and also too shallow, causing too much shifting of elevator, that venture also was a failure.

GOLD AND SCHEELITE MINING AT MACRAE'S FLAT.

The Golden Point Mine has an area of 84 acres, and is owned by Messrs. W. and G. Donaldson. This property is opened by five tunnels, which are driven a total distance of 3,000 ft., and intersect two lines of reef varying in width from 3 ft. to 8 ft., the quantity of ore available being estimated at 200,000 tons. Developments comprise 600 ft. of crosscuts, a total length of 5,000 ft. having been driven on the course of various lodes. In connection with the reduction-works a ten-head stamp-battery, driven by steam and water, is employed, the average duty per stamp per diem ranging from 3 to $3\frac{1}{2}$ tons. The gold is saved by amalgamation on plates and mortar-boxes, concentration, and treatment of tailings by cyanide, a little of which is used in the mortar-boxes. During the year 1905, 3,100 tons of ore yielded 782 oz. of gold, value £3,120. The total quantity of ore crushed was about 18,000 tons, yielding 5,000 oz. of gold, valued at £20,000, the average value of the gold being £3 19s. per ounce. About 400 tons of scheelite was also produced, valued at £24,000. The total expenditure in wages to 31st December, 1905, amounted to £22,000. On an average twenty-five men are employed in the mine, and five in the reduction-works. Value of plant, &c., £10,500.

Until recently the Golden Point has been the only mine in New Zealand that has been a regular producer of scheelite as well as gold. Scheelite has been mined during the past eight years, concentrated, and shipped to Europe, where it is manufactured into tungstic acid, and used in the manufacture of high-grade steels. These steels are put on the market as "tungsten nickel steel," "high-speed steel," "self-hardening steel," &c. Tungsten steel is principally used for tool-steel or engineers' steel. It is also used for the inner tubes of big guns, its properties being great density, hardness, and toughness; it may be glowing hot, yet not lose its temper, and is therefore an ideal tool-steel—so much so that engineers' lathes can now turn out double their former quantity of work.

Tungstic acid is also made into some fine grades of paint; it is used as a mordant (fixing the colours in calico-printing, &c.), and renders cloth non-inflammable.

Scheelite is used as a cheap fluorescent screen for X-rays.

The occurrence of scheelite has been known in the Macrae's Flat district for the last fifteen to twenty years, but nothing was done till Messrs. Kitchener and Donaldson sent a shipment of hand-picked ore to London about fifteen years ago. The ore then shipped was of poor quality, only yielding about 40 per cent., and the returns did not leave a large margin of profit. Nothing further was done till about eight years ago, when Messrs. Donaldson, in working their reef for gold, discovered some extremely rich deposits of scheelite underlying the reef. These deposits were sufficiently pure to be hand-picked; they assayed 68 per cent. of tungstic acid, and realised £58 per ton. The quartz also contained a large percentage of scheelite, which could only be treated by concentrating appliances after going through the battery. A Frue vanner was put in, which gave complete satisfaction, the scheelite concentrates assaying 72 per cent. in tungstic acid. The first year after the vanner was put in scheelite concentrates were saved to the value of £6,000. Since then scheelite has been regularly produced, and, although the price has varied very considerably, the value produced to date (25th June, 1906), is about £24,000. It has been sold as low as £20, and as high as £120, per ton.

The tailings are being saved for treatment. They assay 10 dwt. of gold, and a small sample treated with cyanide yielded 7 dwt. per ton.

The stone is found to be richer in gold the deeper the workings are carried.

Scheelite sometimes carries specimen gold, but as a rule this is not general, and the purer the scheelite the less gold there is in it. Mine-manager, William Donaldson; general managers, W. and G. Donaldson, Macrae's Flat, Otago.

The New Zealand Gold and Tungsten Mine, Mount Highlay, has an area of 90 acres, and is owned by Messrs. William and George Donaldson. One tunnel has been driven a distance of 50 ft. Two reefs are now being worked, which maintain an average width of from 6 ft. to 10 ft., the ore available being estimated at 60,000 tons. The plant in use is valued at £2,000, and consists of one 5 ft. Huntington roller mill, with a capacity equal to ten head of stamps, the average duty of the mill per diem being 20 tons. There are two rock-breakers employed—one ordinary and one very fine crusher. The gold is saved by means of amalgamation in mill and copper plates. Total expenditure in connection with the mine up to the 31st December, 1905, £2,600.

This mine has only recently been started, but the return so far is satisfactory. There are immense bodies of stone very easily mined, and containing a fair percentage of scheelite, which is saved by a Wilfley concentrator. The mine is being connected with the mill by a three-rail incline tramway, with steel sleepers and one-ton trucks; the whole of the material is being obtained from England. A large boiler and engine are in course of erection, and the plant is to be increased.

Lignite suitable for steam purposes is found within three-quarters of a mile of the plant.

Although this mine is six miles distant from the Golden Point Mine, at Macrae's Flat, it is apparently on the same line of reef, and has many of the same characteristics. Mine-manager, George Donaldson.

THE LIVINGSTONE GOLDFIELD.

By John Christian, Livingstone.

Livingstone is that portion of the Maerewhenua Goldfield lying east of the river of that name. It is about twenty miles west of Oamaru, and lying from 800 ft. to 1,200 ft. above sea-level. There was a small rush here about the end of 1863, but, as there was practically no water on the field, work was confined to a few small gullies, with not very satisfactory results. Later on, what is known as the "green-sand deposit" was discovered in all the spurs, and the work of race-construction was commenced. This green sand is a marine deposit, as is evidenced by the countless shells, sharks' teeth, &c., contained therein. It lies on a false bottom, composed of quartz gravel, and is overlain by sand, both free and cemented, and clay. The water-supply is brought from the Maerewhenua River and two small creeks nearer the field. The gold is pretty evenly deposited, but in no case very rich, though highly satisfactory returns have been obtained in most places. The ground was shallow all round the edges of the spurs, but as the workings went back the overburden became too heavy for profitable working, and for the last ten years very little of this deposit has been worked. About that time it was found that the false bottom carried payable gold, and since then nearly the whole of the workings have been in the false bottom, the returns in most cases being fairly payable, and in some instances very good. The gold on this field is very fine and difficult to save. It is found that about one-half will pass over a string of ripples. The stuff is then passed through a sluice paved, or rather thatched, with tussocks, but even then it is found that a considerable percentage is lost. The water is supplied by the following races:—

Yeomans's race: Seventeen miles long; capacity, two heads. Water—only in the spring.

Lory Brothers' race: Fourteen miles; capacity, three heads. Supply depends on rain. Works two claims when water available.

Cook's race: Twenty-five miles; capacity, three heads. Full supply about half the year—always a little. Two claims worked when water available.

Christian's race: Twenty-seven miles; capacity, twelve heads. Full supply most of the year. Works two claims, and supplies water to others.

MINING AT WAIKAIA.

By R. T. Stewart.

Many attempts have been made to work the bed of the Waikaia River in its upper reaches, but all unsuccessfully except one, where the conditions were more favourable than in general, owing to the bed of the stream being wider, and very rich returns were secured and fortunes made. The narrowness of the river-bed—not more than 70 ft. in places—precludes the possibility of working, except at great outlay, to secure temporary diversion of the stream, through overhead flumes, while the gold was being cleaned off the rock bottom.

About twelve miles in a south-easterly direction from Waikaia a volcanic formation exists, carrying gold, silver, and copper, assays of which gave 4 dwt. gold, 3 dwt. silver, and 2 per cent. copper per ton. This would seem to warrant the expenditure of capital in making further tests, as there is a very large body of stone, which, as far as appearance goes, is all the same.

At Nokomai, about twenty-four miles west of Waikaia, a quartz reef, some 14 ft. in width, and in places yielding assay returns of an ounce of gold per ton, the average being about 12 dwt., has received attention from prospectors at different times, but the necessity for an extensive crushing plant places this reef beyond the reach of any but capitalists. It is, however, worthy of attention in the direction of development.

In the Waikaia district there is a large area of auriferous terrace formation, favourably situated for ground-sluicing, which will no doubt receive attention when the richer alluvial flats have been worked out by dredging. Eleven dredges are now at work in the district, which, with two exceptions, are securing highly satisfactory returns.

There is also a large deposit of high-grade shale in the district, and another of marl, both being easily accessible by a good road.

GOLD-DREDGING IN THE WAIKAKA VALLEY.

By McGeorge Bros., Waikaka.

As far as can be ascertained, most of the dredging-areas in the Waikaka Valley are now being successfully worked. The non-success of one or two ventures is attributable to the area of the claims being too small—about 70 acres to 90 acres; at least 200 acres per dredge is required to insure success.

There is an excellent opening in the vicinity of the Little Waikaka, which would probably pay handsomely for hydraulic sluicing if the necessary capital could be found.

At present, with other private companies, we are having a quantity of our concentrates tested by an analytical chemist to prove if gold is being lost by present methods of saving other minerals that exist in payable quantity.

By means of a separating-box soil and sand are distributed over the tailings, which are left perfectly level, and when sown with clover and grass yield excellent grazing, as may be seen on Waikaka United and other claims in the district.

OTAGO AS A MINING DISTRICT.

By L. O. Beal, M.A.I.M.E., Dunedin.

Replying to Mr. Warden Cruickshank's inquiry as to abandoned properties in the district whose failure may be attributed to lack of management or capital, and to other inquiries bearing on the present and future prospects of the mining industry, Mr. Beal writes as follows:—

To my knowledge a great many of the failures have been owing to lack of management. Take as an instance the large number of failures in the district in quartz-mining. No record is kept at any place of the amount of quicksilver used for ripples and copper plates in amalgamating the gold, and very little is done in the way of cleaning the silver by retorting or cleaning it with sodium. A large quantity is lost by flouring owing to there being a considerable amount of arsenical pyrites in many of the reefs. Antimony and galena also sometimes occur. It is only a few companies that concentrate their tailings and have them treated, and many companies and mines could have paid dividends out of what they have wasted. At one mine at which I acted as advising engineer (the Premier, or, later, the Glenrock Company, at Macetown), by saving the concentrates and cyaniding them a profit of from 7s. to 15s. per ton was made over and above the ordinary returns by amalgamation. A considerable loss is often incurred by not crushing the material fine enough. I have seen as much as 80 pounds' worth of gold obtained by grinding the tailings from 120 tons of quartz after it has run over plates kept in excellent order. The 120 tons were crushed to a punched-mesh screen of 280 holes per square inch, and then the tailings were afterwards ground and amalgamated, a little cyanide being used in the grinding plant to keep the silver in good order, and the result was gold to the value of £80, obtained by grinding and amalgamation of 120 tons of quartz.

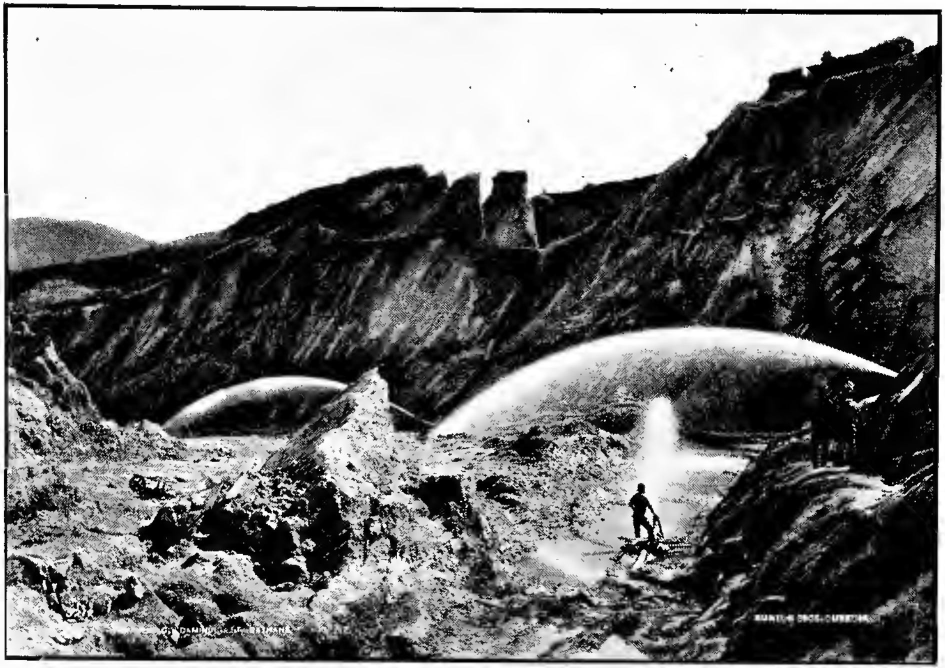
I find by examination of quartz tailings under the microscope that sometimes in lodes there is a large quantity of fine gold imbedded in the pyrites. This can be recovered by concentrating and grinding or cyaniding, and sometimes there is a large quantity of fine gold in the quartz (not in pyrites); this will be mostly lost in concentrating, and only saved by grinding and amalgamating.

Where grinding and amalgamating is done the silver should be first thoroughly cleaned by retorting, or by sodium and some cyanide, and, say, a small quantity of caustic soda added at times to keep the silver in good order. Silver should also be weighed when being put in, and again on cleaning up the grinding and amalgamating plant, also that obtained from squeezing the amalgam and retorting, so that no silver is lost by flouring or other causes.

I am satisfied a large loss takes place owing to insufficient training and careful watching in battery-work.

A large loss in quartz-mining often occurs in not properly opening up first, so as to obtain good ventilation and cheap filling of the stopes. Very few mines keep a record of the longitudinal sections of the workings. I think there can be now no question as to the gold occurring in shoots, and owing to no records being kept the run of gold in the lodes is often lost, and failure ensues.

There can be no doubt that in many cases loss occurs owing to want of capital in putting on efficient plants and doing necessary development-work. Mount Aurum, Advance Peak, the Lammerlaw Range above Waipori, the Old Man Range between Roxburgh and the Nevis, Mount Highlay, Dunback Hill, Garvie Mountains, Rough Ridge, Waitahuna, Mount Stoker, Rock and Pillar, Hummock and Little Hummock, Dunstan Range, Umbrella Mountains, and Mount Pisa Ranges, all contain large numbers of auriferous lodes, and I am of opinion that many quartz-mines would pay under good management, although they have been failures in the past. The number of lodes in the Otago goldfields is very great, but want of capital, and consequent want of proper plant and opening-up and development work, together with some of the causes already indicated, is more to blame than the mines themselves for the failures in the past. The following are



Hydraulic Sluicing, St. Bathan's, Otago.

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names of some of the mines that I consider should pay if properly capitalised and thoroughly well managed: O.P.Q. Reef, Canton Reef, and Gear's reef, at Waipori; Ocean View and Johnson and Gillan's reefs; Canada Reef; the Waitahuna Quartz-mine. The Game Hen Reef, at Hindon, I think, should also pay; also a continuation of the Barewood Reef, south-eastward, where worked a little north-west of Christmas Creek, between there and the Taieri River; also Barewood Reef, towards Matarae, across the river.

I also think the Nenthorn field of reefs would pay if a record of the workings had been kept, as I found after the field had been abandoned, from inquiries I made when preparing a geological section of the field, that the shoots of gold had been almost horizontal. This peculiar fact was not apparently found out; the companies looked for the shoots of gold going down almost perpendicularly, and hence I think the failure of that field.

There must be some more good reefs in the Waipori and Nokomai districts as yet undiscovered and worth prospecting. This I know from the large number of quartz-specimens I have seen among the gold when dredging and sluicing companies are washing up.

There are also some reefs, such as Bradshaw's reef, in Long Sound, Preservation Inlet Goldfield, which would well repay prospecting, and continuation of Morning Star Reef above Cuttle Cove, and I have seen good specimens of copper-ore from that district. Stewart Island is a locality that would well repay a prospecting party; also Mount Aurum and the Longwood Range.

What is badly wanted, in my opinion, is a good strong prospecting party, consisting of, say, two capable hydraulic miners, two good quartz-reefing miners, a person with a good knowledge of mining geology and metallurgy, and a survey hand capable of fixing positions, &c. I think a really efficient prospecting party would be well repaid, as very little prospecting of a systematic nature is done nowadays. I have been over almost every part of Otago and Southland mining districts, and can speak for the localities and ranges I have mentioned.

I find cinnabar and scheelite ores are very little known among miners. I think the Waitahuna Hills would pay to prospect for cinnabar; and Mount Highlay, Dunback Hill, and Lammerlaw Ranges would pay to prospect for scheelite.

I consider a better appreciation of water-power and transmission by wire-rope and the system of self-acting aerial tramways could, with great advantage, be more generally used.

Regarding the dredging industry, it has suffered a good deal from not having dredges quite strong enough or deep enough to do the work, and I think dredge-ladders should be made telescopic so as to be able to be let out 10 ft. to 20 ft. and clamped.

There is, in my opinion, excellent scope for capital in the idea of diverting, say, portions of the Shotover and Kawarau Rivers by means of tunnelling, and I think such a scheme would repay capital spent upon it.

There is probably a good field for alluvial prospecting at Cardrona, as that river must have a higher level of ancient bed like the Shotover and Arrow Rivers, and also like the small portion of the old high bed of the Nokomai River adjoining the Nokomai Sluicing Company.

In conclusion, I may state that, in my opinion, mining in the past has suffered from a general supposition that gold comes where it is apparently by chance, and I am firmly of opinion that such is not the case. Take alluvial gold-deposits: such a thing as the angle and manner of the way the stones are laid down in the wash seems to have been so far unnoticed. When the long flat stones travelled along in the alluvial deposits they must have moved with their greatest length at right angles to the direction of the movement, and canted back towards the direction in which they came. If a face of gold-bearing wash is opened up its direction can be traced, and probably much more good wash found, as the present contour of the country is very different from what it was at previous periods.

As regards reef gold, no study seems to have been made as to the particular character of the country rock in which the reefs are found, and a careful investigation of the exact character of the various country rocks, or particular class of schist rock, should be made, as I find I can often tell the character of a lode by examining the character of the country rock it is in, and there are much greater changes in the various schist rocks than appear at first to the eye. Some schist is very soft, some very hard, other very slaty, and other very clayey or micaceous; some a great deal laminated, and some very dense and black. A slaty, clean schist usually carries coarse reef gold, and a clayey micaceous schist very fine gold. I have found three or four classes of quartz containing a good deal of fine gold, although apparently barren to the eye.

HYDRAULIC MINING.

A Short Review of this Important Industry from its Inception to the Present Day.

By John Ewing, Hydraulic Mining Engineer, Central Otago.

In hydraulic mining we imitate nature. Through countless ages sun, wind, and rain; frost and snow; tiny rivulet, creek, and river were disintegrating the high country and forming the alluvium with which the valleys are filled, the terraces fringing them formed, and the foothills of the mountains made.

Over a great part of the South Island of New Zealand the alluvium has gold—usually in minute specks or grains—distributed through it. This auriferous alluvium is of two classes—first, the old drift; second, the more recent alluvial deposits. The chief of the first class is what is called the "white drifts"—the primary alluvial deposit over the whole island—and, overlying it, other drifts of the age that succeeded the laying-down of the white drifts; these were in part formed from the disintegration of the white drifts themselves. These drifts are described by Mr. Alexander McKay, F.G.S., Government Geologist, in his able work on "The Auriferous Drifts of Central Otago." He examined their outcrops in over seventy places—from opposite Stewart's Island to Cook Strait—and he found them everywhere gold-bearing. I should like to place on record some surmises as to the origin of those drifts; to make some attempt to imagine—

> What did befall
> Far away in time, when o'er this lifeless ball
> Hung idle stars and suns;

but that is not within the scope of this paper. Those drifts were formed when the Middle Island was flat—before the mountain chains arose—when an entirely different river-system from the present existed. They are to be found hundreds of feet beneath the more recent alluvium of the larger valleys; they are to be found fringing the mountains and hills that have been thrust up through them; they are to be found in patches on the sides, and even on the tops, of the mountains themselves in positions where they have been preserved from denudation. These drifts are but poorly auriferous, except in places where during their own age there was concentration in the rivers and streams of the period. The beds of old drift are of all thicknesses, from a few feet to hundreds of feet, and rest at all angles from vertical to perpendicular, but at angles always similar to the dip of the rock bottom they rest upon.

The second class—the more recent drifts—were formed by the streams from the present mountains. These streams cut down their own rock formation, and with it the old drifts resting upon or against it in vast quantity after the upheaval. The result has been a mixture and a concentrate. These deposits are much richer in gold than the other; in them the early discoveries of gold in the Middle Island were made, and from them, with primitive appliances, the early miners in a few weeks or months made small fortunes. In the recent deposits, no matter what the depth of the alluvium, the few feet of it resting on the bottom—whether that bottom be rock or old drift—carry the most, and sometimes nearly all, of the gold. This bottom stratum only was treated by the early miners, and was called "the washdirt." The washdirt was "paddocked" or "driven" out, and carried or carted to where there was water. By water the deposits were laid down, and by water the gold they contain is extracted.

The first appliances used for extraction were the tub and cradle. The washdirt was first puddled, by means of a spade or shovel and a small quantity of water, in a tub to dissolve the clayey part by which many of the specks of gold adhere to the gravel. The cradle is shaped like that in which a child is rocked to sleep, with a hopper or sieve set where top of hood is. The puddled washdirt — a shovelful at a time — is put into the hopper, and water ladled on to it with a dipper, the cradle being rocked the while, until all the gold has been washed out of the gravel and through the holes in the hopper; the washed gravel is then thrown out, and another shovelful operated upon. The finer materials—sand and small gravel—and gold that have passed through the sieve are simultaneously carried by the water over a series of slides, set at a grade sufficient, with the rocking motion, to make the sand and gravel travel. The slides and bottom of cradle are covered with some fabric—plush, baize, blanket, or sacking—with a hairy surface, in which the specks of gold, through their superior specific gravity, are caught; while the lighter material is still, by the action of the water, carried onwards out of the open foot or end of the cradle. The gold is easily taken off the arresting surface by dipping it in a miner's "panning-off" dish filled with water.

The writer has been led to give this detailed description of the earliest method of gold-extraction from the fact that he has never in any book on gold-mining seen any description a layman could understand.

Next to the tub and cradle came the sluice-box, or series of boxes. These were wooden troughs, open at both ends, and set at a grade of half an inch to an inch to the foot. Besides its own bottom the sluice-box has a removable or false bottom, $1\frac{1}{2}$ in. in thickness. It is formed of lattice-work, or sometimes of a solid board with auger-holes bored through it, as close as they can be put without too much reducing the strength of the board. The false bottom is laid on the real bottom of the sluice-box and lightly fastened down; a stream of water is then made to flow through the box, and some of the miners are set to shovel the auriferous gravel into the box, down which the water carries it, leaving the gold in the cavities of the false bottom. One man stands over the box with a "sluice-fork" to throw out, when washed, any stones too large to be carried down by the water, and other men shovel away the material after it has run through the box or series of boxes.

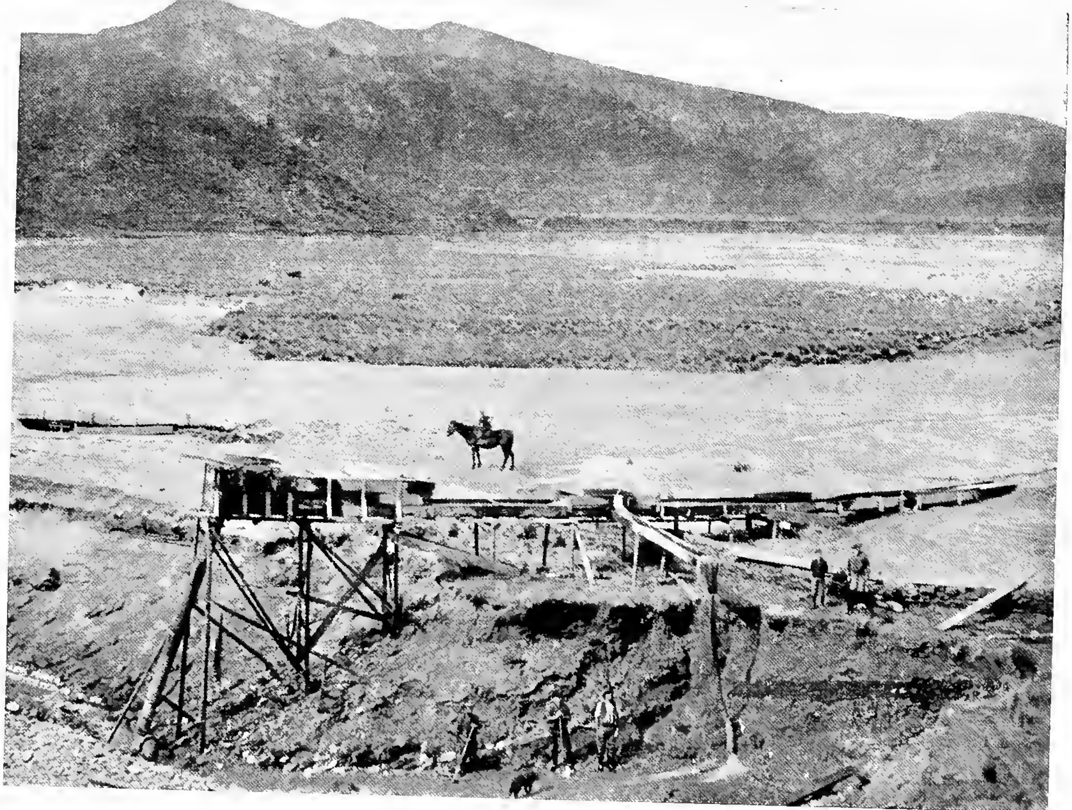
Both of those methods of gold-extraction involved considerable manual labour. By the tub and cradle not more than half a yard per day for each member of a party could, under average conditions, be treated; by box-sluicing, from three to six yards for each man might be got through.

A speedier and more effective method was soon evolved—ground-sluicing; but, as a rule, it can only be employed on auriferous deposits situated on terraces and hills, where the "bottom" on which the washdirt rests is at sufficient elevation to permit of a ground-ditch or channel being constructed with a grade sufficient to run the auriferous alluvium through it into some not-too-far-off hollow or river. Such conditions being fulfilled, the nearest stream that can be conducted on to the top of the auriferous alluvium is diverted and employed to carry the alluvium down the ground-ditch into the hollow. The ground-ditch is roughly paved with stones set against each other in such a way as to resist the action of the flowing water and gravel. In the interstices between the stones the gold is caught. The ground-sluice is cleaned up periodically, when some thousands, or it may be tens of thousands, of yards of alluvium have been run through. The cleaning-up process is simple. The water is first allowed to run clear for a while until the rough paving-stones are bare of sand and gravel. It is then turned off, all except a little in which the rough stones are washed, and then stacked on the sides of the ditch. The small quantity of sand and gravel that occupied with the gold the interstices between the stones is then removed from the ground-ditch, and treated in a sluice-box—the residuum not being more than 10 yards per

100 yards of ditch. At first, in ground-sluicing, the water was allowed to run down over the alluvium operated upon, and the miners broke up the material with picks; but soon canvas hose was called into requisition, and used to bring down and break up the clays, sands, and gravels of the deposit. But canvas soon rotted, and at its best stood but little pressure—100 ft. being the maximum—and for the disintegration of many of the deposits that pressure was inadequate. Some of the deposits were also far distant from the higher ground whence pressure could be obtained, and this led to iron piping being introduced—but not until canvas had for years been universally employed. The first pipes used were flanged wrought iron of but 7 in. diameter (the diameter of the hosing they displaced), but after their introduction the scale of operations rapidly got larger, and the diameter of the pipes used as rapidly increased. As has been said, to work a deposit of auriferous alluvium by ground-sluicing, it had to be so situated as that a grade for a ground-ditch to discharge into some hollow could be found. But wherever deposits existed it was found, as they were opened up, that vast quantities—sometimes of the richest of them—had to be left under foot. At first the difficulty was got over by using larger streams of water, enabling the material to be sluiced through lower-graded ground-ditches, but such ditches were expensive to construct, and still (in many localities) left extensive deposits under foot.

In 1878 the system of hydraulic elevating was invented, and none too soon, for on most of the Otago sluicing-fields the deposits that could be profitably worked by open-face ground-sluicing were all but exhausted. By this system the under-foot deposits became workable to depths proportioned to the quantity and elevation of the streams of water that could be brought to bear upon them. Under this system the water is conducted from the water-race—terminating on the nearest hill that gives the requisite pressure—to the ground to be operated upon in pipes of such diameter as is necessary to carry the quantity of water to be used without undue loss by friction. By means of a suction-jet elevator, provided with swivel joints, a large paddock, or hole, is then sluiced and elevated until the level it is desired to operate at is reached, when the permanent elevator—of greater capacity and power than the suction or "sinking" elevator—is set up. It is very simple, and although but a small percentage of the power that might by other mechanical means be obtained from the water, if used to drive a Pelton or turbine wheel, is got, its simplicity, and the expedition with which it can be shifted from place to place, makes it the cheapest and best machine yet devised for working underfoot alluvial deposits.

The elevator consists of an upright iron tube, its lower end resting some feet under the "bottom" of the ground to be operated upon in a pit excavated for the purpose of receiving it. The tube is of a diameter proportioned to the height it is intended to shoot, or elevate, the auriferous alluvium, and the quantity of water to be employed; it may be but 7 in., and it may be 24 in. or over. The upper end of the tube is on a level with the ground-ditch or sluice-box that the elevated material is to be discharged into. The tube is of wrought iron or steel, save at upper and lower ends, where hard iron castings are used—at the top, for deflecting the *débris*-carrying stream into the sluice; and at the bottom, to take the wear of the ascending alluvium, which is greatest where it first impinges on entering the tube and for a little distance up. The tube is supported on stanchions, and narrows from about 8 ft. above its lower end to about 2 ft. from said lower end, where the contraction ends in a "throat," about 9 in. in length, of a section one-fifth to one-third of that of the tube itself, from which it again expands to form a bell-mouth on lower end. A jet of water is so fixed as to play straight up the tube through the throat, this jet being connected by pipes of suitable diameter with the main pipe-line above described. To do the best work there must be certain ratios between the diameter of the elevating-jet, the diameter of the throat, and the diameter of the uptake pipe; and these again vary with the pressure. Such adjustments having been made, the jet elevator will lift to a height of 12 per cent. of the pressure on the elevating-jet (in addition



THE ARTHUR'S POINT HYDRAULIC GOLD-MINING CLAIM ON THE CELEBRATED BIG BEACH, SHOTOVER RIVER, OTAGO.

Mining Handbook.

to its own water—that is, the water of the elevating-jet) a similar quantity of water used in breaking down and bringing *débris* forward to the lower end of the tube. There is sufficient space left by the bell-mouth between the throat and jet for the water and sluiced material to get in to where they are caught and whirled up by the ascending jet. By a proper arrangement of parts, water and sluiced material may be lifted to a height equal to 30 or even 40 per cent. of the pressure on the elevating-jet, but the proportion of water that can be raised will vary in inverse proportion to the height elevated. The variation in the amount of solid material that can be elevated is inconsiderable.

Hydraulic elevating—as it is called—was first introduced about twenty-eight years ago, and now nearly all the alluvial mining that is done in Otago is by means of it, as is much of what is carried on in Nelson and on the West Coast. By it deposits have been raised and their gold extracted from a depth of 170 ft. But for its invention alluvial mining in Otago would be almost a thing of the past.

The three things wanted for a successful hydraulic sluicing and elevating concern are—a large and constant supply of water, the delivery of that water at a sufficient elevation above the deposits to be operated upon, and the command of extensive deposits of auriferous alluvium. The expenditure necessary to construct water-races and reservoirs, and provide plant to work on a large scale, is usually so great that unless the deposits are extensive they are worked out before the capital expenditure is recouped. If the scale of operations is extensive, very poor ground can by this system be made to pay. It may be laid down as a general rule that one-half the gold that must be in the ground to make dredging pay will give equally payable returns by sluicing and elevating; while ground that, from the nature of the "bottom" the deposit rests upon, cannot be dredged at all may give enormous returns where it can be operated upon by sluicing and elevating. It cannot be used to work the beds of running rivers, but many of them have in the ages past changed their course, and where they ran in the gold-depositing age is now dry land.

By sluicing and elevating those old beds can be worked, and every speck of their gold extracted. Their ancient beds can be laid bare and rendered as dry as a summer road.

I have said there were three things wanted for a successful hydraulic sluicing and elevating concern; but there is a fourth, even more important, without which, where all three exist, there may be disastrous failure—the knowledge how to apply them to proper advantage, how to make the most of them. Some of our best enterprises have failed from the lack of this.

Many of the most extensive, and probably the richest, areas of auriferous alluvium have yet to be worked; but to make success great and certain they must be operated upon on a large scale. They are not regular in their yields: the conditions under which they were laid down prevented that; but, worked on a sufficiently large scale, their poorest parts would pay good interest on invested capital, and their best—now and again come upon—might give the whole capital back in a month. The day of the small company and the old methods is done; there is little left rich enough to pay them. The concern that can only treat 100,000 cubic yards per annum may strike a poor area for a whole twelvemonth's work, may for that time not get its expenses, and suspend work; where the concern that treats 500,000 cubic yards gets quickly over the poor "patch," and secures a good average for the year. Again, the cost per cubic yard of treatment by the small concern may be twice, or even three times, what it is by the large.

Closely connected with the future of hydraulic mining, and the need for larger enterprises in working our remaining alluvial deposits, is the need for a new departure in mining law, under which greater security would be given for the investment of capital, as also for the suppression and punishment of the swindling promoter; but this subject is too large to be handled in the tail of this paper, and is somewhat beyond its scope. There is more gold to be got in the South Island from alluvial deposits than ever has been taken out, and to be got at a profit by properly designed means on a large scale; but one almost dreads the advent of the first highly successful concern of the kind—it will be the means of foisting on the public so many swindling imitations that the public can only lose its money over them. It has been so in quartz-mining in the North, in dredging in the South and West, and assuredly history will repeat itself whenever the successful inventor appears on the scene in hydraulic mining.

HYDRAULIC SLUICING AND ALLUVIAL MINING.

By Robert McIntosh, A.O.S.M., Assistant Inspector of Mines for the Southern Mining District.

It is recorded that alluvial gold was discovered in 1851 in Otago, but owing to the difficulties attendant on prospecting it was not until 1861 that the first important discovery, by Gabriel Read, took place. This was in the locality now known as Gabriel's Gully, Tuapeka. Other portions of the district were found to be gold-bearing, as at Waipori, Waitahuna, and Woolshed Creek, or Glenore. From this base prospectors extended their operations further inland, and in the year 1862 Hartley and Reilly discovered gold in the Dunstan, and Fox discovered auriferous gravels in the Arrow River. The year 1862 was remarkable for the opening-up of the Dunstan, Nokomai, Cardrona, Waikaia, and Wakatipu goldfields. Other auriferous tracts were located from time to time until the existence of extensive auriferous areas in Otago and Southland became an established fact. The chief alluvial districts lie in the valleys of the Taieri, Kyeburn, Manuherikia, Waitahuna, Waipori, Tuapeka, Clutha (known locally as the Molyneux), Pomahaka, Mataura, Waikaka, Waikaia, Nevis, and Maerewhenua Rivers. Extensive deposits are found along the coast-line. The most enormous alluvial deposits may be said to lie within the valleys of the Clutha (or Molyneux) river-system. In the early days of gold-mining very primitive appliances were required to collect sufficient of the precious metal to enable the miners to earn a livelihood. The gold was then found in shallow deposits, especially in the valleys of the Clutha, Shotover, and Arrow Rivers, where the beaches in many places were literally lined with golden sand. But great changes took place in a few years, as the easily worked ground became exhausted. Attention was then given to labour-saving appliances. Water was brought on with or without pressure, and the terraces ground-sluiced, until further disposal of the tailings was rendered impossible. This left much ground still unworked, and large areas which could not be touched at all. Shaft-sinking and tunnelling were resorted to in some places, but in the former case this meant the installation of costly winding and pumping machinery.

Fortunately, the system now known as hydraulic sluicing and elevating was introduced in 1880 by J. R. Perry at Gabriel's Gully, Tuapeka. This system had been in use in California for some years, but Perry's adaptation was a decided improvement on Californian practice, inasmuch as the latter depended to a great extent on suction, whereas direct pressure was the main feature of Perry's application. The success of this appliance was assured, and a new era arose in Otago mining. As the years went on this system was extensively applied. Water-races were cut in at elevations calculated to afford the necessary power to work deposits of auriferous ground. Claims are now being worked in which the perpendicular height to which the material is elevated ranges from less than 20 ft. to 112 ft. The largest claims worked by this principle are the Bluespur and Gabriel's Gully Consolidated Gold-mining Company, near Lawrence; Roxburgh Amalgamated, Roxburgh; Champion, at Beaumont; United M. and E. and Scandinavian claims, St. Bathan's; Nokomai Hydraulic Sluicing Claim, Nokomai; and Bakery Flat Claim, Waipori. Hydraulic sluicing and elevating is carried on at Waipori, Waitahuna, Tuapeka, Deep Stream, Naseby, Serpentine, St. Bathan's, Matakanui, Queenstown, Cardrona, Nokomai, Waikaia, Round Hill, Bald Hill Flat, Roxburgh, Island Block, Beaumont, and some outlying places.

In many localities hydraulic sluicing is adopted, but the material is discharged down a ground-sluice. This is only where sufficient fall for tailings is available.

Smith's jet-pump system, worked on the principle of suction, has enabled long stretches of the Shotover River to be worked profitably during the season when the river is low. This appliance was fully described in Mines Reports, 1899.

The deep leads of Otago have commanded much attention, and extensive work has been done on them. The quartz grits worked by hydraulic sluicing and elevating at St. Bathan's and Matakanui may be termed deep leads, and extensions of these deposits have been worked from time to time by shafts and drives. The Criffel lead, which strikes across the face of Mount Criffel above Cardrona Valley for a proved distance of twelve miles, has hitherto been worked chiefly by sinking and driving. Recently a company was formed to bring in water in order to conduct extensive sluicing operations. The preparatory works have now been accomplished, and sluicing will be started this year (1906). The main deep lead traversing the Waipori Valley for a distance of twelve miles with its tributary leads—viz., the Lammerlaw lead and the Post Office Creek lead—is one of the most extensive in the Otago District. The tributary leads have been worked for many years by hydraulic sluicing and elevating, but no progressive works were done on the main lead until 1903. In that year J. T. Johnson, of Waipori, designed a hydraulic dredge (locally known as the submerged-jet dredge) in order to work this deep lead. Description of this dredge will be found under "Gold-dredging in Otago and Southland," page 272. This lead is now being tested by hydraulic sluicing and elevating. Bottom was reached at a depth of over 60 ft., the gravels passed through being payably auriferous throughout.

Water-conservation and Future Prospects.

Alluvial mining still maintains a high place among the revenue-producing industries of the colony. There are very extensive areas of highly auriferous country unworked throughout Otago and Southland. These are either awaiting the bringing-in of water or the liberation of water now used on other areas. Throughout Central Otago this is especially the case, and the preservation of the first rights of all water in mining districts to the mining community will enable these deposits to be worked, and prolong the life of this important industry indefinitely. The extent and richness of the lead which extends through St. Bathan's, Ida Valley, and Manuherikia Valley cannot yet be appreciated. The remarks of the Hon. the Minister of Mines in 1895 are worthy of note: "The immense areas of ground covered with auriferous gravels, both on the West Coast and Otago, show that the largest percentage of gold produced will be derived from the alluvial workings for many years to come. The extent to which these workings can be carried on is only limited by the quantity of water that can be obtained to command the ground. It is only in a few localities where the washdrift is sufficiently rich to pay for mining in the strict sense of the term—that is, by working from shafts and adit levels. . . . The great factor for carrying on alluvial mining operations of any description is water. . . . The mining districts of Otago being principally in the interior, where the rainfall is considerably less than elsewhere in the colony, extensive water-races and reservoirs, although they may cost a considerable sum to construct in the first instance, will be a valuable asset, as, when they are not required for mining purposes, they can be fully utilised for irrigation." Now, this is exactly the position of affairs in Central and other parts of Otago at the present day. The alluvial-mining industry is yet an important and permanent one. There are extensive tracts of auriferous country, but there is not at present sufficient water available for the industry to expand over these areas. The question of the alienation of water-rights from the mining community, and the acquisition of these rights by the agricultural settlers, is one of grave moment. It is yet too early to speak of the decline of the mining industry; judged from its past and present records, and its high promise for a prosperous future, it should be fostered in every legitimate way.

Alleged Destruction of Agricultural Lands by Alluvial Mining.

Throughout the length and breadth of Otago and Southland alluvial mining, by sluicing, is carried on in sixty sub-districts or localities, in which about one hundred and forty fair-sized claims are at work, as well as numerous smaller ones. But only in two cases can the assertion so often made regarding the destruction of agricultural land be supported. This refers to the operations of the Island Block Sluicing Claim and the past operations of the Golden Run Hydraulic Sluicing and Dredging Company. Both these properties are situated within seven miles of Miller's Flat, and the land is certainly of exceptional quality. In a few cases the disposal of tailings and dirty water has been the source of litigation, but suitable arrangements have generally been arrived at between the interested parties.

Some Particulars of Hydraulic Elevating and Sluicing Claims.

Big Beach, Arthur's Point, Shotover River.—Area, 20 acres. This property is owned by James P. Phelan and party, and 5 acres has been worked since operations were commenced Water is supplied from the company's dam (200 ft. by 40 ft.) by a water-race fourteen miles in length, together with 2,220 ft. of fluming and pipes, and the face is operated on by one nozzle, under an average supply of four heads, at a head-pressure of 330 ft. The gold is fine, and is saved on 60 ft. of tail-race. During the year 1905 the gold won amounted to 150 oz., valued at £577 10s. The capital actually called up is £1,551 15s. 1d.; approximate value of plant, &c., £250. Secretary, James McMullan, jun., Arthur's Point, Queenstown.

Blue Jacket, opposite Deep Creek, Maori Point.—Area, 28 acres (hydraulic river claim, 20 acres; sluicing claim, 8 acres). Work was first commenced by the owners (Timothy and J. S. Collins) in March, 1892, on the sluicing portion of the property, and in April, 1898, in the river. The materials are lifted 12 ft. by a suction pump, and water is conveyed over races five miles and a half in length. The face is operated on by two nozzles, an average supply of nine heads being available in spring, when water is plentiful, and five heads in summer, at a head-pressure of 150 ft. in sluicing claim, and 350 ft. vertical in river claim. The gold, which is coarse and fine, is saved with longitudinal bars and perforated steel plates, with cocoanut matting underneath plates, and scrub and matting under the ripples. During the year 1905 the ground operated on was as follows: River, 300 ft. in length by 70 ft. in width, material raised, 3,888 cubic yards; on sluicing claim, 150 ft. by 100 ft., and 130 ft. in depth. Yield of gold, 155 oz. 10 dwt.; value, £598 13s. 6d. Four acres have been worked since the claims were opened up, the total yield of gold obtained from this area being 976 oz., value £3,758. Approximate value of plant, £7,500.

Blue Spur and Gabriel's Gully Consolidated, Blue Spur.—Gold was discovered in Gabriel's Gully by Gabriel Read in the year 1861, when operations were conducted in the alluvial deposits lying in gullies and on the neighbouring terraces. In 1862 the miners commenced to extract gold from the breccia-conglomerate deposit forming the divide between Gabriel's Gully and Munro's Gully. For many years the richest parts of the deposit were driven out and the material crushed in stamper-batteries. In 1881 the Blue Spur and Gabriel's Gully Sluicing Company (Limited) started operations in the bed of Gabriel's Gully, where there was an accumulation of tailings deposited from the cement-workings In order to treat these tailings profitably, the late Mr. J. R. Perry introduced from California, and afterwards improved, the system of hydraulic sluicing and elevating which became general in use on the Otago goldfields. This claim continued operations until 1888, when, as the result of the amalgamation of all the claims on the Gabriel's Gully side of the cement-deposit, the Blue Spur and Gabriel's Gully Consolidated Company was formed, having its headquarters in London. The company was registered on the 1st February, 1888; its subscribed capital is stated at £91,266, and scrip to the value of

Moonlight Hydraulic Sluicing Claim, Moke Creek, Otago, near Queenstown.

£48,268 was given to the holders of the various claims consolidated in the company's holding. Since registration 44,618 oz. of gold, value £169,334, was obtained; the total expenditure in connection with mining operations, since registration up to date of last balance-sheet, being £38,532. Hydraulic sluicing was commenced in 1888, and has been carried on continuously ever since. All the available area of tailings was first worked, so as to carry up an underground drainage channel, and also to have worked-out ground on which to dump tailings from the cement-workings. The company acquired valuable water-rights from Beaumont and Waipori watersheds, and was thus enabled to concentrate a large body of water under effective pressure upon the deposit, with the result that part of the spur has been almost completely broken down and sluiced away, while the historic Gabriel's Gully itself has been filled with tailings from the claim to a depth of from 90 ft. to 100 ft. Work in the claims continues to be carried on in the usual safe manner, the mine having been practically free from accident during recent years. The solid cement is shattered by heavy charges of roburite, being subsequently sluiced away from the face and further broken by the workmen with spalling hammers, thence conducted by lengthy paved races to the elevators, where final runs of boxes are in use with gold-saving appliances for recovery of the balance of fine gold which had not been retained by the paved sluicing-runs. Twenty-eight men employed in and about claims.

The following interesting extracts are from the last annual report of the general manager to the London board of directors: "The mean value of the gold per cubic yard of cement works out this year at 3·7 gr., a slight improvement on last year, and, I believe, a world's record for low-grade dirt worked without loss. The 1,722 oz. of gold saved would form 4·644 cubic inches, and $\frac{140}{1,000,000}$ of the volume of cement handled in getting it. The above reads uncommonly like a newspaper snippet, but it illustrates in a way the proportion of things at Blue Spur. The dirt is most undeniably low-grade, and requires cautious handling to be made to yield even the meagre margin of profit actually secured. Subjoined are details of the year's work and results: Total gold won, 1904–5, 1,524·8 oz., value £6,062 6s. 2d.; total gold won, 1905–6, 1,721·9 oz., value £6,836 5s. 5d.: an increase of 197·1 oz., and £773 19s. 3d. Total expenditure, 1904–5, £4,558 10s. 1d.; 1905–6, £4,895 10s. 2d.: an increase of £337 0s. 1d. The mean value of the gold-contents of the cement treated for the year 1904–5 was 3·603 gr., or 7·11d. per cubic yard; for 1905–6, 3·717 gr., or 7·435d. per cubic yard: an increase of 0·114 gr., or 0·324d. per cubic yard—a very slight difference of under ⅓d. per cubic yard. No. 1 division was worth 3·331 gr., or 7·11d. per cubic yard; No. 2 division was worth 3·717 gr., or 7·434d. per cubic yard. One requires to be very familiar with low-grade dirt to be able to view these figures without a shudder, when the amount of heavy work necessary to save 1,722 oz. of gold from 333,500 tons of hard-cemented breccia, all of which lies below sluicing-level, is intelligently considered. The value of the cement worked last year was 16s. 8d. per hour (4 dwt. 5 gr.); this year the value is 17s. 9d. per hour (4 dwt. 11 gr.): an improvement of 6 gr., or 1s. 1d. per hour. The cost of winning the gold has been £2 16s. 6½d. per ounce, or 71·61 per cent.; last year the cost was £2 19s. 9½d. per ounce, or 75·19 per cent.: a decrease of 3·58 per cent. Thirty hours' less pumping were necessary this year than last, the cost of which has been, on the basis of what the water used for the purpose would have earned had it been possible to use it for sluicing: Pumping, 525 hours at 17s. 9d. per hour, £465 8s. 9d.; less 71·61 per cent., £333 6s.: cost of pumping, £132 2s. 9d. Cost last year, £115 16s. 6d.: an increase of £16 6s. 3d. The total quantity of water used for all purposes during 1904–5 was 626,321,300 cubic feet in 7,228 hours sluicing and 555 hours pumping—7,783 hours; during 1905–6, 613,879,000 cubic feet in 7,653·5 hours sluicing and 525 hours pumping—8,178·5 hours: being 12,442,300 cubic feet less, 425·5 hours more for sluicing, 30 hours less for pumping, and 395·5 hours more altogether; which exhibits a less water-supply more advantageously applied. In other words, the efficiency of both elevators and pump has been increased by remodelling them in such a manner as to allow the use of smaller jets, with the result as shown above, that with 12½ millions of cubic feet less volume of water 395·5 hours more work has been done. The pump has worked very well and has given no trouble; it has maintained its previous efficiency. The ratio of sluicing and pumping water is shown by the following figures: Sluicing-water—No. 1 division 317,520,000 cubic feet, No. 2 division 275,569,000 cubic feet, total 593,089,000 cubic feet; pumping, 20,790,000 cubic feet: total, 613,879,000 cubic feet, or 3·3866 per cent. Last year the percentage was 3·3910, a barely perceptible difference of 0·0044 per cent. The head-races furnished a water-supply for sluicing during 1904–5 of 903·5 eight-hour days; 1905–6, 956·8 eight-hour days: an increase of 53·3 days. And this water was subdivided and applied as under:—1904–5—No. 1, 565·6 days; No. 2, 338 days; total, 903·6 days. 1905–6—No. 1, 490 days; No. 2, 466·8 days; total, 956·8 days: an increase of 53·3 days. The working and up-keep of the head-races for the year has cost—Ordinary wages, £605 16s.; timber-cartage and wages extra, £38 16s. 5d.: total, £644 12s. 5d. Rather more roburite has been used this year than last, more hours have been worked, and consequently more blasting has been necessary. Explosives in 1904–5 cost £426 4s. 8d.; in 1905–6, £597 3s.: an increase of £170 18s. 4d. Blast fired in No. 1 face, 24th February, £90; the cost of this blast should really be debited to the current year, as no gold has been won from the cement dislodged by it. Wages paid in 1904–5 amounted to £3,001 1s. 2d.; in 1905–6, £3,175 9s. 2d.: an increase, due to extra hours worked, of £174 8s. The following is a statement of work and values for the year 1905–6:—Sluicing: No. 1 division, 3,919·5 hours; No. 2 division, 3,734 hours: total, 7,653·5 hours. Cement: No. 1 division, 97,987·5 cubic yards; No. 2 division, 124,342·2 cubic yards: total, 222,329·7 cubic yards. Gold: No. 1 division, 680·15 oz.; No. 2 division, 1,041·74 oz.: total, 1,721·89 oz. Value per cubic yard: No. 1 division, 3·332 gr., 6·66d.; No. 2 division, 4·021 gr., 8·04d.: mean value, 3·7175 gr., 7·435d." General manager, J. Howard Jackson; mine-manager, J. Uren.

Butterfly Sluicing Claim, Teviot Survey District.—This claim has an area of 3 acres, and is owned by Weatherall Bros., who commenced to open up the ground in May, 1903. The gravels, 12 ft. in depth, consist of rough yellow wash, carrying large stones. The dam covers an area of half an acre, from which water is conveyed through two miles of water-race and 160 ft. of fluming and 18 in. and 9 in. pipes, which maintain a supply of five heads on one nozzle, at an average presure of 20 ft. The gold is fine, and is saved with perforated plates and cocoanut matting, the tailings being carried over 160 ft. of tail-race. From an acre operated on 52 oz. of gold was obtained, valued at £194. Value of plant, &c., £100. Mine-manager, Henry Weatherall.

Carroll and Lynch's Claim, Bald Hill Flat.—This claim, which was partly worked by the Last Chance Company, but abandoned owing to poorness of returns, has an area of 8 acres, of which 2¾ acres have been worked since operations were commenced in November, 1904. Water is conveyed over races about seven miles in length and 2,000 ft. of fluming and pipes. Two nozzles are in use—one at the face and one at the tail—an average supply of six heads being available, when water is plentiful, at a head-pressure of 280 ft. The gold is medium-sized, and is saved with boxes and ripples. In the year 1905 the yield was 110 oz. 3 dwt. 18 gr., valued at £424 4s. 4d. Total yield of gold, 162 oz. 3 dwt. 18 gr., valued at £624 8s. 4d. Value of plant, £600. Mine-manager, Patrick Carroll; secretary, Pierce Carroll, Bald Hill Flat.

Christian's Claim, Livingstone.—Area, 8 acres. The wash operated on consists of quartz gravel lying under greensand, and is got at a depth of 2 ft. The dam covers an area of 4 acres, from which water is conveyed over twenty-seven miles of water-races and 82 chains of fluming and pipes, which maintains a supply of eight heads on one nozzle, at an average pressure of 190 ft. The gold is very fine, and is saved with ripples and tussocks, the tailings being carried over 36 chains of tail-race. During the year 1905 an area of half an acre was worked. Value of plant, races, &c., £7,000. Mine-manager and owner, John Christian.

Commissioner's Flat Sluicing Claim, Roxburgh.—Area, 25 acres. The present owners commenced operations in December, 1901, but the claim was first opened up by Haughton and party about twelve years previously. There is one elevator employed, and the materials are lifted 28 ft. Water is conveyed over races about six miles in length and a quarter of a mile of fluming. The face is operated on by one nozzle, an average supply of ten heads being available, and, when elevating, twenty heads can be got from water stored in the dam, at a head-pressure of 100 ft. The gold is mostly fine, and is saved with $2\frac{1}{2}$ in. by $\frac{5}{8}$ in. flat-iron bars made into ripples, the tailings being carried over 640 ft. of tail-race. During the year 1905 an acre was worked, yielding 322 oz. 10 dwt. 23 gr. gold, valued at £1,239 14s. 3d. During the past three years between 3 and 4 acres have been operated upon, yielding 940 oz. 16 dwt. 12 gr. gold, valued at £3,640 18s. 6d. Approximate value of plant, &c., £1,500. Four men are employed. Owners, W. Coulter and party; secretary, R. George, Roxburgh.

Cooper and Party's Claim, Horseshoe Bend.—Area, 7 acres. The claim was first worked in 1863 by Mr. Stewart; the present owners (Cooper and party) commenced operations in October, 1905. The dam covers an area of 4 acres, from which water is conveyed over four miles of water-race, 2,000 ft. of fluming, and 17 in. and 10 in. pipes, which maintain a supply of three heads on one nozzle, at an average pressure of 50 ft. The gold is mixed, and is saved with longitudinal ripples and perforated plates, the tailings being carried over 10 chains of tail-race. A total area of 5 acres has been operated upon, and it is stated that gold to the value of £10,000 was taken out by previous owners. Value of plant, races, &c., £300. Mine-manager, J. Cooper.

Criffel Lead Sluicing Company, Cardrona.—Area, 100 acres. This company was registered on the 30th September, 1906, and has a called-up capital of £4,054 8s. The cutting of a tail-race up to the lead was commenced in April, 1906. with the view of working an alluvial lead or wash in the hillside. The lead apparently consists of an old river-bed, the overlying strata being composed of *débris* or slips from the mountain-side. The tail-race will be 300 ft. to 400 ft. in length, and about 3,000 ft. of fluming and pipes (22 in. to 9 in.) will be required, the distance of the penstock from the claim being about 1,000 ft. With a full supply of water there should be thirty heads available, giving a pressure of about 500 ft. at the face. Twenty men will be generally employed. Approximate value of claim, race, &c., £4,000. Mine-manager, Dugald Macgregor; secretary, Edward Trythall. Dunedin.

Eagle and Gray's Claim, St. Bathan's.—Area, 3 acres. Work was commenced on this claim in 1867. Water is conveyed over races six miles in length and 900 ft. of fluming and pipes, the dimensions of the latter varying from 22 in. to 9 in. The face is operated on by one nozzle, an average supply of two heads being available at a head-pressure of 120 ft. The gold is fine, and is saved with iron ripples and matting, the tailings being carried over 1,500 ft. of tail-race. For a period of four years the claim was worked by tub and cradle, and sinking and driving was carried on, but eventually ground-sluicing was resorted to as being the most favourable way of working the claim. Value of plant, &c., £700. Estimated life of claim, twenty years, or sixty years from date of commencement. Mine-manager, R. Wade.

Edinburgh Spur, Waikaia.—Area, 40 acres. This claim started work in May, 1904. Five acres have been worked to date, the depth of the auriferous gravel being 30 ft., and 180 oz. of gold was obtained, valued at £697 10s. A tail-race 132 ft. in length has been constructed, and the dam covers an acre of ground. There is 1,000 ft. of fluming and pipes; dimensions, 15 in. to 9 in. One nozzle is in use, and there is a pressure of 170 ft. at the face. Value of plant, &c., £600. Mine-manager, James Mutch.

Fordham and Gay's Claim, Cambrian's.—Area, 5 acres. Work was commenced in December, 1904. Water is conveyed over two and a half miles of water-race and 800 yards of fluming and pipes. The face is operated on by one nozzle, an average supply of three heads being available, at a head-pressure of 70 ft. The gold is fine, and is saved with a paved race, the tailings being carried over a quarter of a mile of tail-race. During the year 1905 an area of 900 square yards was operated on, yielding 13 oz. 4 dwt. 13 gr. of gold, valued at £50 18s. 7d. Value of plant, races, &c., £1,000.

Golden Crescent Sluicing Company, Weatherstone's.—Area, 90 acres. This company was registered in November, 1898, and commenced work in March, 1900. There is one elevator employed, and the materials are lifted 20 ft. to 30 ft. Water is conveyed over races eighteen miles in length and 4,000 ft. of fluming and pipes. The face is operated on by two nozzles, an average supply of eight heads being available, at a head-pressure of 260 ft. The gold is fine, and is saved with perforated plates, coir matting, and angle-iron bottoms, the tailings being carried over 40 chains of tail-race. During the year 1905 an area of about 4 acres was worked, yielding 480 oz. of gold, valued at £1,868 9s. 9d. Thirty-six acres have been worked during the past five years, the yield of gold being 3,759 oz., value £14,576 3s. Dividends have been disbursed amounting to £6,300. Amount of called-up capital, £3,500. Value of plant, races, &c., £4,000. Mine-manager, J. A. McNeilly; secretary, J. C. Browne, Lawrence.

Golden Padlock, Mitchell's Flat, Waipori.—Area, 4 acres. The nature of the material operated on consists of rotten reef and quartz wash, taken from a depth of 6 ft. There is one elevator employed, and the materials are lifted 12 ft. The dam covers an area of abont 4 acres, and water is conveyed through twelve miles of water-race and 60 ft. of fluming and pipes, which maintains a supply of four heads on one nozzle, at an average pressure of 60 ft. During the year 1905, 136 oz. 9 dwt. 15 gr. of gold, valued at £545 8s. 7d., was obtained. Value of plant, &c., £300. Owners, Gare and Sons.

Golden Rise, Weatherstone's.—Area, 40 acres. This claim is owned by Messrs. Smyth, Donlan, and Adams. Work was first commenced in the early part of 1895. There is one elevator employed, and the materials are lifted 30 ft. Water is conveyed over races eighteen miles in length and 3,600 ft. of fluming and pipes. The face is operated on by one nozzle, an average supply of four and a half heads being available, at a head-pressure of 280 ft. The gold is fine, and is saved in angle-iron bottoms, perforated plates, and cocoanut matting, the tailings being carried over one mile of tail-race. During the year 1905 an area of 10 acres was worked, the quantity treated being 242,000 cubic yards, at a cost of $1\frac{1}{12}$d. per yard, yielding 945 oz. of gold, valued at £3,686. Since the beginning of operations about 80 acres has been worked. Capital called up, £2,500; approximate value of plant, races, &c., £3,000. Seven men employed. Mine-manager and secretary, William R. Smyth, Lawrence.

Island Block Gold-dredging and Sluicing Company, Island Block, near Miller's Flat.—Area, 600 acres. This company was registered in February, 1900, and commenced work in October of the same year. There are two elevators employed, and the materials are lifted 70 ft. The dam covers an area of 85 acres. Water is conveyed over races four and a half miles in length and three miles of fluming and pipes, the dimensions of the latter varying from 22 in. to 9 in. The face is operated on by two nozzles, an average supply of twenty-six heads being available, at a head-pressure of 710 ft. The gold is fine, and is saved with longitudinal iron ripples, cross angle-iron ripples, with cocoanut matting underneath, the tailings being carried over a mile and a half of tail-race. During the year 1905 an area of 4 acres was operated on, yielding 1,459 oz. of gold, valued at £5,715. Thirty acres has been worked during the past five years; the yield of gold obtained from this area was 6,231 oz., valued at £24,290. Dividends have been disbursed amounting to £2,403; capital called up, £24,030. It is stated that the ground could be levelled after working, and top-dressed with silt from the elevator, and so rendered available for fruit-culture or pastoral purposes. Approximate value of plant, races, &c., £20,000. Fourteen men employed. Mine-manager, David Weir; secretary, James Brown, Dunedin.

Jewett's Gully, Round Hill, Colac Bay, Southland.—Area, 42 acres 3 roods 22 perches. The Jewett's Gully Gold-mining Company was registered in May, 1905, and commenced work six months later. There is one elevator employed, and the

in Elevator of Champion Hydraulic Company's Claim, Beaumont, Otago
Mining Handbook.

materials are lifted 38 ft. Water is conveyed over water-races two miles in length and 103 chains of fluming and pipes. The face is operated on by two nozzles, an average supply of five heads being available, at a head-pressure of 240 ft. The gold is fine, and is saved by ripples and mats, the tailings being conveyed over 80 ft. of tail-race. During the year 1905, 30 oz. 13 dwt. 2 gr. of gold, valued at £121 2s. 10d., was obtained Capital called up is £1,800; approximate value of plant, races, dams, &c., £1,700. Four men employed. Mine-manager, J. Thurgood; secretary, L. W. Petchell, Riverton.

Johnstone's Sluicing Claim, Blackstone Hill.—Water is obtained from the Government water-race, and conveyed through 600 ft. of fluming and pipes. The face is operated on by one nozzle, an average supply of four heads being available, at a head-pressure of 150 ft. During the year 1905 prospecting was chiefly carried on, 30 oz. of gold, value £115 10s., being obtained. Owner, R. Johnstone.

Kitto and Party's Sluicing Claim, Blue Spur, Tuapeka.—Area, 21 acres. Work was commenced on this claim in 1870. There is one elevator employed, and the materials are lifted 75 ft. Water is conveyed over races about forty miles in length and 40 chains of fluming and pipes. The face is operated on by two nozzles, an average supply of eighteen heads being available, at a head-pressure of 450 ft. The gold is fine, and is saved with angle-iron ripples and perforated plates, the tailings being carried over 12 chains of tail-race. During the year 1905, 441 oz. 15 dwt. 10 gr. of gold, valued at £1,701 10s. 6d., was obtained. Approximate value of plant, &c., £5,000.

Ladysmith Gold-dredging Company, Roxburgh East.—Area, 55 acres 2 roods 18 perches. This company was registered in April, 1900, and commenced work in December following. There is one elevator employed, and the materials are lifted from 20 ft. to 45 ft. Water is conveyed over races three and a half miles in length and 35 chains of fluming and pipes. The face is operated on by one nozzle, an average supply of twenty heads being available, at a head-pressure of 150 ft. The gold is fine, and is saved with iron ripples, the tailings being carried over a quarter of a mile of tail-race. During the year 1905 an area of 5 acres was worked, yielding 1,003 oz. 11 dwt. 6 gr. of gold, valued at £3,863 13s. 9d. About 15 acres has been operated on during the past five years; the yield of gold from this area was 3,292 oz. 6 dwt. 12 gr., valued at £12,675 5s. Dividends have been paid amounting to £3,473 15s.; called-up capital, £3,964 1s. 9d. Value of plant, races, &c., £6,400. Mine-manager, William Donnelly; secretary, Jabez Burton, Roxburgh.

Lammerlaw Flat Hydraulic Mining Company, Waipori.—Area, 30 acres. This company commenced work in July, 1899. There is one elevator employed, and the materials are lifted 26 ft. Water is conveyed over races thirty miles in length and 52 chains of pipes (dimensions 13 in. and 9 in.). The face is operated on by two nozzles, an average supply of ten heads being available, at a head-pressure of 240 ft. The gold is coarse and fine, and is saved with Venetian ripples, perforated plates, and matting. During the year 1905 an area of 3 acres was operated on, yielding 147 oz. 13 dwt. 23 gr. of gold, valued at £568 12s. 5d. Forty-five acres has been worked during the past six years; the yield of gold obtained from this area was 1,857 oz. 14 dwt. 21 gr., valued at £7,156 13s. 3d. Dividends have been disbursed amounting to £1,408; capital called up is £1,500. Value of plant, races, dams, &c., £3,100. Mine-manager, Henry Blackmore; secretary, F. W. Knight, Waipori.

Manuel Bros.' Claim, Coal Creek Flat.—Area, 12 acres. The overlying strata is composed of gravel, stones, and sand from surface to a depth of 60 ft. There is one elevator employed, and the materials are lifted 18 ft. to 20 ft. Water is conveyed over races three miles in length and 200 ft. of fluming and pipes. The face is operated on by one nozzle, an average supply of twelve heads being available, at a head-pressure of 75 ft. The gold is fine, and is saved with iron ripple-bars, the tailings being carried over 600 ft. of tail-race. During the year 1905 a quarter of an acre was worked, yielding 203 oz. of gold, valued at £781 11s. Value of plant, races, &c., £500.

Estimated life of claim ten years, or forty years from date of commencing work. There is a scarcity of water at times, which prevents the claim being worked constantly, but the owners contemplate constructing a race higher up the range.

Matakanui Gold-mining Company, Matakanui.—Area, 45 acres. This company was registered in January, 1902, and commenced work the same month. One elevator is employed, and the materials are lifted 64 ft. Water is conveyed over races fourteen miles in length and a mile and a half of fluming and pipes. The face is operated on by two nozzles, an average supply of twelve heads being available, at a head-pressure of 200 ft. The gold is fine, and is saved with ripple-plates, matting, and boxes, the tailings being carried over three-quarters of a mile of tail-race. During the year 1905 about half an acre was worked, yielding 538 oz. 18 dwt. 14 gr. of gold, valued at £2,074 16s. Total yield of gold, 2,315 oz. 1 dwt. 16 gr., valued at £8,870 9s. 5d., out of which dividends have been disbursed amounting to £1,924 3s. 6d.; capital called up, £7,000. Value of plant, races, &c., £6,000. Mine-manager and secretary, W. Norman, Matakanui.

Mount Morgan Sluicing Company, Matakanui.—Area, 60 acres. This company commenced work in October, 1903. There is one elevator employed, and the materials are lifted 25 ft. Water is conveyed over races ten miles in length and one mile of fluming and pipes. The face is operated on by two nozzles, an average supply of ten heads being available, at a head-pressure of 120 ft. The gold is fine, and is saved by means of gold-boxes 40 ft. in length and 3 ft. in width, the tailings being carried over 60 ft. of tail-race. During the year 1905 an area of 2 acres was worked, yielding 188 oz. 8 dwt. 2 gr. of gold, valued at £725 6s. 10d. Eight acres has been worked during the past two years; the yield of gold from this area was 537 oz. 4 dwt. 4 gr., valued at £2,067 9s. Capital called up, £1,010. Value of plant, races, &c., £3,404. Four men employed. Mine-manager, James Percy; secretary, J. D. Nicolson, Matakanui.

Munro and Party's Claim, Post-office Creek, Waipori.—Area, 27 acres. One elevator is employed, and the materials which consist of fine hard gravel, are lifted to a height of 50 ft. Water is conveyed over races fourteen miles in length and 2,400 ft. of fluming and pipes. The face is operated on by one nozzle, an average supply of four heads being available, at a head-pressure of 230 ft. The gold is fine, and saved with ripples and perforated plates, the tailings being carried over 5 chains of tail-race. During the year 1905 half an acre was operated on, yielding 367 oz. 4 dwt. of gold, valued at £1,413 14s. 5d. Value of plant, £2,000. Mine-manager, A. Munro; secretary, H. S. George, Berwick.

Murray and Gair's Claim, Adams Gully, Bannockburn.—Area, 3 acres. The wash consists of rough gravel 20 ft. in depth. Water is conveyed over a race one mile in length and 900 ft. of fluming and 9 in. and 7 in. pipes. The face is operated on by one nozzle, an average supply of five heads being available, at a head-pressure of 50 ft. The gold is fine, and is saved with tail-race and box, the tailings being carried over 100 yards of tail-race. During the year 1905 a quarter of an acre was worked, yielding 22 oz. of gold, valued at £84 14s. Value of plant, races, &c., £150. Mine-manager, Henry Murray.

New Skipper's Sluicing Company, Skipper's.—Area, 82 acres. This company was registered in September, 1902, and commenced operations the same month. The gravels, 160 ft. in depth, consist of mica schist with quartz and ironstone boulders, some of which are several tons in weight, overlying the true bottom. The dams owned by the company cover an area of 1½ acres, from which the water is conveyed over seven and one-eighth miles of water-races and 7,060 ft. of fluming and pipes (30 in. to 11 in. diameter), which maintain a supply of fifteen heads of water on two nozzles, at an average pressure of 160 ft. The gold is coarse, and is saved with iron rails, with brush underneath, the tailings being carried over 3,400 ft. of tail-races. During 1905, 1½ acres was operated on, yielding 163 oz. of gold, valued at £622. About 12 acres has been worked during the past three years; the yield of gold obtained from this area was 658 oz., valued at £2,504. Capital called up, £3,414. Value of plant, races, dams, &c.,

estimated at £10,000. Mine-manager, John Corbett; secretary, H. E. Wilson, Dunedin.

Nokomai Hydraulic Sluicing Company, Nokomai Creek, Southland.—Area, 211 acres (embracing two claims). This company was registered in March, 1898, and commenced work the following month. There are two elevators employed, and the materials are lifted 75 ft. by No. 1 and 50 ft. by No. 2 lift. Water is conveyed over races forty-eight miles in length (twenty-seven miles Nos. 1 and 2, and twenty-one miles of race for Lion Claim) and 6,700 ft. of fluming and pipes. The face is operated on by three nozzles, an average supply of eighteen heads being available at No. 1 and twenty-four heads at No. 2 claim, at a head-pressure of 650 ft. and 250 ft. respectively. The gold is coarse and fine, and is saved with Venetian ripples and cocoanut matting, the tailings being carried over a mile of tail-races. Electric light is installed in both claims, the annual cost for wages, materials, repairs, &c., being £500. During the year 1905 an area of 2½ acres was operated on in each claim, yielding 2,619 oz. 6 dwt. of gold, valued at £9,925 2s. 4d. Fifty acres has been worked during the past eight years; the yield of gold obtained from this area was 13,166 oz. 12 dwt., valued at £50,243 4s. 8d. Dividends have been disbursed amounting to £17,783 11s., and £2,351 expended over and above the called-up capital (£24,000) in developing the property. Approximate value of plant, races, &c., £26,351. Thirty-six men employed. Mine-managers, William Robinson and Charles Atkinson; secretary, Kum Poy, Dunedin.

Norwegian Sluicing Claim, Waitahuna Gully.—Area, 29 acres 3 roods. The nature of the wash operated on is hard gravel, locally known as "Maori bottom," also a breccia conglomerate similar to the Blue Spur formation, having a depth of 20 ft. to 60 ft. The overlying strata is composed of yellow clay. One elevator is at work, the height of lift being 43 ft. The total length of water-races in connection with the claim is forty miles; area of dams, about 3 acres; dimensions of pipes, 18 in. to 7 in. Eight heads of water are available, and one nozzle is in use, the pressure of the elevator-jet at the face being 250 ft. Gold has been won to the extent of 452 oz.

9 dwt., valued at £1,741 17s. 10d. The gold is fine; the appliances for saving it consist of angle-iron ripples and perforated plates over cocoanut matting, with boxes 100 ft. by 3 ft. in width. Five men employed. Value of plant, &c., £3,000. Mine-manager and secretary, Charles Thomson, Waitahuna Gully.

Ourawera Gold-mining Company, Round Hill, Southland.—Area, 40 acres. This company was registered in May, 1895, and commenced work in December of the same year. One elevator is employed, and the materials are lifted 67 ft. Water is supplied from the company's dam (an acre in area, depth 7 ft.) by a water-race eighteen miles in length, together with 143 chains of fluming and pipes, the latter being 13 in. diameter. The face is operated on by one breaking-down and one tail nozzle, under an average supply of ten heads, at a head-pressure of 446 ft. and 300 ft. respectively. The gold is fine, and is saved with steel ripples and cocoanut matting. During 1905, 1¼ acres was operated on, yielding 881 oz. 12 dwt. 22 gr. of gold, valued at £3,557 17s. Twelve acres has been worked during the past six years; the yield of gold obtained from this area was 7,842 oz. 6 dwt. 12 gr., valued at £31,101 4s. 4d. Dividends have been disbursed amounting to £10,915; capital called up, £3,000. Value of plant, races, &c., £3,000. Eleven men employed. Mine-manager, James Couling; secretary, John Erskine, Invercargill.

Our Mutual Friend, Galvin's Terrace, Nevis.—Area, 20 acres. This claim, taken up in 1894, is owned by W. Masters and party. One elevator is employed in the main ground, and occasionally two in the deepest ground, the materials being lifted 36 ft. Water is conveyed over races twelve miles in length, together with 100 ft. of fluming and half a mile of 7 in. and 9 in. pipe-line. The face is operated on by four nozzles, an average supply of twenty-five heads being available, at a head-pressure of 300 ft. The gold is of a rough description, and is saved with ordinary cobble-stones, the tailings being carried over a quarter of a mile of tail-race. During the year 1905 a quarter of an acre was operated on, yielding 210 oz. of gold, valued at £803 10s. Value of plant, races, &c., £5,000.

Patearoa Sluicing Claim, Patearoa, Maniototo County.—Area, 56 acres. Work was commenced in February, 1900. One elevator is employed, and the materials are lifted 30 ft. Water is conveyed over races three and a half miles in length and a mile and three-quarters of fluming and pipes. The face is operated on by one nozzle, an average supply of eight heads being available, at a head-pressure of 202 ft. (hydrostatic) and 192 ft. (hydraulic). The gold is medium-sized, resembling bran, and is saved with angle-iron ripples and perforated plates. During the year 1905 an area of 3½ acres was operated on, yielding 709 oz. 6 dwt. 22 gr. of gold, valued at £2,776 16s. 11d. Twelve acres has been worked during the past five years; the yield of gold obtained from this area was 2,306 oz. 13 dwt. 6 gr., valued at £9,043 4s. 7d., and dividends have been paid amounting to £2,750. The gold is obtained principally off the bottom, from which prospects up to as much as 16 oz. to the dish have been obtained. Some parts of the bottom are covered with a film of gold-particles. There is no recognised lead of gold, but most of the ground worked has paid well since operations were begun in the creek-bed, which is about 6 chains in width. A peculiar feature of this claim is that it is right in the heart of the Patearoa Township, which has been in existence for forty years, and the rich gold has lain there undiscovered until five or six years ago. Value of plant, races, &c., £1,600. Nine men employed. Mine-manager, Douglas C. Stewart; secretary, R. T. Stewart, Waikaia.

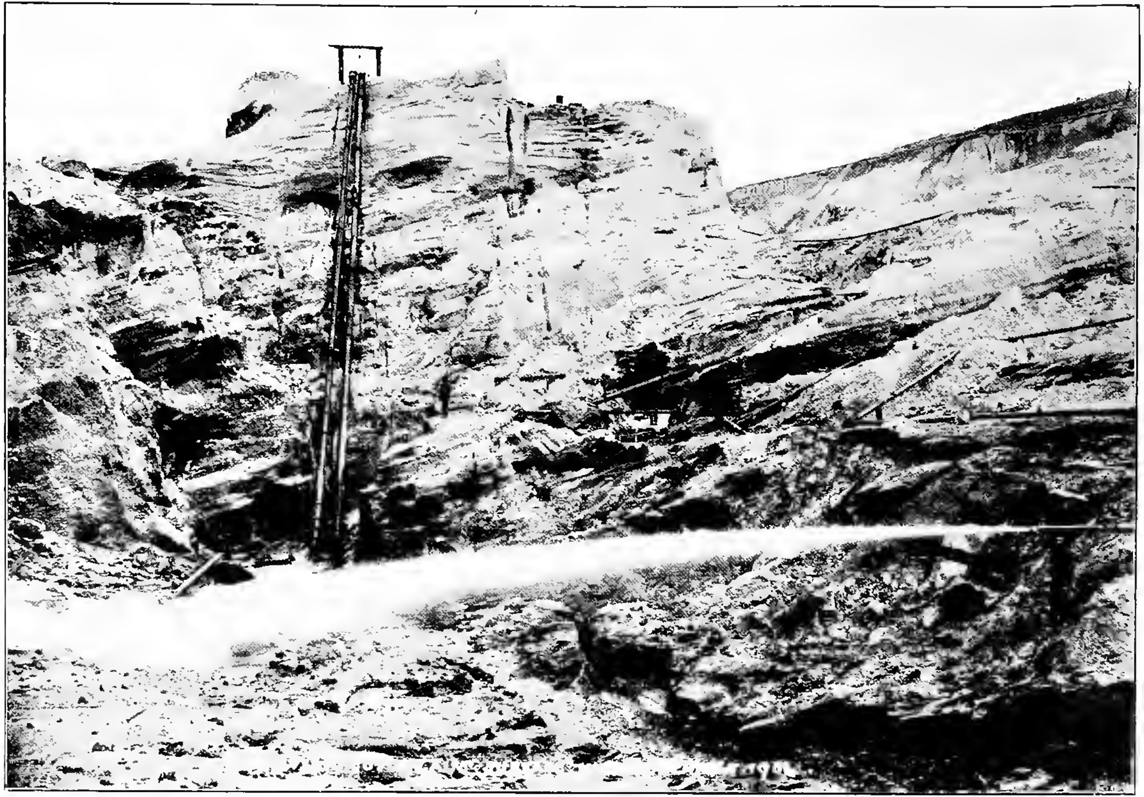
Pleasant Valley Hydraulic Claim, Coal Creek.—Area, 10 acres. There is one elevator employed on this claim, which is owned by McPherson Bros., and the materials are lifted 20 ft. Water is conveyed over races a mile and three-quarters in length and 15 chains of fluming and pipes. The face is operated on by one nozzle, an average supply of eight heads being available, at a head-pressure of 300 ft. The gold is fine, and is saved with boxes and ripples, the tailings being carried over 900 ft. of tail-race. An area of a quarter of an acre has been worked since September, 1905, yielding 37 oz. of gold, valued at £142 9s. Approximate value of plant, race,

&c., £400. Mine-manager, F. Swanwick; secretary, Robert McPherson, Coal Creek Flat.

Private Enterprise, Cardrona Valley.—Area, 10 acres. The wash consists of clean gravels, which is taken from a depth of 21 ft. One elevator is employed, and the materials are lifted 36 ft. Water is conveyed over races seventeen and a half miles in length and 33 yards of fluming and pipes, the dimensions of the latter varying from 24 in. to 9 in. The face is operated on by two nozzles, an average supply of twelve heads being available, at a head-pressure of 320 ft. The gold is fine dust, and is saved with ripples and hopper-plates, the tailings being carried over 27 yards of boxes. During the year 1905 three-quarters of an acre was worked, yielding 129 oz. of gold, valued at £504. Value of plant, races, &c., £1,600. Owner, Walter Little.

Rogers and Johnston's Claim, Upper Shotover.—Area, 14 acres. Work was first commenced on this claim in December, 1897. One elevator is employed, and the materials are lifted 27 ft. Water is conveyed over races a mile in length and 4,000 ft. of fluming and pipes. The face is operated on by two nozzles, an average supply of fifteen heads being available, at a head-pressure of 300 ft. The gold is coarse and fine, and is saved with angle-iron ripples, the tailings being carried over 300 ft. of tail-race. During the year 1905 an area of a quarter of an acre was worked, yielding 100 oz. of gold, valued at £385. Three acres has been operated on during the past eight years; yield of gold, 1,000 oz., valued at £3,850. Approximate value of plant, races, &c., £1,200.

Round Hill Mining Company, Round Hill.—Area, 140 acres. This company was registered in 1891, and commenced work the same year. There are sometimes four elevators employed, the height of the present lift varying from 64 ft. to 68 ft. (vertical). Water is conveyed over races fifty-six miles in length and 160 chains of fluming and pipes. The face is operated on by two nozzles, an average supply of twenty heads being available, at a head-pressure of 300 ft. (130 lb.). The gold is fine, and is saved with angle-iron ripples and cocoanut matting, the tailings being carried over



Scandinavian Gold-mining Company's Claim, St. Bathan's, Otago. Sluicing and Elevating.

10 chains of tail-race. During 1905 an area of 10 acres was operated on, yielding 2,536 oz. 5 dwt. 16 gr. of gold, valued at £10,210 13s. 8d. Since work first commenced the total gravels sluiced comprise an area of 70 acres, for a yield of 22,306 oz. 18 dwt. 5 gr., valued at £88,988 6s. 8d. Dividends have been disbursed amounting to £1,972 3s.; called-up capital, £28,245. About 12 oz. of platinum per year is saved on this claim, which is the only one in the colony that has systematically looked after the saving of this valuable metal. Approximate value of plant, races, dams, &c., £50,000. Mine-manager, Frederick Hart; secretary, Alfred Reynolds, Round Hill, Colac Bay.

Sailors' Gully, Waitahuna Gully.—Area, 71 acres 3 roods 39 perches. The Sailors' Gully Gold-mining Company was registered in June, 1896, and commenced work the same month. One elevator is employed, and the materials are lifted 20 ft. Water is conveyed over races seventeen and a half miles in length and 20 chains of fluming and pipes. The face is operated on by two nozzles, an average supply of eight heads being available, at a head-pressure of 220 ft. The gold is fine, and is saved with angle-iron ripples, the tailings being carried over 106 ft. of tail-race. During the year 1905 an area of 5 acres was worked, yielding 345 oz. 18 dwt. 14 gr. of gold, valued at £1,339 13s. 1d. Twenty-five acres has been operated on during the past ten years; the yield of gold from this area was 2,270 oz. 12 dwt. 13 gr., valued at £8,448 18s. 2d. Dividends have been disbursed amounting to £2,150; called-up capital, £1,900. Approximate value of plant, races, &c., £1,500. Mine-manager, Andrew Barr; secretary, Alfred Crooke, Lawrence.

Scandinavian Water-race Claims, St. Bathan's.—Area, 140 acres (in several claims). The Scandinavian Water-race Company was registered in 1868, and commenced work the same year. Two elevators are employed, and the materials are lifted 140 ft. Water is conveyed over races (from which several claims are supplied) ninety-six miles in length and two and a half miles of fluming and pipes. The face is operated on by two nozzles, an average supply of twenty-five heads being available, at a head-pressure of 380 ft. The gold is fine, and is saved with ordinary angle-iron ripples, but the tail-race is chiefly depended upon, the tailings being carried over five miles of tail-race. During the year 1905 an area of three-quarters of an acre was operated on, yielding 1,029 oz. of gold, valued at £4,014. Dividends have been disbursed amounting to £15,666; capital called up, £12,000. Mine-manager and secretary, Neil Nicolson, St. Bathan's.

Smith Gold-mining Company, Round Hill.—Area, 39 acres 1 rood 29 perches. The company was registered in October, 1898, and commenced work in 1899. One elevator is employed, and the materials are lifted 35 ft. Water is conveyed over races two and a quarter miles in length and 60 chains of fluming and pipes. The face is operated on by one nozzle, an average supply of five heads being available, at a head-pressure of 190 ft. The gold is fine, and is saved with ripples and mats, the tailings being carried over 70 ft. of tail-race. During the year 1905 the yield of gold was 195 oz. 19 dwt. 10 gr., valued at £774 1s.; total yield, 1,093 oz., valued at £4,317. Called-up capital, £1,700. Value of plant, races, &c., £1,720. Mine-manager, David Smith; secretary, L. W Petchell, Riverton.

Spring Vale Sluicing Claim, Spring Vale.—Water is conveyed over a race twelve miles in length and 4,000 ft. of fluming and 13 in. to 9 in. pipe. The face is operated on by one nozzle, an average supply of fourteen heads being available. During the year 1905, 65 oz. of gold, value £252, was obtained. Value of races, &c., £3,000. Owner, James Gartly.

Surface Hill Sluicing Claim, Livingstone.—Area, 5 acres. Work was commenced on this claim in November, 1901 Water is supplied from the dam, 2 acres in area, by a water-race four miles in length, together with 651 ft. of fluming and pipes, and the face is operated on by one nozzle, an average supply of four heads being available, under a head-pressure of 70 ft. The gold is fine, and is saved with perforated iron plates and matting, the tailings being carried over 440 yards of tail-race. During the year 1905 half an acre was worked, yielding 37 oz. of gold, valued at £142 17s. During the past four years 2 acres has been operated on, yielding 148 oz. of gold, valued at £571 16s. Value of plant, &c., £500. Owner, James Meikle.

Another claim of 5 acres is held at Surface Hill, at the foot of Ben Ledi, Livingstone, by George Meikle, who worked a quarter of an acre last year and turned over 3,000 cubic yards, at a cost of 4d. per cubic yard, for 30 oz. of gold, valued at £115 10s. Since commencing operations in December, 1901, an area of 1½ acres was worked, yielding 112 oz. of gold, valued at £426 4s., the depth of the auriferous wash taken from the true bottom varying from 10 ft. to 40 ft. Four heads of water are available, at a pressure of 40 ft.; and the gold, which is of fine quality, and worth £3 17s. per ounce, is saved by means of perforated plates and matting.

Tallaburn Hydraulic Sluicing Claim, Miller's Flat.—Area, 85 acres. Work was commenced in November, 1904. Water is conveyed over five miles of races and two miles of fluming and pipes, giving an average supply of twenty heads to two nozzles, under a head-pressure of 400 ft. One elevator is employed, the height of lift being 25 ft. The gold is fine, and is saved by ripples, hopper-plates, and matting. Value of races, plant, &c., £1,500. Mine-manager, John Whelan; secretary, Barbara Bennet, Miller's Flat.

Tinkers Gold-mining Company, Matakanui.—Area, 87 acres. This company commenced work in March, 1902, and was registered in June the same year. One elevator is employed, and the materials are lifted 60 ft. Water is conveyed over races six miles in length and three-quarters of a mile of fluming and pipes. The face is operated on by two nozzles, an average supply of twenty heads being available, under a head-pressure of 600 ft. The gold is fine, and is saved with boxes, ripple-plates, and matting, the tailings being carried over three-quarters of a mile of tail-race. During the year 1905 half an acre was operated on, yielding 739 oz. 3 dwt. 16 gr. of gold, valued at £2,845 15s. 10d. Ten acres has been worked during the past three years, the yield obtained from this area being 2,823 oz. 19 dwt. 2 gr. of gold., valued at £10,872 2s. 5d. Dividends have been paid amounting to

£5,437 10s.; called-up capital, £15,000. Value of plant, races, dams, &c., £20,000. Seven men employed. Mine-manager, Joseph Naylor; secretary, T. Duggan, Matakanui.

Twelve-mile Sluicing Claim, Glenorchy.—Area, 2 acres. The material worked consists of heavy wash and huge boulders. During the year 1905 about 5,000 yards was treated, giving a return of 54 oz. 14 dwt. of gold, valued at £210 13s.; total value of gold won since work first commenced, £400. There is one elevator employed, the height of the present lift being 30 ft. Total length of tail-races, 132 ft.; length of fluming and pipes, 500 ft., the dimensions of the latter being from 13 in. to 9 in. There are eight heads of water available, and one nozzle is in use, the pressure of the elevator-jet at face being 40 ft. Value of plant, £110. Owners, Valpy Bros.

Undaunted Gold-mining Company, Matakanui.—Area, 114 acres. This company was registered in March, 1898, and commenced work the same month. Two elevators are sometimes employed, the materials being lifted from 45 ft. to 60 ft. Water is conveyed over thirty miles of races and 2,150 yards of fluming and pipes, the dimensions of the latter varying from 22 in. to 7 in. The face is operated on by three nozzles, an average supply of thirty-five heads being available, when there is sufficient water, at a head-pressure of 420 ft. and 320 ft. from two lines of pipes. The gold is fine, and is saved with bags and cocoanut matting, the tailings being carried over eight miles of tail-race and one channel. During the year 1905, 1½ acres was operated on, yielding 618 oz. 2 dwt. 14 gr. of gold, valued at £2,449 6s. 8d. Since the claim first commenced work until the 31st March, 1906, 11 acres has been worked, yielding 7,870 oz. of gold, valued at £30,628 2s. 3d. The called-up capital has amounted to £15,000, and the dividends declared to £12,000. Value of plant, races, dams, &c., £17,000.

The mine-manager and secretary of the Undaunted Company (Mr. Thomas C. Donnelly), in a note covering the above details, furnishes the following interesting information: "Matakanui was better known amongst the early diggers as 'Tinkers,' and is so called by many persons to the present day. It is computed that 100,000 oz. of gold has been won by private parties and companies on this rich field. At present there are four limited-liability companies carrying on sluicing operations — viz., Undaunted, £20,000 capital; Tinkers, £15,000; Matakanui, £7,000; Mount Morgan, £2,800. These four companies hold unworked ground to the extent of about 300 acres, and it is estimated that there is a further area of 1,000 acres of auriferous ground in the locality. The 100,000 oz. of gold already won has been got from a comparatively small area."

United M. and E. Water-race Company, St. Bathan's.—Area of claim, 24 acres. This company was registered in 1872 for the purpose of supplying water to various claims at St. Bathan's. Hydraulic elevating was not commenced till fifteen years ago. The top materials have been stripped off 15 acres. An acre of ground was treated during the past year for 951 oz. 7 dwt. 18 gr. of gold, valued at £3,662 16s. 7d. The materials operated on consist of water-worn quartz gravels, lying at an angle of 45° on a slaty reef, the true bottom not having been yet found, though a depth of 200 ft. has been reached; the overlying strata is composed principally of water-worn gravel to the surface. One elevator is employed, the height of present lift being 60 ft. Fifteen heads of water are conveyed from the company's dam, covering an area of 2 acres, over twenty-five miles of water-races and 3,000 ft. of fluming and pipes (diameters varying from 22 in. to 7 in.) to three nozzles, the pressure at the elevator-jet being 400 ft. The gold is fine, and three tail-boxes, each 14 ft. in length and 3 ft. in width, are placed at the end of the tail-races to save it. The company has a called-up capital of £7,600, and £3,078 has been paid in dividends. The estimated life of the claim is twenty-five years, or forty years from date of commencing operations. When worked the ground can, it is stated, be utilised for grazing or tree-growing. Value of races, plant, claim, &c., £6,000. Mine-manager, Patrick O'Regan; legal manager, William Pyle, St. Bathan's.

Upper Waikaia Gold-mining Syndicate, Upper Waikaia River.—Area, 4 acres 2 roods. Work was commenced on the claim in March, 1905, 36 oz. 5 dwt. being obtained to end of year. One elevator is employed, and the materials are lifted 30 ft. Water is conveyed over races two miles in length and 1,000 ft. of fluming and pipes. The face is operated on by one nozzle, an average supply of twelve heads being available, under a head-pressure of 300 ft. The gold is coarse and fine, and is saved with angle-iron ripples, the tables being 80 ft. in length and 2 ft. 6 in. in width. Approximate value of plant, &c., £500. Four men employed. Mine-manager, J. S. Phillips; secretary, H. A. Tamblyn, Coal Creek Flat.

Upper German Flat Company, Lawrence.—Area, 14 acres. Work was commenced by the owners (S. Johnston and party) in May, 1904. One elevator is employed, and the materials are lifted 22 ft. Water is conveyed over races four miles in length and 32 chains of fluming and pipes. The face is operated on by one nozzle, an average supply of eight heads being available. The gold is coarse, and is saved with angle-iron and matting, the tailings being carried over 60 ft. of tail-race. During the year 1905 the yield of gold was 112 oz., valued at £431 4s., the total won since commencing operations being 215 oz., valued at £827 15s. Mine-manager and secretary, F. Bell, Lawrence.

Vinegar Hill Hydraulic Sluicing Company, Vinegar Hill. —Area, 62 acres. This company was registered in September, 1900, and commenced operations the same month. One elevator is employed, and the materials are lifted 82 ft. Water is conveyed over races twenty miles in length and one mile of fluming and pipes. The face is operated on by two nozzles, an average supply of from twelve to fifteen heads being available, with a head-pressure of about 500 ft. The gold is fine, and is saved with boxes 60 ft. in length and 3 ft. in width, the tailings being carried over two miles of tail-race. During the year 1905 about 2 acres was worked, yielding 360 oz. of gold, valued at £1,387. The total amount of gold won since work first commenced is 1,568 oz., value £6,075 11s. 7d. Dividends have been disbursed amounting to £600; capital called up, £6,500. Value of plant, races, dams, &c., £6,500. Seven men employed. Mine-manager, Thomas Morgan; secretary, Edward Morgan, Cambrian's.

Winding Creek Sluicing Claim, Winding Creek, Waikaia. —Area, 80 acres. This property is held by the Round Hill Mining Company, which commenced work in October, 1904. One elevator is employed, and the materials are lifted 11 ft. and 58 ft. Water is conveyed over races nineteen miles in length and 60 chains of fluming and pipes. The face is operated on by one nozzle, an average supply of ten heads being available, at a head-pressure of 280 ft. The gold is coarse and fine, and is saved with angle-iron ripples and cocoanut matting, the tailings being carried over 12 chains of tail-race. Since the claim was first opened up 3 square chains has been worked, yielding 354 oz. of gold, valued at £1,397 4s. 6d. Cinnabar is found in the wash, but none is saved. Value of plant, races, dams, &c., £10,000. Mine-manager, John Ramsay; secretary, Alfred Reynolds, Round Hill, Colac Bay.

Zala's Sluicing Claim, Cardrona Valley.—Area, 4 acres Work was first commenced on this claim in August, 1901. During the year 1905 a quarter of an acre was worked, yielding 34 oz. of gold, valued at £129 4s. 4d. There is one nozzle in use, the pressure of the elevator-jet at the face being 60 ft. The tail-race is 2,100 ft. in length.

METALS AND MINERALS FOUND IN SLUICING CLAIMS.

In forms sent to the various managers of sluicing claims in Nelson, West Coast, Otago, and Southland information was sought by the Editor of the Mining Handbook as to traces of platinum or other metals or minerals found in the course of mining operations. The following affirmative replies have been received:—

Nelson District.

Parapara, Collingwood.—Some native lead is found in the wash.

Takaka, Pupu, Waitapu, Golden Bay.—Platinum in very small quantity is present.

West Coast.

Kiri Momona, Maruia, Burnett Survey District.—Iron-pyrites.

Mont d'Or, Sailors' Gully, Ross, Westland.—No platinum; only ironsand.

New Nine-mile Creek, near Ten-mile Creek, Grey Valley.—No trace of platinum. Ironsand and a little ruby tin in small quantities.

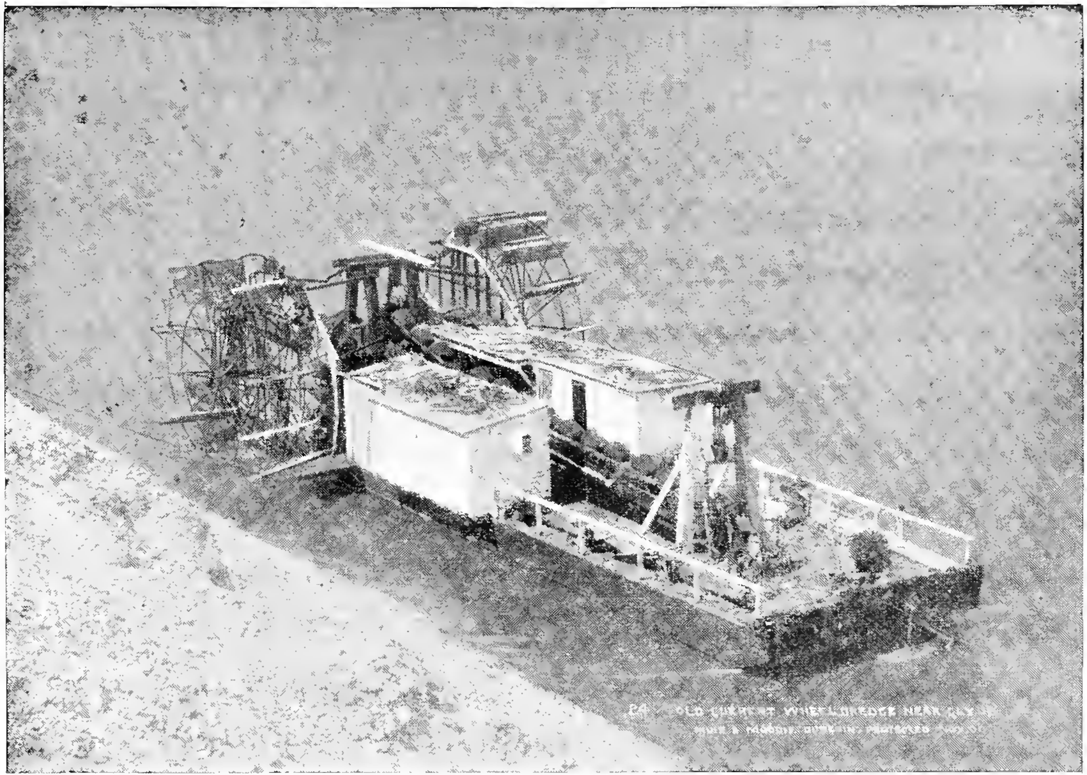
Otago and Southland.

Blue Jacket, opposite Deep Creek, Maori Point, Shotover River.—Small particles of silver occur in the wash.

Butterfly (Weatherall Bros.), Teviot Survey District.—A few small rubies.

Jewett's Gully (J. Thurgood), Round Hill, Colac Bay.—Platinum.

Ladysmith, Roxburgh East.—Only ironsand.



THE OLD CURRENT-WHEEL DREDGE.

Lammerlaw Flat (F. W. and W. E. S. Knight), Waipori.—Scheelite and cinnabar.

Munro and Party, Post-office Creek, Waipori.—Cinnabar, fine; not saved.

Nokomai, Nokomai Creek, Southland.—Silver and gun-shot.

Ourawera, Round Hill, Colac Bay.—Platinum and silver.

Our Mutual Friend, Galvin's Terrace, Nevis.—Black sand only.

Round Hill, Round Hill, Colac Bay.—Platinum; about 12 oz. per year saved.

Sailors' Gully, Waitahuna, Tuapeka County.—Ironsand.

Smith, Round Hill, Golac Bay.—Platinum.

Undaunted, Matakanui.—There is a lot of ironsand in the auriferous wash.

United M. and E. Water-race, St. Bathan's.—None other than iron-pyrites.

Winding Creek, Winding Creek, Waikaia.—Cinnabar; none saved.

THE GOLD-DREDGING INDUSTRY IN OTAGO AND SOUTHLAND.

By Robert McIntosh, A.O.S.M., Assistant Inspector of Mines for the Southern Mining District.

A good deal of information has been recorded from time to time regarding the rise and development of the dredging industry in New Zealand. The information hereafter detailed has been chiefly culled from the official annual reports of Inspectors of Mines, Wardens, and other goldfields officials.

The earliest gold-discoveries by Europeans in Otago and Southland are accredited to the year 1851. From that year small discoveries of gold-bearing gravels took place in different localities, until in the year 1861 payable gold was found in the Waitahuna and Tuapeka River watersheds. Prospectors extended their operations further afield, and in the year 1862 the Dunstan, Nokomai, Waikaia, and Wakatipu goldfields were opened out. Other auriferous tracts were located from time to time, until the existence of extensive areas of gold-bearing country in Otago and Southland became an established fact. The chief alluvial districts lie in the valleys of the Taieri, Waitahuna, Waipori, Tuapeka, Molyneux (or Clutha), Kawarau, Arrow, Shotover, Mataura, Waikaia, Waikaka, Nevis, and Maerewhenua Rivers. On each of these goldfields the first gold was won by the primitive methods of the prospector, consisting of tin dish, cradle, long-tom, and other simple appliances. As the claims became more difficult to work, ground-sluicing was adopted where sufficient water for sluicing and plenty of room for disposal of tailings were available. Shaft-sinking and tunnelling were also adopted to work deep ground. To deal more effectively with deep wet ground and low-grade deposits, hydraulic sluicing and elevating was the next system brought into use; but even this process had its limitations. In many cases water was not procurable, while in others the cost of race-cutting was prohibitive. The necessity arose for an efficient method of winning gold from the beds of rivers and streams, and from deep wet ground. The first appliances used in this connection were very primitive, but one improvement followed another until the present dredge was evolved. This system was first tried on the Molyneux (or Clutha) River. Although gold was found in the lower reaches of the river in the year 1852, the earliest reference to the production of a quantity of gold from this river, as recorded in the "Handbook of New Zealand Mines, 1887," states that two Californian miners, Hartley and Reilly*, lodged at the office of the Gold Receiver at Dunedin 1,047 oz. of gold. The locality proved to be that portion of the river lying between the confluence of the Kawarau and Manuherikia Rivers with the Molyneux, a distance of about twenty miles. It was not long before a large population was located in the diggings known as the Dunstan, and other parts of the river were found to be gold-bearing also. The gold was first obtained from the shallow bars and beaches, and followed from there into the deeper river and into the terraces on the river-banks. The river gold not being procurable by the then existing appliances, the miners turned their attention to sluicing away the terraces, material being sluiced into the river. The natural result was that this enormous quantity of *débris*, and, in addition, the vast amount of material washed in by climatic influences, in time raised the bed of the river and smothered the auriferous gravels. Previous to this, when the rivers were low, it is recorded that men would wade into such rivers as the Shotover, Kawarau, and Arrow, and with a shovel dig up the auriferous wash. This was known as "blind stabbing."

The next step ahead of this method was the spoon dredge,

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* Generally spelt Riley in these days, as in the "Hartley and Riley Dredging Company." But in Mr. Vincent Pyke's report, published in the "Appendix to the Journals of the House of Representatives, 1863," and included amongst the despatches printed by the Secretary of State for the Colonies, the name is spelt several times "Reilly."—Editor, MINING HANDBOOK.

worked by hand-labour, and a very primitive means at first, but gradually improved. This was, however, a very slow method, and could only be used in shallow, calm water, as currents and travelling drift militated against efficiency. Several spoon dredges were in operation for a few years, working with varying success, so far as can be learned, but, at any rate, proving the existence of gold-bearing wash in various parts of the river.

The increasing amount of travelling drift in the river was gradually bringing to an end the spoon dredge, and it was a natural step forward to the adoption of the current-wheel dredge in 1868, which, deriving its power from the current, was enabled to work in midstream. This type of dredge consisted of two parallel wooden pontoons, braced apart, with a clear waterway or well-hole running between them. The current-wheels were set on the outside of each pontoon, and the power was transmitted through a horizontal shaft to the top tumbler, which imparted motion to an endless chain of buckets working in the well-hole. Hand-winches were placed on deck to work the mooring-lines, and to raise and lower the buckets. The material brought up in the buckets was washed in a sluice-box, the water being obtained by a water-wheel, which raised it to the level of the sluice-box. This type of dredge was improved upon from time to time, and a considerable number was at work for some years on various parts of the river. In 1901 a modern dredge was equipped with current-wheels to operate in the gorge below Alexandra, where the current is very strong. When the dredge had been working some time a diminution of current was experienced, due, no doubt, to the stacking of tailings behind the dredge, and it was found necessary to procure additional power by the installation of an oil-engine to drive the centrifugal pump.

It was early recognised that the most effective power was not derived from current-wheels. These only acted in midstream, so that it was impossible to follows leads or runs of gold into still water or into the beaches. It was then resolved to adopt the use of steam-power. The earliest record of the application of steam-power to bucket dredges is attributed to the case of the Dunedin dredge, which was designed and erected in 1881 by the late Charles McQueen, of Kincaid and McQueen's Foundry, Dunedin, to work on the Clutha River, near Alexandra, although it is recorded that a steam spoon dredge was in operation in 1870. The Dunedin was the first dredge to be built on an elaborate scale, having due regard to the amount of material to be lifted, and to the efficiency of the appliances for washing the material and saving the gold. Although many improvements have taken place since 1881 in the construction of dredge machinery, still the chief features of the Dunedin dredge have been retained on all dredges to the present day. As a result of the successful construction and working of this dredge, more attention was given to the possibility of raising larger quantities of gravel, and thus treating profitably low-grade gravels. The increasing amount of drift brought down by the river made it imperative that large, powerful machines should be employed, and during the next few years more dredges were built.

In the year 1887 a Welman, or suction, dredge was erected at Alexandra, and several others were afterwards erected on the West Coast ocean-beaches. Although proved capable of dealing with fine sand and shingle, these dredges were not suitable for working where large stones and coarse gravel existed. In consequence they did not come into permanent use.

Among other systems tried during this period on the West Coast may be mentioned Taylor's dredge, worked on a dry-land principle—a combination of a Priestman grab and a cataract pump; and Brown's dredge, which consisted of an American type of pump, known as the Cataract pump.

All these years the industry was progressing quietly, and it was not until 1889 that a decided advance took place. In that year Sew Hoy, a Chinese merchant in Dunedin, took up a claim on the Big Beach, Shotover River, and erected a dredge thereon. This enterprise was attended with great success, and something in the nature of a dredging boom took place. Many more dredges were placed on the Shotover

River and the upper reaches of the Kawarau River; some of these were successful, while others were not. Several of these early dredges are still in operation, having been shifted to and re-erected on claims on the Clutha, Manuherikia, and Waikaka Rivers.

In 1890 the first application of electric motive power to a dredge was undertaken at the Sandhills dredge, Upper Shotover River. The installation proved successful, and the plant worked well. About this time several dredges on the Welman principle were working on the ocean-beaches of the south-east coast. These dredges were considerably improved on the original type, but failed owing to the difficulty of saving the extremely fine gold with the ordinary gold-saving appliances. It was in this year that the possibility of working by dredges wet, flat land with small streams of water running through it was first demonstrated. The Upper Waipori alluvial dredge was built to work a flat claim at Waipori, and the success attendant on this venture proved that ground could be worked in which dredges would have to depend to a great extent on the drainage of the surrounding country. This brought within the scope of dredges large areas of auriferous ground of this nature in Waikaka, Waikaia, Waipori, Tuapeka, Waitahuna, Nevis, and other districts. At first these flat-land dredges were constructed on the sluice-box principle, and this principle is adopted to the present day wherever practicable. In the case of deep ground and high faces above water-level, the question of the disposal of tailings arose. This was satisfactorily solved in 1894 by the invention of Cutten's elevator, which, fitted at the stern of the dredge, received the washed material from the revolving screen and stacked it to the desired height. Elevators, differing in construction, have been since designed by other dredge engineers, the most recent and successful patent being "Payne and Peck's Centrifugal Elevator." As showing what the application of the elevator meant to the dredging industry, claims are now being worked in which the face of gravel is 25 ft. below and 45 ft. above water-level, the material being stacked 60 ft. above water-level.

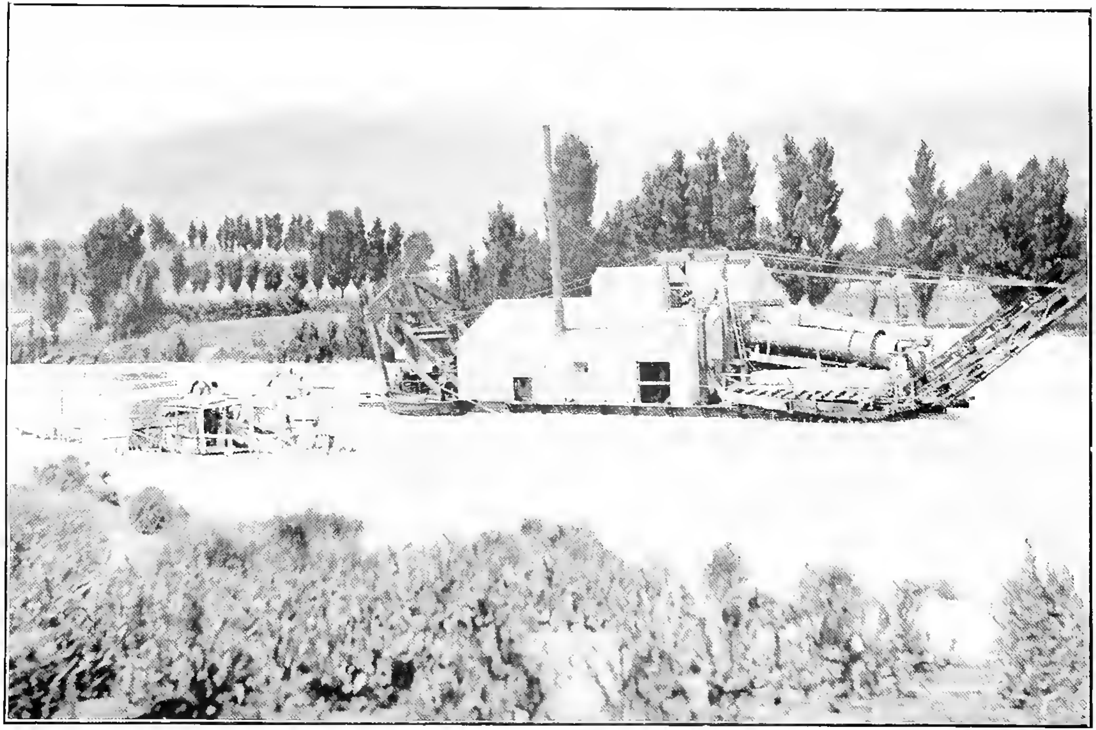
From 1894 the industry continued to expand, and the profitable working of many of the dredges on the Clutha River made this branch of mining at that time one of the most important in Otago. A great many claims were pegged out in 1895 on the Clutha and Kawarau Rivers, and several additional dredges were in course of construction. It was about this time that the No. 1 Electric dredge—a private concern—was reported to be dredging rich wash, and, in consequence, considerable activity in securing claims was displayed all through the district. In 1897 two dredges (Perry's and McGill's) started operations on the Waikaka field, and the Golden Crown dredge at Waikaia. There are now (in 1906) twenty-six dredges on the Waikaka field, and sixteen on the Waikaia field.

At the end of March, 1899, the number of working dredges in Otago and Southland was seventy. Four were undergoing removal, nine were standing for various reasons, and about thirty were in course of construction. These dredges were not confined to the Clutha River, but were spread over Waimumu, Gold Creek, Waikaka, Waikaia, Shag River, Macrae's, Chatto Creek, Ophir, Glenore, Waipori, and Tuapeka. About this time there was a decided tendency on all sides to build dredges of a larger and more efficient type. It was hardly to be expected that every venture would be attended with success, and this want of success was due in some cases to lack of gold sufficient to pay expenses, and in other cases to inefficient management, or to the class of dredge not being suitable for the claim. Many concerns which went into liquidation passed into other hands, and became successes in later years, while several private parties acquired expensive and up-to-date dredges very cheaply and worked them with success. However, as time went on weaknesses in machinery were detected and overcome, new methods were evolved, and many improvements were applied. A large number of men were gaining experience in the working of dredges, and thus capable men were available to command the different dredges.

Writing now in 1906, it can be safely said that the dredging industry is conducted on a sound basis, and has proved itself to be a legitimate branch of the mining industry. In the accompanying notes reliable data will be found regarding the dredging industry from the time of the spoon dredge up to the present day. Descriptions are given of improvements in all matters of interest appertaining to the industry. It is impossible to enter fully into details, the desire being to afford a general idea of the localities where dredging is being carried on, the rise or fall of the industry in each place, and the present and future prospects of the fields.

The following table shows the numerical strength of the dredging fleet from 1877 to the 31st December, 1905. Prior to the year 1877 there were a number of spoon dredges and current-wheel dredges at work on various parts of the Clutha (or Molyneux) River :—

Year.	Otago.	Southland.	Chief Improvements.
1877	6	...	Dredges driven by current-wheel.
1878	5		
1879	5		
1880	5		
1881	9	...	Introduction of steam-power on Dunedin dredge by Charles McQueen.
1882	10		
1883	11		
1884	9		
1885			
1886	12		
1887	18	...	Introduction of Welman suction dredge at Alexandra.
1888	12	1	Introduction of Welman suction dredge at Waipapa.
1889	14	...	Extension of use of dredges to work flat land at Waipori.
1890	31	3	Application of electro-motive power, Sandhills dredge, Shotover.
1891	27	4	A large number of current-wheel dredges converted to steam.
1892	26	2	
1893	28	1	
1894	30	2	Cutten Bros. designed tailings-elevator, thus widening scope of application of dredges.



Gold-dredging in the Clutha River, Otago: The Old Style and the New.

Mining Handbook.

Year.	Otago.	Southland.	Chief Improvements.
1895	72	2	
1896	51	3	
1897	63	3	
1898	74	5	
1899	162	34	Tendency to build larger and more powerful dredges.
1900	187	41	Application of electro-motive power, Earnscleugh No. 3 dredge, Alexandra.
1901	183	38	Adaptation of O'Brien's system of water-power to work dredges.
1902	163	46	Payne and Peck's centrifugal elevator designed.
1903	144	56	Johnson's submerged-jet dredge started.
1904	131	53	
1905	117	55	Introduction of shaking-table to replace screens.

Clutha (or Molyneux).

In dealing with the dredging industry in the Clutha Valley, the whole district will be divided into sections, and each section separately dealt with.

Tuapeka Mouth, Beaumont, Miller's Flat, Dumbarton, Roxburgh, and Coal Creek—a distance of about Forty Miles.

The earliest attempt to win gold from the deeper portions of the river was by means of the spoon dredge, operated by hand-labour. These were first used prior to 1868, in which year it is recorded that a man named Ward introduced the current-wheel dredge at Miller's Flat. This dredge had a string of buckets, as in the modern dredge, the power being derived from the current by means of the current-wheels. This was soon a popular method of dredging, and several more were built. In 1870 Seideberg applied the use of steam on a spoon dredge, but the current-wheel system continued to be used for many years. In the year 1880 Warden Carew reported, "Two steamboats, the 'Ino' and the 'Jane,' each of about 30 tons and 10-horse power, are now in the Clutha River, a few miles above Tuapeka Mouth, and are being fitted up for dredging the river-bottom. This enterprising undertaking is well thought of, as vessels working with steam-power will have great advantage over the current-wheel dredges. They can be moved about and their positions changed with greater ease, work in eddies where current-wheel dredges would be useless, and put through a much larger quantity of drift. It is generally admitted that, even with the ordinary boats, dredging would yield highly payable results but for one great impediment—that the smallest flood in the river now brings down by the force of the current immense quantities of tailings and other *débris*, which fills up the dredging-buckets to the exclusion of the gravel from the older deposits that contain gold in quantity." There were four current-wheel dredges at Roxburgh during 1881, all doing well; but several dredges placed on the river between Beaumont and Tuapeka Mouth could not work successfully. At this time the Pride of Dunkeld, at Beaumont, was getting good returns. About the same number of dredges continued here and there on the river until 1886. In that year Gibson's suction dredge, at Alexandra, was being erected, and several claims were pegged out in anticipation of it turning out a success. During 1887 there were five current-wheel dredges upon the river between Roxburgh and Horseshoe Bend, while four special claims were granted on the river above Beaumont. These were, however, awaiting the results from the suction dredge at Alexandra. Cowan and party's dredge, at the Beaumont, continued to work during 1887. Owing to the non-satisfactory results of the suction dredge, the four claims held at Beaumont by the Austral Company, Mr. Brown, Mr. Woods, and Mr. Tockel were abandoned in the year 1888.

During the same year there were six dredges at work between Beaumont and Coal Creek, while the Dunedin dredge was being re-erected at Coal Creek. Warden Revell states, "From reports I believe that this class of mining still continues to give satisfactory results for the capital and labour expended." The six dredges at work belonged to Brazil and party, Bennet and party, Pringle and party, Macdonald and party, Valentine and party, and Crookston and party. The Dunedin steam dredge, the Dunedin current-wheel, Telford and party, all between Dumbarton Rock and Coal Creek Flat, continued to work until 1890. The Ettrick gold steam dredge was erected during the year, as was also the Miller's Creek steam dredge. Other dredges were Aitken and party's current-wheel, Brazil and party's steam dredge (formerly current-wheel), Pringle and party's current-wheel, Bennet and party's steam dredge (formerly current-wheel). Adams and company also built a dredge below Steele's farm. The lowest dredge was the small steam dredge of the Clutha Dredging Company. Cowan and party's dredge was removed from Beaumont to Pomahaka River.

In 1892 there were ten steam and one current-wheel dredges at work on the river between Horseshoe Bend and Coal Creek, representing a plant-value of £25,000, and employing continuously sixty-five men. Six of these dredges were owned by registered companies, and the remainder by private parties. It would appear that about this time the majority of the dredges were getting handsome returns. The conversion of several of the current-wheel dredges to steam was rendered imperative by the necessity of working independent of the current, current-wheel dredges being only suitable for working in places where the current is strong, and not adapted for working near the beaches or in eddies.

During the period 1893–95 the industry continued to expand, and good returns were obtained. Many new dredges were built, among them being the Golden Treasure, Edina, and Golden Gate. The industry progressed smoothly until 1899. During that year every available portion of the river, from Tuapeka Mouth to Coal Creek, was pegged for dredging. On the same stretch of river there were about ten dredges at work and twenty-one in the building stages. All the working dredges, with the exception of one current-wheeler, were driven by steam-power, the only electrically driven dredge, formerly at work on the Upper Shotover, being in course of re-erection for the Timmaburn Electric Gold-dredging Company at Miller's Flat.

During 1901 several up-to-date dredges were completed to work on various portions of the river, while others were in the building stages. At the end of 1901 there were twenty-one dredges working in this district, and a number building. By the end of 1902 several additional dredges were got to work, and the number of working dredges was thirty. During the year the Paul's Beach, Golden Gravel, Britannia, and Teviot companies went into liquidation and were reconstructed; the dredges started work again on the original claims. Around the Beaumont the gold-returns were small, but all the dredges around Roxburgh averaged good returns, while at Miller's Flat the industry was prosperous. Warden McCarthy furnishes the following particulars of four dividend-paying dredges:—

Name.	Capital.	Gold won.	Number of Weeks worked.	Average Return per Working-week.	Dividends paid.	Interest on Capital invested per Cent.
	£	Oz. dwt. gr.		Oz. dwt. gr.	£ s.	
Golden Gate ..	2,500	1,706 3 0	50	35 14 11	4,825 0	193
Majestic ..	6,500	1,088 7 0	40	27 4 4	1,687 10	26
Molyneux Kohi-noor	10,500	619 17 11	26	23 16 17	481 5	4½
New Roxburgh Jubilee	7,500	1,450 13 17	19	76 7 0	1,125 0	15

As regards the dredging industry around Roxburgh during 1903, Warden Burgess remarked, "Although a few dredging companies in this portion of the district have perished for want of the necessary capital, and fewer dredges are now in operation, I think the industry is in a sounder condition at present than at any time during or since the boom. There are sixteen dredges at work in the river between Coal Creek and the Island Block, and with the exception of the Teviot (idle at present) all are working steadily and with very satisfactory results. The Endeavour dredge and the Gold King dredge fell into the hands of Mr. Joseph Sparrow, who lost no time in getting them to work. The returns are not published, but I am credibly informed that both are getting above 40 oz. per week. The Golden Gate, during the year, paid in dividends £2,125—an amount closely approximating to the total capital of the company. The Golden Run, Golden Bed, Ettrick, Golden Treasure, and the Island Block are all obtaining satisfactory returns, and most of them are paying dividends. At Roxburgh the Jubilee is a very persistent gold-getter, and has paid steadily since commencing work, while the Lady Roxburgh and the Molyneux Kohinoor are obtaining returns which leave a handsome margin of profit." At the end of 1903 there were seventeen dredges at work from Coal Creek to Beaumont, but during that year seven ceased operations, five of these being removed to other claims, one going to Victoria.

In his report for 1904 Warden Burgess indicates that dredging in the Roxburgh and Miller's Flat district has improved very much.

Name of Company.	Capital.	Amount of Gold won.			Number of Weeks worked.	Dividends paid.		Average per Working-week.
	£	Oz.	dwt.	gr.		£	s.	Oz.
Roxburgh Jubilee ..	7,500	2,254	0	4	38	6,750	0	59
Golden Bed ..	12,706	1,809	8	0	41	1,270	6	44
Lady Roxburgh ..	6,660	1,754	10	7	42	1,663	0	41
Otago No. 2	5,000	1,643	10	0	40	875	0	41
Otago No. 1		763	7	0	42			18
Ettrick	10,250	1,098	6	0	39	1,015	0	28
Golden Gate ..	2,500	797	1	0	46	500	0	17

At the end of 1904 there were eighteen dredges at work on this portion of the river. The Golden Treasure and Otago companies discarded their old dredges and purchased up-to-date machines. Eighteen dredges were at work at the end of 1905; eight of this number were under private ownership, some being owned by parties of working shareholders. A regrettable accident was the loss of the Roxburgh Jubilee, which unaccountably sank at her moorings on Sunday, the 18th February, 1906.

It may safely be said that the dredging industry will be represented in this district by many dredges for years to come.

There are still stretches of the river which will pay small parties well to work with modern dredges. Around Miller's Flat also it has been ascertained that the river-banks are payably auriferous, and it is reasonable to expect that the areas will be found to be extensive. The question of the disposal of the silt in working these bank claims has been successfully answered by the application of the silt-elevator wheel, which lifts the silt from the sump and discharges it into the main elevator. With the exception of several dredges around Miller's Flat, the machines are mainly operating on the river itself. Several dredges at Miller's Flat are working the river-banks, and, being of the elevator type, the restoration of the land to its former state is next to impossible with the present appliances.

INCLUDING COAL CREEK TO ALEXANDRA GORGE, ALEXANDRA, CLYDE, CROMWELL, LOWBURN, KAWARAU, MANUHERIKIA, AND SHOTOVER.

Prior to 1880 the dredging industry went through the stages of spoon and current-wheel bucket dredges. In 1880, at Alexandra, two large areas of river-bed were applied for, and steam dredging plants were to be erected on new principles. These two dredges were got to work in 1881. One of these was the Dunedin dredge, designed and erected by Mr. Charles McQueen, of Dunedin.* After working on the river near Alexandra for some years this dredge was shifted to a claim on the Clutha River near Coal Creek. An impetus was given to the industry in 1886, when all the available portions of the Clutha River from Alexandra to Cromwell were pegged off. This was on account of the erection of one of Welman's dredges at Alexandra. During 1887 there were one steam and three current-wheel dredges at work between Clyde and Alexandra. No dredges were erected on the special claims taken up in 1886, on account of the non-working of the Welman dredge at Alexandra: the first dredge was too small, and

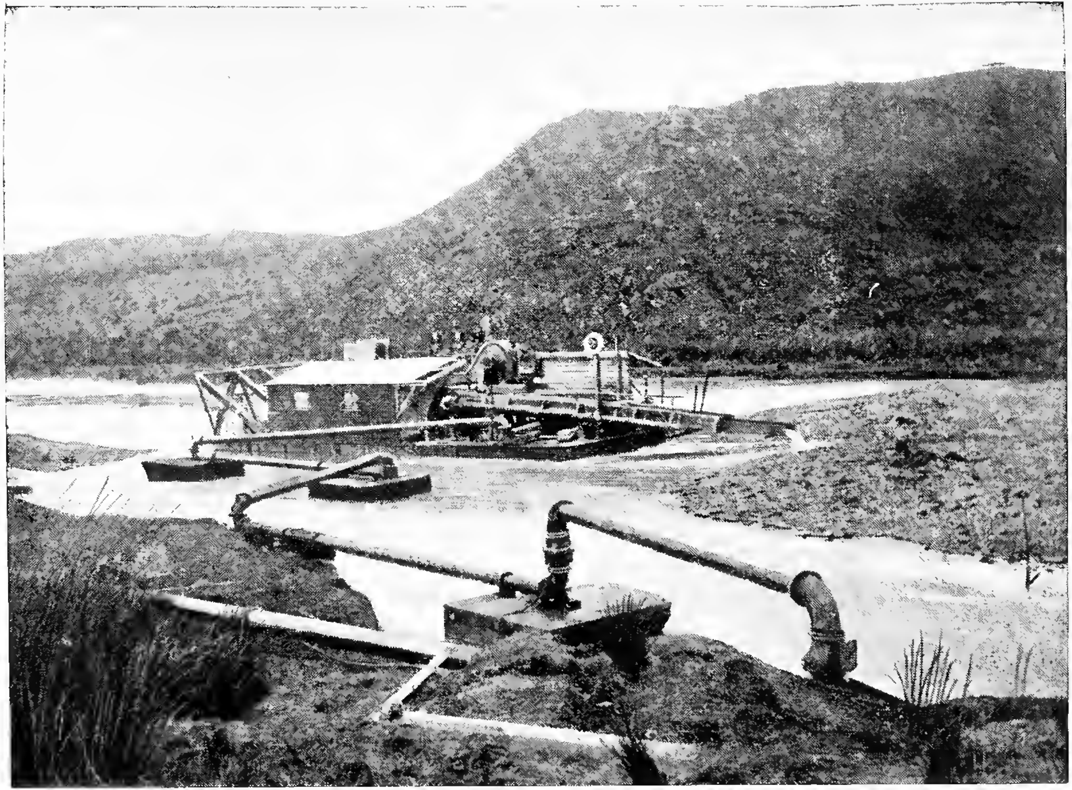
* The late Mr. McQueen's interesting account of the start of the steam dredge will be found in the *New Zealand Mines Record* of the 16th June, 1906, pages 459–460.

larger parts were being substituted. During 1888 the Dunedin steam dredge was removed to Coal Creek, leaving only two current-wheel dredges at work near Alexandra. It was unfortunate, at this time, that the Welman dredge sank before it had a fair trial. No advance was made in the district around Alexandra and Clyde during 1889, but Coote and Horn floated a company to work claims on the Kawarau River. Kloogh and party were also working a current-wheel dredge at Lowburn, on the Clutha River. It was in 1889 that Sew Hoy and Co. placed the first dredge on the Big Beach, Shotover River. Its operations were successful, and led to claims being taken up on the Kawarau, Shotover, Arrow, and Cardrona Rivers; also on the Dart River, Twenty-five-mile Creek, Twelve-mile Creek, and Bucklerburn. It was during the year 1890 that the industry made a decided advance. Apart from the pegging-out of claims, new dredges were built. Three were built for the Sew Hoy Company, one for the Talisman Company, and one for the Frankton Beach Company. Two others were at work below the Shotover River on the Kawarau River. The Sandhills Company also constructed a dredge to be worked by electro-motive force: the claim was situated on the Upper Shotover. In the same year the only advance made around Alexandra, Clyde, and Cromwell was the granting of several special claims in these districts.

The only item of interest in the lower part of the district during 1891 was the construction of a pneumatic dredge to work in the gorge of the Clutha River below Alexandra: this was the property of a Melbourne syndicate. No new dredges were added to this district during that year, either in the lower or upper portions of it. If the wholesale cancellation of the claims in various parts of the district can be accepted as a criterion, then the industry received a decided set-back in 1891. It is claimed, however, that the bursting of the "boom" in the upper portion of the district was an important factor in promoting the permanency of the industry, because many of the dredges were purchased and removed to claims between Alexandra and Clyde in 1892. Here they became successful gold-producers. Spencer and party purchased the Kawarau Big Beach dredge, Hyde and party purchased the Frankton Beach, and other dredges were removed from time to time. The pneumatic dredge previously mentioned did not fulfil expectations. From this year the industry began to expand slowly, the extension of the application of dredges to auriferous gravels being assisted by the tailings-elevator designed by Cutten Bros., consulting engineers, Dunedin, and first erected on the Enterprise dredge at Alexandra in 1894. Dredges fitted with the tailings-elevator were enabled to work deeper ground, and also banks above water-level, as this application enabled them to dispose of their tailings to better advantage.

The late Mr. John Gow, Inspector of Mines, reporting in 1895, states, "The addition to the fleet of dredges on the Clutha River has been going on apace." New dredges were erected at Alexandra, Manuherikia, and Lowburn. The profitable working of many of the dredges on the Clutha River during 1895 made this branch of gold-mining for the time being the most important in Otago. It was in the year 1895 that the first Electric dredge was built and started to work, but it was not until 1896 that gold was struck on Cornish Beach. An interesting account of the history of this famous stretch of river will be found in Mr. James Horn's communication on the subject to the writer of this paper. It will be sufficient here to say that the apparently successful working of this dredge led to another period of claim-pegging. The Kawarau River was pegged out from Cromwell to the gorge, and the Clutha River from Cromwell to Rocky Point. The claims on the Clutha stretch of river were held awaiting results from Crookston and party's new dredge, which was about to start work.

Rapid strides were made in the industry in 1896, as it was found that there was practically no limit to the ground which could be worked by dredges. Beaches, banks, and flats could now be operated on with the greatest ease. The Manorburn Company's dredge got to work on the Manuherikia River, and at the end of the year there were twelve dredges in active operation on the river around Alexandra and Clyde.



O'Brien's Hydraulic Dredge, Lammerlaw River, Waipori, Otago.

It was said at the end of 1897 that the prospects of the dredging industry had never been so good as at that time. Thirteen dredges were at work around Clyde and Alexandra, three on the Manuherikia, and an additional five were being constructed on the Clutha at Alexandra, and three on the Manuherikia. All those working were doing remarkably well. On the other hand, a great measure of success had not attended operations on the Clutha at Lowburn, due, doubtless, to the depth of the ground and the smallness of the dredges. Below Cromwell the Hartley and Riley dredge was ready to receive machinery at the end of 1897. The Electric Nos. 1 and 2 were working, and No. 3 was nearly completed. The Golden Terrace Nos. 1 and 2 (formerly the Sew Hoy Big Beach) continued to work on the Lower Shotover, near Queenstown.

During 1898 there was a general tendency to build larger and more powerful dredges, and as examples may be taken the Magnetic and Electric No. 3 dredges, at Cromwell; the Earnscleugh No. 2 and the Golden Point dredges, at Alexandra. In later years still more powerful dredges were built —viz., the Dunstan Lead, Alexandra Lead, Earnscleugh No. 3 (electric), Rise-and-Shine, Rising Sun, &c.

During the year 1900 the phenomenal yields of the Hartley and Riley dredge and the dredges of the Electric Company caused a decided rush for dredging claims on all parts of the Clutha, Kawarau, Shotover, and other rivers and streams in Otago. At the end of 1900 there were fifty-one dredges at work in the Alexandra, Clyde, Cromwell, and Queenstown districts.

During the six years which have followed the year 1900 numerous changes have taken place. While some companies met with success from the start, and became dividend-paying concerns, it is to be regretted that very many were failures. The causes contributing towards this were many, chief among these being inefficient management, and in some cases still more inefficient machinery. However, as time went on, the weaker concerns became weeded out, as it was impossible for them to survive. The failures were most noticeable in the gorges of the various rivers. Experience has proved that the machine to work these claims successfully must be of a superior class to any that have yet been tried on these claims. In the gorges many things have to be contended with, such as hard bottom, tight wash, travelling drift, and short seasons. Judging from a hard crust broken through in the Alpine Consols Claim below Cromwell, and in the Meg and Annie Claim at Waitiri, below which good gold was found, it is possible that the operations of the gorge dredges have been carried on over this false bottom. There are long stretches of the river in the Alexandra Gorge, in the Cromwell Gorge, and in the Kawarau River, which, in spite of several dredges having been tried on them, are practically untried. The dredge to work these stretches must be large, powerful, and costly.

The most successful and permanent locality has been the large basin between Clyde and Alexandra, and here powerful dredges have been built to work the Dunstan and Earnscleugh Flats. By the adoption of machinery suitable to deal with deep, heavy ground, the life of dredging has been indefinitely prolonged in this district. The same remarks apply to the Clutha Basin around Lowburn. Here, again, powerful dredges have been working with success, and many more are being started. Beside these huge dredges the original vessels on the field are mere toys. There is an extensive field here for dredging should prospecting reveal the existence of payable auriferous wash.

With regard to improvements in methods of working, there are several worthy of note. Electricity has been successfully applied to drive the Fourteen-mile Beach and Earnscleugh No. 3 dredges; Payne and Peck's centrifugal elevator has been fitted on a large number of dredges, and has been proved to do satisfactory work, while at the same time minimising wear-and-tear. The latest idea is the substitution of the shaking-box in place of the revolving screen. As applied to the Rising Sun dredge, this appliance has been found to deal effectively with the material, while at the same time lessening the enormous wear-and-tear associated with the revolving screen.

Mr. James Horn, of Bannockburn, near Cromwell, who is the Electric Gold-dredging Company's local director, and who was one of the original promoters, has supplied the following graphic and interesting information respecting this company's claims and two dredges: "Electric Claim, containing 75 acres 3 roods 32 perches, and about one mile and three-quarters of the Kawarau River, starting near the rocky outlet of the Kawarau Gorge and extending down to near the Macandrew Bridge at Bannockburn, is one of two claims originally taken up by Messrs. Coote and Horn in January, 1890, under section 114 of 'The Mining Act, 1886.' It was held by the original owners for five years, and, although several attempts were made to float a company to work the ground, it was not till January of 1895 that final arrangements were concluded for the working of this now famous property. The failure of the fleet of dredges in the upper reaches of the Kawarau in 1888 and 1889 had given this river a bad name, and it was only by the faith and determination of the owners that Messrs. Horn Bros. and William Roy, of Bannockburn; Mr. Henry Young, of Cromwell; Messrs. Stewart Bros., of Scotland; and Messrs. McGeorge Bros., P. Duncan, B. Thorp, Barr, and Crow, of Dunedin, were induced to form a private partnership of thirteen shares in order to build a prospecting dredge. This dredge, known as No. 1, was built at the cost of £3,000, and started to work on the lower claim, known as the original Magnetic (now the New Cromwell) ground in August, 1895, but no gold was got till January of 1896, five months after the dredge started, when gold was got at the Cornish Beach in the present Electric Company's claim. No. 1 dredge worked on this claim from January, 1896, to November, 1897, and won 2,763 oz. of gold, valued at £10,657. This enabled the partnership to take up a third claim at Cromwell and build No. 2 dredge, which was placed on No. 3 claim, at the junction of the Kawarau and Clutha Rivers; also No. 3 dredge, which was launched by Lord Ranfurly, and named by him the 'Lady Ranfurly,' in 1898. This dredge started work in October, 1898, and won 755 oz. of gold for the first four weeks' work. In September, 1899, the partnership was formed into a registered company, or rather two companies — the Electric Gold-dredging Company and the Junction Electric Gold-dredging Company—the two lower claims, with Nos. 1 and 2 dredges, being the Junction Electric Company, and the top claim, with the 'Lady Ranfurly' dredge, the Electric Gold-dredging Company. Meanwhile—from October, 1898, to the date of registration of the companies (September, 1899)—the 'Lady Ranfurly,' for a period of eleven months, had won for the partnership 3,467 oz. of gold, valued at £13,317 19s.; this, added to the gold won by the No. 1 dredge, £10,637, gives a total of 6,250 oz., valued at £23,954 19s. Working for the company in July, 1900, the 'Lady Ranfurly' broke all previous dredging records for a week's work with 1,234 oz. In July, 1902, the Electric Company purchased the Magnetic Gold-dredging Company's dredge (sister ship to the 'Lady Ranfurly'), and since that date there have been two dredges working on the claim. In February, 1904, the newly acquired dredge lowered the 'Lady Ranfurly's' record with a return of 1,265½ oz. This dredge's return for a period of four weeks also established a new record for a month's work—viz., 30th January, 1904, 620 oz.; 5th February, 1,265½ oz.; 15th February, 611 oz. 15 dwt.; 20th February, 530 oz.: grand total for four weeks, 3,027 oz. 5 dwt., valued at £23,204 18s. 3d. In November, 1904, the 'Lady Ranfurly' again topped her sister ship with a return of 1,273 oz. for one week's work, but she failed to break the four weeks' record, her return being—15th October, 367 oz.; 22nd October, 529 oz.; 29th October, 606 oz.; and 5th November, 1,273 oz.. total for four weeks, 2,775 oz., being 252 oz. short of No. 2 dredge's record. The total gold won out of this claim from January, 1896, to date of last yearly balance (31st August, 1905) is as follows:—

	£	s.	d.
Amount won for partnership ..	23,954	19	0
Amount won for Electric Gold-dredging Company	149,960	8	11
Total	173,915	7	11

No. 1 dredge was the first steam dredge to work in the Cromwell district, and the 'Lady Ranfurly,' when built, was by far the largest dredge in the colony, and at the present day is among the best-equipped on the river."

Nevis.

Very little information has been recorded regarding the rise and progress of the dredging industry in the Nevis, but an intimate knowledge of the district enables the following narrative to be given :—

A considerable amount of gold was obtained by hand-labour and by hydraulic sluicing, until the advent of dredging in 1896. In that year nearly every available dredgable area of the Nevis River was taken up, but the erection of dredges proceeded slowly until the maximum number of six was reached. The ground has never been very rich, although fair returns have been obtained from time to time. The richer parts of the flat had been worked by hand-labour, and when the dredge came along this worked ground was reworked along with the poorer solid ground left by the early miners. Nature has provided this treeless tract of country with several seams of coal of good quality and thickness. These seams are all semi-vertical. The Lower Nevis dredges receive their coal-supply for about 12s. per ton delivered. The foregoing applies to that portion of the Nevis lying below the gorge which separates it from the Upper Nevis. At the Upper Nevis there is an extensive tract of flat and terrace land, covering several thousand acres. There are four sluicing claims working successfully at the Upper Nevis on the line of drift, skirting the foothills of the Remarkables Range; but what little dredging has been done there, as far as can be gathered, has been a failure up to the present. The line of drift alluded to is in close proximity to a fault-line, which is said to traverse the country, and the Upper Nevis apparently has geological conditions which are at present little understood. However, during the summer season of 1906–7 this extensive tract of country is to receive thorough prospecting on behalf of companies holding claims thereon. Prospecting hitherto has been retarded chiefly owing to the necessity for pumping-appliances, as the flat is very wet. Should payable ground be found, there will be an extensive field on the Upper Nevis, but every portion will require to be well prospected, as in the case of Waikaia.

Warden McCarthy reports that in 1896, at the Nevis River, the Nevis Gold-dredging Company put up a 10-horse-power dredge, which, for the short time it worked before the frost set in, got fairly good returns. Two other dredges were being built on the Nevis, and were expected to be ready to start in the early spring of 1897. The first machine placed on the Nevis River was the Nevis dredge, owned by the Nevis Gold-dredging Company. Formerly at the Kyeburn River, it was removed to Nevis, and started work in 1897. Unfortunately, the boiler and engine were too small for the work to be done at the Nevis. The ground was not rich enough for a dredge of this class, but with a powerful dredge would have yielded fair returns. Area of claim, 98 acres.

The New Nevis Gold-dredging Company was registered in November, 1901, to take over the assets of the Nevis Company (in liquidation). The working-expenses were about 8 oz. weekly. The dredge continued in operation until April, 1903, when the company sold the dredge to the New Era Gold-dredging Company, consisting chiefly of working shareholders. The dredge is still in operation in 1906, and has three years' work ahead yet. The results obtained are now satisfactory to the shareholders. The ground averages 8 ft. to 15 ft. in depth. Weekly cost of running, £39. 296,000 cubic yards turned over in 1905. Being a private company, the returns are not published.

The Ngapara No. 2 dredge, owned principally by the proprietors of the Ngapara dredge at Alexandra, started work on Nevis Flat about 1897, and has continued to operate with success ever since. There are still some years' work ahead of this company.

The Carrick dredge, owned by a registered company, was built to work a claim on the river at the Upper Nevis. The dredge did not make a success of the claim, and was transferred to a new claim about four miles below Nevis Township, where operations were resumed until 1903, when the dredge was purchased by the Crewe Gold-dredging Company, and shifted back to a claim higher up on the Nevis River. The dredge was fitted with a screen and elevator, and, as deep ground was struck, but little success was met with. During the summer of 1905 the screen and elevator were discarded, and the dredge was transformed into the sluice-box type.

The Success (Nevis) dredge started work in March, 1899, on a claim adjoining the Carrick. Operations were continued until 1902, when the company went into liquidation, and the dredge and claim were bought by the Crewe Gold-dredging Company. Since then the dredge has worked continuously during the dredging seasons with fair success, and is still in operation in 1906. As before stated, the Crewe Company hold the Crewe No. 2 dredge, on the Upper Nevis.

The Ngapara No. 3, owned by a registered company, started work early in 1900, and worked along without success until the summer of 1905–6, when the dredge was closed down permanently.

The Remarkables Gold-dredging Company purchased the Golden Spec dredge, Naseby, and transferred it in 1900 to a claim on the Nevis River, opposite the township. After a short period of work the dredge was unable to prove the claim payable, and was closed down. In 1903 the dredge was purchased by James Horn and party, and transferred to a claim at the Lower Nevis, owned by the Nevis Crossing Company. The dredge has been at work during the past three seasons with moderate success, and has several years' work ahead yet.

Mr. John Hayes, Inspecting Engineer, reporting for 1898, records that Allen and Aitken's claim of 22 acres at the mouth of the Nevis, where it junctions with the Kawarau River, was prospected by the Victoria Bridge dredge in 1898. Although coarse gold was obtained, the prospects did not warrant the expenditure on a new dredge. The Grand Junction No. 1 dredge also entered the Nevis-mouth in 1904 from the Kawarau River, but the ground was not found payable.

The Nevis district is about 1,800 ft. above sea-level, and the winters are very rigorous. Dredging operations generally cease about May or June, and are not resumed until August or September—that is, the dredges only work about thirty-two weeks in the year.

The ground operated upon is totally unfit for anything but grazing purposes, and therefore the question of the restoration of the surface is not considered; the dredges, being provided with elevators, leave the heavy open material on top.

The cost of working in this district runs about 1d. per cubic yard dredged.

There is now a sufficient number of dredges and hydraulic plants on the Lower Nevis Flat; but, as before stated, systematic boring, such as has been carried on at Waikaia with reliable results, would prove the existence or otherwise of an extensive dredging-field on the Upper Nevis.

Cardrona.

As a dredging-field Cardrona was first brought under public notice in 1890, when, in sympathy with the Sew Hoy Big Beach "boom," 1,190 acres were taken up in twelve special claims for dredging purposes. Some prospecting was done with boring-rods during that year. No dredges were, however, erected in this locality, and the holders abandoned their claims in 1891. In 1899 dredging claims were again taken up, and the Rolling Stone dredge started to work below Branch Creek. The whole valley was then pegged out for dredging, and in 1900 the White Star dredge was erected, and started to work with a fair show of success. The operations of the Rolling Stone did not meet with success, and the dredge was closed down after a few months' work. Several other dredges were erected during 1901, but only two were working at the end of the year. The Cardrona field, so far, had proved a disappointment, but it was reasonably believed that the dredges were not suitable for the class of ground. The only representatives of the industry in the district in 1906 are the Lone Star and Tuohy's Creek. The latter dredge is worked by O'Brien's system of applying water-power to dredges, and the former is now being converted from steam to the same power.

The opinion is still held by those who know the district that the whole length of the valley—a distance of over twenty miles—will pay for working, provided that the extent of auriferous wash is located by boring-rods, and suitable machines with large engine-power and bucket-capacity put on to work.

There is no agricultural land in this valley being dredged, as the ground is only suited for rough grazing purposes.

Naseby, Ophir, Matakanui, Taieri, and Cambrian's.

Spoon dredging was first tried on the Taieri River, near Hyde, by a Dunedin syndicate in 1889, and a number of dredging claims were taken up in the vicinity. The industry made slow progress until 1895, when a small bucket dredge was working at Hyde. Operations were, however, unsuccessful, and the dredge was removed to Kyeburn. In 1897 dredges were at work at Ophir and Naseby, and from that year the industry began to expand, dredges being built at Naseby, Kyeburn, Cambrian's, Matakanui, and Ophir. Warden Dalgleish reported in 1899 as follows: "A great deal of attention has been paid to dredging, leading to very noticeable activity in many portions of the district, but I regret very much that I am not in a position to report favourably on the results so far. Several of the companies which have been inaugurated for that class of mining have been compelled to cease operations Whether this has been caused by an actual scarcity of gold in the wash treated, or that defective dredges were built and placed on the claims, I cannot say with certainty, but I incline to the latter opinion. So far as I am informed, undoubtedly good prospects were obtained in every case before dredges were built and placed on the claims, but the issue in several cases has not been by any means equal to the prospects. I am of opinion that the preliminary prospecting carried out was not sufficiently exhaustive in many cases, and too hasty conclusions as to the payable nature of large areas were arrived at when only small portions of the whole were exploited. Many more dredging claims have been and still are being taken up, and there appears to be little or no doubt that most of them will be given a good trial. I may say that the whole district seems, in a mining sense, to be in a state of transition from a sluicing and elevating system to dredging."

The state of the industry at the end of the year 1900 may be gathered from the following report by Warden McEnnis: "It must be admitted that dredging has so far not been a success, such ventures having up to the present proved failures. The Naumai dredge, which has just commenced to work on the Main Kyeburn Creek, alone remains, and it is premature yet to say what its results will be. All other dredges in the vicinity have been dismantled, and removed from the district. On the Kyeburn Diggings some dredging claims have been taken up, and, no doubt, if the Naumai dredge should pay, dredges will be put on these claims. At Matakanui, dredging, as a method of extracting the precious metal, has not been successful. Great hopes were entertained from the operations of the Klondike dredge, but, unfortunately, either the gold was not in the ground or the saving appliances were not efficient. From the many reports as to the payable prospects obtained from the claim before the dredge commenced to work, I should be inclined to think that our present method of treating the wash obtained in dry-land dredging is not sufficiently advanced. The Blue Duck dredge has also made a start in Thompson's Creek, but so far its returns do not warrant great expectations. Several claims have been taken up in Ida Valley for the purpose of dredging. One company has been formed, but so far the directors have not thought it advisable to place a dredge on the claim. It is understood that the prospects were good, but the ground generally is shallow, and water not plentiful. At Ophir (Black's) the field is now left to a few fossickers. At the Serpentine the Pile-up Company, it is said, intends to place a dredge on ground in this locality. A number of dredging claims have been taken up on the Taieri River near Middlemarch, and a dredge (the First Taieri) was placed on a claim, but after working some time turned out a failure, chiefly, I think, because the dredge was too small and not powerful enough."

There are now, in 1906, only two dredges at work in the above districts—one at Poolburn, and one at Black's. The chief cause of failure of so many dredges may be set down to all or any of the following reasons: Hard, rough bottom; tight wash; scarcity of water; inefficient machinery and gold-saving appliances; or non-auriferous character of the ground. The district is essentially suited for sluicing, and this class of mining, assisted by the Government water-conservation scheme, has been successfully carried on for many years. There are still extensive tracts of auriferous ground which only require water to make them productive.

Macrae's and Shag Valley.

Dredging operations were first started in these districts in 1898. In the former district one dredge was started in 1898, and another in 1902. Neither of these dredges was successful. The chief causes of failure may be attributed to the presence of very stiff clay, and to the absence of a stream of running water. Under these conditions, it was impossible to properly treat the material and save the gold. In 1899 there were four dredges at work in the Shag Valley, above Palmerston; two of these continued to work until 1904, obtaining moderate returns. In the Shag Valley the depth of the ground worked by the dredges averaged 20 ft. The gold is found at that depth on a false bottom, consisting of pipe-clays and sands.

The land being dredged is fit for agricultural purposes, but no steps have been taken to restore the soil or loam to the surface. The dredges were fitted with elevators, and the material is piled up, with the larger material on top. The finer material is washed over the gold-saving tables, and finally escapes at water-level, the larger material covering it as the dredge advances. With the sluice-box dredge all the material is discharged together, and the ground has some likelihood of reverting to its original state in time.

At Macrae's a large area of auriferous ground, partly worked and partly unworked, is lying idle, awaiting a suitable appliance being designed for its efficient operation.

North Otago: Maerewhenua.

The following is an extract from Warden Keddell's report in 1901: "The Pioneer Company, holding a claim on the Maerewhenua River, on the Duntroon Road, purchased the Macrae's Flat dredge in 1900, and removed it to the claim, where work was started early in 1901. After working three or four months the ladder was found to be insufficiently long to bottom the ground, and the result was a failure. This was disheartening, not only on account of want of success in finding the gold which the company's former prospecting efforts had shown to exist, but because its failure will discourage other owners of dredging-areas to put on machines. In fact, the Maerewhenua Claim has never been properly tested yet. The Premier No. 1, a claim on the Awamoko, also started a dredge in 1901, and it was confidently expected it would be a success. The chief drawback to its success was the opposition to its being worked on any large scale, the Awamoko and its water-shed generally passing through private lands, whose riparian rights would be affected. This venture was not successful." These dredges were removed from the district, and the industry has been at a standstill. Rich alluvial ground has been worked for many years on the Maerewhenua and Livingstone diggings, and it is reasonable to expect payably auriferous ground to exist in the valley of the Maerewhenua River.

Tuapeka.

It is recorded that gold was first discovered in Tuapeka in 1856, on what is now known as Evans Flat Stream, but it was not until 1861, when Gabriel Read found gold in Gabriel's Gully, that the real auriferous character of the district became known. During the years that followed the flats were all turned over by hand-labour. When the ground became too poor to pay by this method, hydraulic sluicing and elevating was adopted. Dredging was first started in 1896, when Uren and party's dredge was constructed to work on Tuapeka Flat. In the same year James Robertson took up a special claim on

Weatherstone's Flat,* and started to re-erect a dredge purchased from McKenzie and party at Coal Creek. In 1898 there were five dredges working throughout the year—namely, the Record Reign, Harris and party's, Evans Flat, Tuapeka, and Balclutha dredges; while Smythe and party's dredge (late Robertson's) was working on Weatherstone's Flat. During 1900 the Record Reign was removed to Berwick, and the Reliance dredge was built. These dredges continued to work, the number being increased in 1901 by the erection of the Happy Valley dredge at Weatherstone's. Several of the dredges changed hands from time to time, and were dismantled when their claims were worked out.

During 1906 the Taniwha (formerly the Balclutha) dredge came to the end of its career on Labes's Flat, where the heavy clay and poor returns forced it to cease operations. The dredge was bought by the Labes Bros., who are dismantling her and selling the machinery, &c., as purchasers are found. The Reliance dredge (Harris and party) is now the only representative of an industry once represented by seven dredges.

The greater part of the ground turned over by these dredges consisted of old ground, 10 ft. to 14 ft. in depth, worked by hand-labour, assisted by Californian and Spear pumps. Much of it had been turned over several times by Europeans and Chinese. The dredges were thus enabled to put through a larger amount of material than would have been the case had solid ground been worked. This applies to a

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* *Weatherstone's* is variously spelt in different publications. Mr. James McKerrow, F.G.S., late Surveyer-General, on being asked by the Editor of the MINING HANDBOOK as to the correct orthography, courteously replied as follows: "In reply to your letter as to the proper spelling of *Weatherstone*, the name of a small settlement on a flat two miles from Lawrence on the road to Waipori, I have to state that a family of that name, in the early sixties, lived in a house on the line of the mountain-track, halfway between Dunedin and Port Chalmers. I did not know them, but I believe I am correct in stating that it was one of them who was the first to discover and open out a claim on the flat which now bears the name of Weatherstone's, just as in a similar manner the gully where Gabriel Read discovered gold was, and is, known as Gabriel's, situated close to, and partly in, Lawrence. The place where the Weatherstones had their house, on the track between Dunedin and Port Chalmers, is also known as Weatherstone's. In the late Professor Hutton's 'Geology of Otago,' published in 1879, he refers to *Weatherstone* and *Weatherstone's* in his explanation of the geology of the Tuapeka district. The other spellings which you give are evidently corruptions of *Weatherstone*."

great extent to the Waipori, Waitahuna, and Glenore dredging-fields also. The dredges were all of the sluice-box type, and by their operations transformed areas of mounds and hollows into level areas fit for cultivation, grass-growing, or tree-planting. As an instance of a typical dredge for this class of claim may be given the case of the Tuapeka Flat dredge. The pontoons were 60 ft. long and 24 ft. wide over-all, and were 4 ft. 6 in. deep. The buckets were of 3½ cubic feet capacity, and the ladder was 36 ft. long, and could dredge to a depth of 20 ft. The average depth of the ground was 12 ft.; the weekly expense of running about 6½ oz.; the gold-saving appliances consisted of a long sluice-box, 60 ft. in length by 4 ft. in width, and fitted with ripples and perforated steel plates on top of cocoanut matting and calico. The future working of the deposits in this district must be mainly on the extensive terraces which lie in the valley of the Tuapeka River. Powerful pumping plants are required in order to raise the necessary sluicing-water.

Waipori.

The Waipori Goldfield was discovered in December, 1861, when gold was found on the Verterburn, afterwards named the Post Office Creek. It developed into a rich and important alluvial field. The Waipori Valley is about twelve miles in length, and has an average width of half a mile. The Waipori River is a stream of considerable dimensions, and the flat is very wet; this prevented systematic working of the flat by hand-labour. Dredging was first introduced into this district in 1889, and solved the problem of the efficient working of wet auriferous ground. The industry was hampered considerably in 1893 by litigation regarding the alleged pollution of the stream, but ten years after there were thirteen dredges in the district. Waipori is the birthplace of two notable adaptations of water-power to dredges—namely, O'Brien's and Johnson's systems, each of which is detailed hereafter. Now, in 1906, with the exception of the holdings of the Consolidated and Perseverance companies, all the other claims are either worked out or only the poorer fringes left, and the dredges are passing into the hands of semi-private companies or parties of working shareholders. There are at present seven dredges in the district, only six of which are working. As regards the future prospects of the Waipori alluvial goldfield, there still remain possibilities for the investing capitalist. A deep, tortuous ravine, filled with gravel, traverses the entire length of the valley, proved to a depth of at least 80 ft by Charles McQueen in 1889. This may not have been the bottom, but it was proved that the whole distance passed through was more or less auriferous. During the present year J. T. Johnson has been operating the Bakery Flat water-power to bottom this deep lead with the hydraulic sluicing plant. A depth of over 60 ft. has been reached, and the material passed through is payably auriferous. It was to work this deep lead that Johnson's submerged-jet dredge was designed and constructed. It it certain that the dredging industry will be represented by one or more dredges for some years yet. Local people confidently look forward to the day when a cheaply worked plant of large dimensions, capable of raising and treating efficiently a very large amount of material, will be set to work to turn over the old worked ground in a wholesale manner. The power would require to be procured cheaply, and partake of the form of electricity, O'Brien's, Johnson's, or any other improved system.

The adaptation of water-pressure to the work of driving dredge machinery was applied by W. O'Brien, of Waipori, with considerable success in 1901. The patentee supplies the following particulars: "The pressure is obtained as in any ordinary hydraulic claim—viz., the water being conveyed in pipes down the slope of a hill. The water is conveyed on to the dredge from the bottom of the hill or edge of the paddock by means of a floating column of pipes, coupled with revolving joints, each joint to be fixed and supported by means of floating pontoons. The water-pressure, when conveyed on board the dredge, will work the turbine, Pelton wheel, or any other water-motor to drive the dredging machinery. The length of pipes and position of pontoons of floating column will be so arranged as to take up the smallest space up and down the hull of the dredge when close to the bank. The pontoons will be worked from the dredge, and can be so manipulated as to permit of the dredge being moved from side to side of the run or face with ease by the ordinary gear on board the dredge. A dredge can be built to work by the above method at a considerably less cost than those which are worked by steam-power, as there will be no expensive engines and boilers to provide for. The turbine or Pelton wheel will be placed at the same elevation as the sluice-boxes. The water discharged from the turbine or Pelton wheel, after working the machinery, will wash the stuff discharged from the buckets. The water-pressure provides a power which can be turned on at any moment. Water-power, where available, is the cheapest power known, and when used direct very poor ground can be made to pay. Advantages claimed: No fuel will be required; no engine and boiler to keep in repair; less oil and wear-and-tear; less labour required, as when the water-motor is once set to work it does not require attendants—therefore the second man on the dredge can attend to the lines, sluice-boxes, &c., and give any assistance which may be required."

In 1903 a new departure in dredge mining—applicable, however, to those places only at which hydraulic power is available—was made by J. T. Johnson, of Waipori, who supplies the following particulars: "The principle of the submerged-jet dredge is simply that of the hydraulic elevator adapted to the requirements of a dredge, and consists of ordinary dredge-pontoons, divested of boiler, engine, and bucket-ladder, these being replaced by an hydraulically driven Pelton wheel to work the winches, an hydraulic elevator in place of a bucket-ladder to raise the material to the shoots, and a breaking-down nozzle working on the submerged face to disintegrate the material. The power-supply is conveyed in a main pipe-line, as in ordinary sluicing, to the level line, supported by floats. The idea of submerging the line is to relieve the floats of the weight of the water in the pipes, and to enable a longer span of pipes to be carried from float to float, thus extending the length of the face reached by the flexible pipe-line. By carrying the last span underneath the dredge, the

SWIVELLING ARRANGEMENT FOR SUPPLYING WATER TO WORK GOLDEN BEACH DREDGE, ALEXANDRA.

machine is enabled to pass the flexible line to work first on one side of it and then on the other, thus doubling the length of face that can be reached when the flexible line works only on one side of the dredge. The flexible line connects on deck with a deck-pipe supplied with valves, by which the water is deflected as required to the elevating-jet, breaking-down nozzle, and Pelton nozzle. The first dredge of this type was worked at Waipori for seven weeks, the available quantity of water being fifteen heads. To utilise this, a $\frac{3}{8}$ in. tip was used on the Pelton-wheel nozzle, a $\frac{3}{4}$ in. tip on the breaking-down nozzle, and a 4 in. jet for elevating. The throat was 12 in. in diameter, and 15 in. outside diameter, with 15 in. disc for elevating-pipes. A right-angle bend on top deflected the discharge on to a drop-plate, 4 ft. by 6 ft., from whence it spread over a spreading-table 12 ft. by 12 ft., and from thence into three shoots, totalling 600 ft. of gold-saving area. The tables and shoots were fitted with perforated plates and angle-bar ripples. On starting, the lifting-power of the dredge proved too great for even the large shoots provided, and a regulator had to be provided at the intake to lessen the inrush of gravel, while, to break the force of the stream of water and material on the shoots, a hood was so placed as to moderate the current before it left the spreading-tables. I estimate the lifting-power of the dredge elevator at 1,000 tons per hour, while the capacity of the tables was 250 tons per hour, and no difficulty was experienced in gravel formation in keeping the tables going at their maximum treating-capacity. The same water used in hydraulic elevating to advantage lifted less than one-fifth of the material per week in the ordinary way."

The greater part of the Waipori Flat had been turned over by hand-labour, and before the advent of dredging hollows and hummocks covered the surface. The sluice-box type of dredge restored the ground to its former level surface, and vegetation is now springing up. Owing to the severity of the climate the district is only of use for grazing purposes.

It is now well recognised that future mining operations on Waipori Flat and the neighbouring gullies and terraces must be conducted on a large and cheap scale, in order to make low-grade ground pay for working. The improvement of some water-rights, and probably the amalgamation of others, is now occupying the attention of water-race owners. To this end also Messrs. W. and F. Knight are constructing a large storage-reservoir in Nardoo Creek, at a cost of £1,000. This water will be employed either for hydraulic sluicing and elevating or for driving dredges by water-power.

Waitahuna.

During the early part of the year 1893 Mr. Perry had a dredging plant on the Waitahuna River, opposite the Town of Havelock. This, however, dealt only with the more superficial deposits. Clays, lignites, and quartz drifts underlie the modern river-gravels over Waitahuna Flat, but the lower beds of these have never been prospected. In the lower grounds this would be a work of some difficulty, on account of the presence of water in greater quantity than could easily be dealt with, but towards the margin of the basin it might be possible to reach bottom. In the meantime nothing is being done towards prospecting these beds. This dredge continued to work under different ownerships until 1897, when a new and more powerful dredge was erected. Other dredges were also erected, and in 1902 there were five at work.

A notable example of the inefficiency of the bucket dredge to recover gold from rocky bottoms is the case of the Waitahuna Gully dredge. Since the closing-down of this dredge the claim has been worked by hydraulic elevating and sluicing, and is said to be paying well.

During the present year (1906) the Havelock and Imperial dredges still continue operations on their respective claims. The results of the hydraulic plant's operations on the Waitahuna Gully claim are quite satisfactory, and prove again the decided advantage sluicing has over dredging on hard and uneven bottom.

Before dredges were put on this ground the surface was just as the diggers and Chinese had left it. Now that the sluice-box dredges have passed through it, the surface is comparatively even, and were it not for the severe floods which visit this river the dredged area would be capable of growing good grass and clover. It is the intention of the Forestry Department to procure an area of the worked ground for tree-planting purposes.

Regarding future prospects of this district, as far as can be learned, apart from the present sluicing claims, which will last for many years to come, the lower beds of the valley below the false bottom may be worthy of prospecting by boring or otherwise.

Glenore.

Glenore is situated on the branch railway-line from Milton to Lawrence. Gold is said to have been discovered here by Edward Peters ("Black Peter") about 1858. In 1894 Warden Hawkins reported that Messrs. Nelson and party were busily engaged with their dredge at Glenore in working the old bed of the river, with most satisfactory results. This dredge worked up-stream from the Glenore Bridge. The depth of the ground operated on runs from 20 ft. to 35 ft., but no solid bottom has yet been touched. The lowest depth reached consists of a very stiff yellow clay, in which it is thought a small quantity of gold exists, and, of course, is being left behind at present. It is, however, intended at an early date to sink a prospecting shaft to the rock bottom a short distance below the bridge, in order to arrive at the value of the subsoil and yellow clay to the rock, and with the view also of opening another claim in that locality. The present dredge is said to be lifting about 12 yards per hour. The Gold Bank dredge was erected in 1896, and in 1897 Robertson and party's dredge was erected. These three dredges were very successful in their operations, some of the weekly returns from the Stirling and Woolshed dredges being as high as 40 oz.

The Riverbank and Adams Flat dredges were erected during 1899, but about this time the industry was considerably hampered by the opposition of the farmers and land-holders on the Tokomairiro Plain. It was alleged that the dredging operations caused pollution of the stream. By the end of 1900 there were two dredges at work—namely, the Gold

Bank and the Stirling—and these continued to work up to 1905, when the Stirling sank. The Gold Bank, now working under private ownership, continues to work with moderate success.

Several of the dredges in this district were operating on agricultural land, but, owing to the fact that they were fitted with elevators, no attempt was made to restore the surface of the land to its former condition. As is the case with all dredging operations where elevators are used, the fine silt and loam is buried under the loose, clean tailings. Where silt-elevators are used, discharging into the main elevator, the material becomes more intermixed, but the surface is not levelled, as is the case with sluice-box dredges.

Tapanui.

Dredging operations have been carried on from time to time on the Pomahaka River, Tapanui district. In 1887 Gannon and party had a small dredge on the river, but it did not pay. One or two other dredges were started later on, and in 1896 there were three dredges, with buckets of 1 cubic foot capacity, at work above Conical Hills; but these dredges were all too small to be successful. In 1900 the Ardmore dredge, a privately owned concern, started work. This was also a rather small dredge, but it proved the ground to be payable, so that in 1904 the owners dismantled it and erected a powerful up-to-date dredge, which is still at work. This district has lately attracted renewed attention as a dredging-field, and several claims have been pegged out. A new dredge was started during 1906, and more will follow should its operations be attended with success. Each claim should, however, be thoroughly prospected to ascertain the value and extent of the auriferous wash before a dredge is put on.

The Ardmore dredge has been operating mainly on private lands which are used for agricultural purposes. A hinged extension of the sluice-box is used sometimes for top-stripping to restore the soil to the surface. Dredging operations in this district should be so conducted that agricultural areas would be restored to their former state as far as possible.

SOUTHLAND DISTRICT.

Waikaka.

This is a valley about nineteen miles in length, and containing over 5,000 acres of dredgable land. The main Waikaka Stream traverses the valley the greater part of the length, but at the Forks the Big Waikaka and Little Waikaka Streams join together. It was in 1896 that the late J. R. Perry took up a special claim and erected a dredge thereon. About the same time William McGill also applied for a special claim and prepared to place a dredge upon it. These two dredges continued to work with satisfactory results in 1897 and 1898, and during the latter year J Marr and party and W. Little and party were engaged building dredges for their claims. Other claims were also taken up, as it was recognised that a very large portion of the land was suitable for dredging. During 1899 much interest was taken in dredging operations, and a good deal has been done in the development of that industry, particularly in the valley of the Waikaka, where five dredges were at work and six were in course of construction. Dredging operations were considerably hampered by the opposition of the settlers and Messrs. Wallis Bros., fellmongers, to the application which was made to have the Waikaka River declared a sludge-channel. At the end of 1900 there were eleven dredges at work in the Waikaka Valley, and two in course of construction. Thirteen dredges were in operation at the end of 1901, and one in course of erection; three of these were privately owned. During 1902 there was every indication that the industry was in a prosperous condition and likely to expand. There were nineteen dredges at work at the end of that year, six of these being privately owned. Several dredges were built in the lower portion of the valley, the earlier dredges being situated on the Big or the Little Waikaka, or at the Forks. The number of dredges increased during 1903 from sixteen to twenty, twelve of these being owned by parties of a private or semi-private nature. Messrs. McGeorge Bros. acquired large areas of land on the Big Waikaka, and erected dredges with large power and bucket-capacity. The ground requires to be turned over rapidly to secure good returns. The number of dredges continued to increase during 1904, and on the 31st December there were twenty-eight dredges in this field; but this number dropped to twenty-seven during 1905. Although there are large areas of land in the lower valley which have not yet been dredged, it is safe to assume that the number of dredges on this field will never be much larger. New dredges may yet be brought into the district, but several of the older ones are fast working out their claims. Perry's dredge, the pioneer of the field, ceased operations recently, and has been dismantled. This district has been fortunate in possessing large deposits of lignite, which can be mined and conveyed to the dredges at a reasonable cost. The ground averages 12 ft. to 14 ft. in depth, and consists mainly of a heavy layer of clay overlying a few feet of auriferous gravel. Large areas of the land are low-lying and swampy, and practically useless even for grazing purposes.

The advent of the sluice-box dredge may be looked upon as a blessing in this locality. The actual result of dredging is that these areas are drained, the gravels and clays become intermixed, and the surface is raised several feet higher than the original surface. This ground is fit to grow root-crops, grass, clover, or trees. Extensive tree-planting has been done in the lower part of the valley. Several dredges on the Big Waikaka are probably dredging the best agricultural land in the district, but Messrs. McGeorge Bros. have taken steps to return the finer material to the surface of the dredged tailings by means of a silt-distributor. This appliance has been adopted on several dredges with apparently satisfactory results.

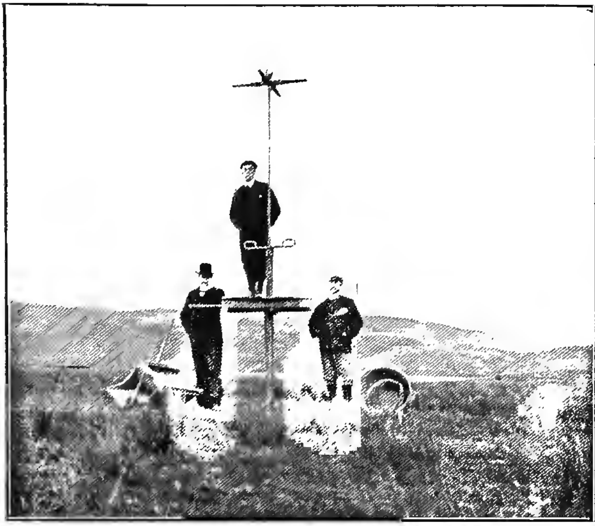
Waikaia.

In 1890 Gow's Creek was the scene of dredging operations, but the ground was too poor to pay working-expenses, and the several claims taken up were abandoned on that account. In 1894 Messrs. Munro and party placed a dredge on the Dome Creek, where good prospects were said to have been obtained. This venture was also a failure, and the dredge was removed from the district. The next dredge to be built belonged to the Golden Crown Gold-dredging Company, and cost £3,500. This dredge was erected in 1897, but failed to make a success of the claim, and was closed down, being subsequently removed to Shag Valley. In 1898 renewed attention was paid to this district, and claims were taken up at Glenary and Growler's Flat, Upper Waikaia. The Nugget Company's dredge, Growler's Flat, started to work in 1899, and continued to work until 1900, during which year the Dome Creek dredge was also built. Neither of these dredges turned out a success, and both were closed down during the year. In spite of these failures the Garvey Burn, Day Dawn, and Switzers dredges were in the building stages during that year. Warden Cruickshank reported for the year 1901. "Dredging, so far, has been a failure in this district. For the nine months ending the 31st December, 1901, no less than twenty-seven special-claim licenses were surrendered and the claims given up. The Mystery Flat Dredging Company's dredge has recently started, and gives promise of turning out a success, having obtained 72 oz. of gold for one week's work. The above dredge is the only one at work in the district." For the year 1902 Warden Cruickshank reports: "Mining in this locality has maintained a fairly even tenor throughout the year. The dredges at work—viz., the Mystery Flat and the Muddy Creek—have yielded very consistent payable returns for some time past, and in consequence of these returns a lot of prospecting has been done, and the results having proved satisfactory four new dredges are being built, one for each of the following companies: Fairdown Dredging Company, Garryowen Company, Nugent Wood Company, and Hessey Dredging Company. I have ascertained on reliable authority that about 2,600 oz. of gold has been won in this district for the year."

The result of prospecting by means of boring was to prove extensive and rich gold-bearing leads traversing the valley through freehold properties. These lands were sold to the dredging companies on cash and royalty terms, and the erection of dredges was proceeded with during 1903. When these dredges got to work they obtained good returns, and the success of the district as a dredging-field began to be assured. In 1904 Warden Cruickshank stated in his annual report: "The dredging industry in this subdistrict, I am pleased to report, has gone on improving, and there are now ten dredges working in the locality, all on payable gold, some of them getting very handsome returns, and paying the owners and shareholders large dividends. The revenue collected by the Receiver of Gold Revenue for rents, &c., amounted to £300 for the year. I am informed on good authority that the local bank at Waikaia purchased 5,200 oz. of gold during the year, and it is estimated that at least 1,600 oz. have been disposed of outside the bank, making a total of 6,800 oz., valued at about £27,000, which, I think, must be considered very good indeed. Of course, the hydraulic elevating and sluicing claims in the district have assisted in the above production."

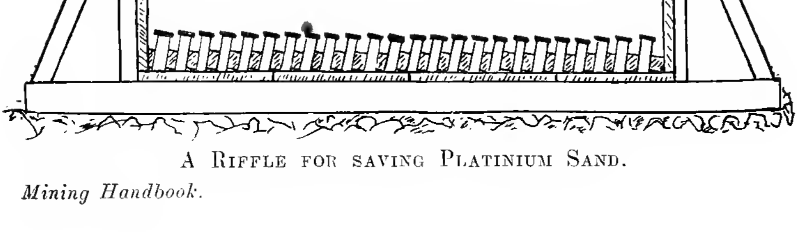
At the end of 1905 the dredges in this district were the Argyle, Hessey's, Mystery Flat, Masterton, Duke of Gordon, New Fairdown, Te Aroha, Waikaia, Waikaia Kia Ora, Lady Annie, Lady Gordon, Muddy Creek (Limited), Nugent Wood, Garryowen, and Magnum Bonum.

During the year 1906 the Argyle Hydraulic Sluicing Company's dredge, driven by water-power, was erected, and dredging was commenced. The system of applying the motive power is an improvement on the practices in other districts. In O'Brien's application small wooden pontoons are introduced to support the pipes and swivel connections. In the system adopted on the Argyle dredge these pontoons are discarded. The main pressure-line is 11 in. in diameter. At the 11 in. terminal a swivel joint is placed. Thence the water is conveyed through a span of 9 in. piping, 66 ft. in length. Another swivel joint is placed at the end of this span, and underneath the swivel a wheel is placed which travels on a single rail curved to a 66 ft. radius. The water is finally conveyed on board the dredge in 9 in. piping. The main machinery is driven by a 4 ft. Pelton wheel, placed upon the deck, with belt connections. Water for the sluice-box is procured by means of an ordinary jet elevator, thus doing away with the wear-



Prospecting at Waikaia, Southland: Glossop's Boring-platform.

Mining Handbook.



A Riffle for saving Platinium Sand.

Mining Handbook.

and-tear attached to centrifugal pumps. A small 22 in. Pelton wheel drives the dynamo for tho electric lights. This claim was worked for several years by hydraulic sluicing and elevating, but since dredging has been commenced the company is convinced that the present system is the better method, both with regard to cost and treatment of the ground. The method has since been applied to the Golden Beach dredge, Alexandra South, with success.

Prospecting by means of boring is still being carried on, and dredges are being erected as the gold-bearing runs are located. There is still an extensive field here for prospecting both above and below Waikaia Township. The district has been provided with good deposits of coal, and the dredges are supplied with fuel at a reasonable cost.

When the dredges first started on this field their operations were confined to the river-bed and low-lying parts adjacent thereto, and the question of restoring the soil to the surface did not crop up; but since the extension of dredging operations away from the river on freehold agricultural lands this question has arisen. In two cases, where the dredges are fitted with elevators, the ground is apparently being destroyed for all time. The majority of the dredges are of the sluice-box type, and at least leave the surface level behind them. The soil in this district is light; hence it will be a long time before the surface of the tailings becomes covered with soil. The use of a silt-distributor, as used on Waikaka, would, by throwing the silt on the tailings, assist in the restoration of the surface.

Charlton Creek, Gore.

The Charlton Creek Company's dredge started work about the beginning of 1900, and yielded satisfactory returns from the commencement. The Central Charlton was being erected during the year. The Lady Charlton was erected in 1901, and these three dredges were in operation at the end of that year. The number of dredges was increased by the addition of the MacCharlton and Charlton Valley dredges, which were at work during 1902. In 1903 the Lady Charlton and the Charlton Valley companies went into liquidation, and their dredges ceased operations. In 1904 the Lady Charlton was removed from the valley, but the Mill Creek Freehold dredge was erected and put to work, and the Charlton Valley dredge resumed operations under private ownership. The other three machines continued to operate successfully, and there are still, in 1906, five dredges at work in the Charlton Valley.

The ground operated on is for the greater part low-lying, and only suited for grazing purposes. As in other parts of Southland, the sluice-box dredge has considerably improved this land by draining it and raising the surface in height. The ground is now fit for growing good grass or trees.

Waimumu.

The Waimumu Gold-dredging Company's dredge commenced to work in 1899. This was the first dredge to start, but others followed in quick succession until, in 1901, there were seven dredges at work in the valley. Several of these were very successful in their operations, while others were not. At first these dredges were all owned by public companies Now, in 1906, there are five dredges at work in the district, three of which are privately owned. There is a good supply of lignite in the neighbourhood, and this fuel is delivered at the dredges at a cheap rate.

With regard to the restoration of the land after dredging, much can be said in favour of the dredging operations in this valley. Before dredging commenced the valley was low-lying and swampy, and totally unfit for agricultural purposes. Owing to its swampy nature it was also a menace to cattle. Since the advent of the dredges the ground has been turned over, raised in height, and drained, and is now capable of being converted into pasture lands.

Mataura River.

In 1889 a dredge was placed on the Mataura River, about three miles and a half above the Township of Fortrose, by an Invercargill syndicate. They leased the bucket dredge from the Invercargill Harbour Board, and fitted it up with appliances for gold-saving. The operations were mostly of a prospecting character, and sufficient gold was not obtained to pay working-expenses. In 1900 Crookston's Mountaineer dredge was at work on the Eureka Claim, Mataura. The Otama dredge was also working on the Mataura River, and the Milestone dredge started work at the junction of the Nokomai Creek with the Mataura River. Messrs. Graham Bros. built a dredge in 1899 to work a claim about a mile above Gore, but being privately owned the returns were not made public. During 1900 the Mataura River, from Mataura Township to Riversdale, a distance of about thirty miles, was taken up under special dredging claims or prospecting licenses. In the same year the Central Mataura Gold-dredging Company purchased the dredge and claims of Graham Bros., and erected a second dredge. There was also the Mataura Consolidated (late Eureka) dredge, working at Mataura Island. During 1901 the industry received a decided set-back on this river; most of the claims granted were surrendered, and the only dredges at work were the Central Mataura No. 2 and the Mataura Consolidated. None of the above-mentioned dredges were successful in their operations, and all ceased work and were removed from the river, with the exception of the Central Mataura No. 2. This dredge changed ownership several times, and is now held by a private party, who are said to be working with moderate success.

It is quite apparent that the valley is payably auriferous in places, but it is wide, and the runs of gold are too far apart to make it possible to work the claims to advantage with the present appliances. There is an enormous area of dredgable ground in the Mataura Valley, but only by systematic boring can the payable areas be located. Suitable dredges to work this ground would require to have large power and bucket-capacity. An up-to-date dredge is being erected this year (1906) about two miles below Gore Township.

Waipapa: Waiau.

Two special claims, having frontages of half a mile, were taken up in 1887 at Bushy Point, with the intention of working them with Welman dredges. The Waipapa Creek Gold-mining Company got a Welman suction dredge to work satisfactorily in 1888, but the dredge started in old worked ground near the Waipapa Creek. There were six special claims held on the Waipapa Beach at that time, for some of which machines were ordered. The Waipapa Creek Company continued dredging operations during 1889 on poor ground. This was the only beach claim using a Welman dredge, but four of these machines were on their way from England. The Lake Brunton Dredging Company, on Waipapa Beach, expected to commence operations in June, 1890. Steps were also being taken about this time to get other claims worked at the mouth of the Waiau River, as it was believed that the Welman dredge would inaugurate a new and prosperous era in gold-mining. Warden Rawson reported in 1891 that the Waipapa Creek Gold-mining Company had been wound up and re-formed under the name of the Waipapa Dredging Company. The yield of gold for the year ending the 31st March, 1891, was 190 oz. 14 dwt. The Lake Brunton Gold-dredging Company commenced work in February, 1891, as a beach-dredging company, and the Six-mile Beach Dredging Company in March, 1891, while the machinery for the Otara Gold-dredging Company arrived from England in May, 1891. Towards the end of 1891 the Waipapa Company installed a larger Welman pump. It was stated that for the year ending September, 1890, this dredge obtained about 1,000 oz. of gold. The Lake Brunton Company continued to work until early in 1892, when operations were suspended. Two dredges were erected during 1891—one for the Otara Company and one for the Bushy Point Company. These dredges were fitted with Gwynne's centrifugal pump. The Six-mile Beach Company carried on operations very successfully during 1891 on its claim, five miles north of Waipapa Point. It was found, however, that while these dredges could lift the necessary amount of material they could not effectively treat it with the gold-saving appliances then in use; the gold, being very fine, required special care in the saving process. These dredges were consequently forced to cease operations. In 1895 the agents of a wealthy South African syndicate secured special claims on the Six-mile and Waipapa Beaches. It was then stated that the syndicate was prepared to spend £25,000 to test these beaches by the cyanide process; but the proposal fell through. In 1898 a number of dredging claims were taken up on the Upper Waiau River, also on Lake George, near Round Hill, and at Colac, and a suction dredge was erected on the Waiau River. This principle was not a success, and the dredge was converted to a bucket dredge in 1899. This dredge (the Belmont) continued to work, off and on, on various portions of the river with indifferent results, and was sold in 1902 to Mr. Francis Jack, of Winton. The dredge was shifted to the mouth of the Waiau River, and was unfortunately wrecked there in 1903. Owing to the want of success attending the operations of this machine no other dredges were put on this river.

Since the wreck of the Belmont there have been no dredges in the Wyndham, Orepuki, and Waiau districts, but it is proposed to erect a dredge at Lake George this year (1906). As a dredging-field this portion of the district has great possibilities, provided suitable appliances are available for saving the fine gold.

Some Particulars of Dredging Operations.

Alexandra-Eureka, Molyneux (or Clutha) River, Alexandra.—Area, 60 acres. The Alexandra-Eureka Gold-dredging Company was registered in November, 1899, and commenced work the same month. The material, which is dredged from a depth of 22 ft. to 23 ft., consists of three-fifths of sand and gravel and two-fifths of stones. During the year 1905 the yield of gold was 1,440 oz. 5 dwt., valued at £5,873 11s. 11d.; total yield of gold since dredge first commenced work, 8,807 oz. 8 dwt., valued at £33,981 2s. 9d., out of which dividends have been disbursed amounting to £14,250. Cost of dredge, £6,000; average weekly cost of work, £40; average yearly cost of repairs, £300. Length of pontoons 95 ft., depth 5 ft. 10½ in., beam 25 ft. 10 in.; ladders capable of dredging 31 ft.; capacity of buckets (34), 4½ cubic feet; rate of discharge per minute, 11. Length of gold-saving tables, 15 ft.; breadth, 12 ft. Peck and Payne's centrifugal elevator in use. Height of unworked face above water-line, 7 ft. to 12 ft. Average number of weeks worked, 47; average number of men employed, 6. Dredgemaster, Charles Curno; secretary, Andrew Hamilton, Dunedin.

Alexandra Lead, Alexandra.—Area, 82 acres. The Alexandra Lead Gold-dredging Company was registered in July, 1899, and commenced work in February, 1902. The claim embraced a part of the Molyneux (or Clutha) River, abutting on the Township of Alexandra, which is now worked out. The dredge, whilst working in the river, won some handsome returns, viz.:—

Week or period ending—

			Oz.	dwt.	gr.	£	s.	d.
June 25,	1902	...	155	10	0	598	3	6
July 2,	,,	...	253	0	0	974	1	0
,, 5,	,,	...	348	12	0	1,342	4	3
,, 16,	,,	...	366	0	0	1,409	2	0
,, 23,	,,	...	216	13	0	834	2	0
,, 30,	,,	...	148	6	0	570	19	1
Aug. 6,	,,	...	413	0	0	1,590	1	0
,, 13,	,,	...	190	9	0	731	10	9
,, 20,	,,	...	160	9	0	617	16	6
,, 27,	,,	...	166	15	0	642	0	0
Sept. 3,	,,	...	204	18	0	788	17	3
,, 10,	,,	...	220	11	0	849	4	6
,, 17,	,,	...	213	14	0	822	14	10
,, 22,	,,	...	302	8	0	1,164	4	9

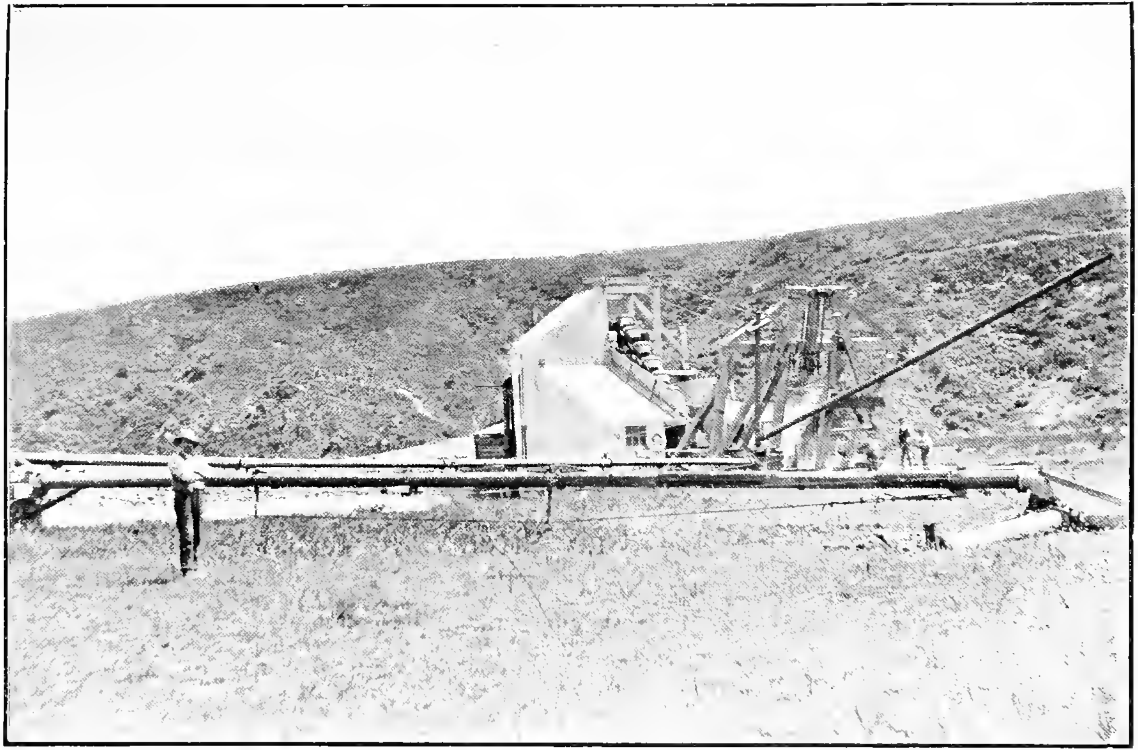
For the six months ending the 28th February, 1903, the dredge won 2,101 oz. of gold, valued at £8,221; but since the bank was dredged the returns have dropped down to an average of about 22 oz. per week. The dredge is one of the largest operating on the Molyneux River, and is now working a face of 45 ft. above water-level and 23 ft. (on soft rock bottom) below water-level. Eventually the top stuff will have to be sluiced off, and arrangements can be made for the lease of water for that purpose. The Molyneux Hydraulic Company's dredge is working the adjoining ground, and is getting fair returns. During the year 1905 the Alexandra Lead dredge won 647 oz. of gold, valued at £2,506, making a total of 7,064 oz., valued at £27,355. Dividends have been paid amounting to £14,033, as against a called-up capital of £17,521. The dredge cost £13,734, the average weekly cost of working being £78 10s. The ladders are capable of dredging to a depth of 40 ft., and there are 34 buckets, each having a capacity of 7 cubic feet, with an average discharge of 12 per minute. The materials now operated on are dredged from a depth of about 23 ft., the average quantity raised per hour being 130 tons. The pontoons are 125 ft. in length, with a depth of 10 ft. and a beam of 46 ft. The average number of weeks worked is 40, and 9 men are employed. Dredgemaster, Charles Simonsen; secretary, R. T. Wheeler, Dunedin.

Ardmore, Scrubby Flat, near Kelso.—Area, 100 acres. The dredge, which is privately owned, commenced work in February, 1900, at Scrubby Flat, near Kelso, in Tuapeka County. The material, dredged from a depth of 14 ft. to 24 ft., consists of heavy wash, but without clay; average quantity raised per hour, 65 cubic yards. During the year 1905 an area of 5 acres was worked, the quantity treated being 343,200 cubic yards; yield of gold, 641 oz. 7 dwt., valued at £2,469 5s. Total quantity of gold obtained since dredge first began work, 2,616 oz. 0 dwt. 18 gr.; value, £10,073 5s.; out of which dividends were disbursed up to the 31st December, 1905, amounting to £1,650. Capital called up, £2,800. Cost of dredge, £1,500; average weekly cost of working, £48; average yearly cost of repairs, £300; yearly cost of fuel, £750. Length of pontoons 95 ft., depth 7 ft., beam 29 ft.; ladders capable of dredging 20 ft.; capacity of buckets (32), 4½ cubic feet; rate of discharge per minute, 11. Average number of weeks worked, 48; average number of men employed, 8. Dredgemaster, Thomas Gillespie; secretary and part owner, J. F. Herbert, Kelso.

Argyle, Waikaka Valley.—Area, 130 acres. The Argyle Gold-dredging Company was registered in December, 1902. The material is dredged from a depth of about 14 ft.; average quantity raised per hour, 75 cubic yards. During 1905 an area of about 18 acres was worked, the quantity treated being 480,293 cubic yards; yield of gold, 1,090 oz.; value, £4,432. Total quantity of gold obtained since dredge first commenced work, 3,385 oz.; value, £13,517 16s. 2d. Capital actually called up, £6,000; dividends declared, £3,600. Cost of dredge (including cost of erecting), about £3,900; average weekly cost of working, £50. Length of pontoons 80 ft., depth 6 ft. 10 in., beam 27 ft.; ladders capable of dredging about 14 ft.; capacity of buckets (30), 4¾ cubic feet; rate of discharge per minute, about 12. Length of gold-saving tables, 70 ft.; breadth, 4 ft. 9 in. Average number of weeks worked, 49; average number of men employed, 10. Dredgemaster, David Caithress; secretary, Alexander Mutch, Waikaka Valley.

Argyle, Winding Creek, Waikaia.—Area, 69 acres. This dredge is owned by the Argyle Hydraulic Sluicing Company, which carries on hydraulic sluicing and dredging at Winding Creek, Waikaia, in Southland. Rough gravel wash is operated on from surface to bottom, the depth dredged being from 16 ft. to 29 ft.; average quantity raised per hour, 80 cubic yards. During the year 1905 an area of 5 acres was worked; yield of gold, 416 oz., valued at £1,622 8s. Amount of capital called up, £1,200. Cost of dredge, £1,600; cost of other plant, £2,640. Average weekly cost of working, £30; average yearly cost of repairs, £150, and of water-power, &c., £125. Length of pontoons 74 ft., depth 5½ ft., beam 29 ft.; ladders capable of dredging 28 ft.; capacity of buckets (38), 4½ cubic feet; rate of discharge per minute, 12. Size of gold-saving tables, 280 square feet. Number of weeks worked, 48; average number of men employed, 7. Dredgemaster, J. W. Stewart; secretary, R. T. Stewart, Waikaia.

Central Charlton, Charlton Creek, near Gore.—Area, 100 acres. The Central Charlton Dredging Company was registered in December, 1899. Hard gravel is operated on to a depth of about 15 ft.; average quantity raised per hour, 22½ cubic yards, or 30½ yards including clay. For the financial year October, 1904, to October, 1905, an area of 8 acres was



ARGYLE DREDGE, WAIKAIA. (Driven by Water-power.)

worked; quantity treated, 193,600 cubic yards; yield of gold, 1,133 oz. 12 dwt. 6 gr., valued at £4,378 3s. 9d. Total quantity of gold won since dredge first commenced work in October, 1900, 4,767 oz. 5 dwt. 6 gr.; value, £18,553 8s. 1d Fifteen dividends of 1s. per share have been declared, amounting to £5,250; capital called up, £5,300. Cost of dredge, £5,000; average weekly cost of working, £50; cost of dredging for the year—wages £1,200, coal £500, repairs £550, making a total of £2,250. Length of pontoons 57 ft., depth 5 ft., beam 25 ft.: ladders capable of dredging 15 ft.; capacity of buckets (28), 3¼ cubic feet; rate of discharge per minute, 11. Length of gold-saving tables, 40 ft. by 3½ ft. and 4½ ft. Average number of weeks worked, 47; average number of men employed, 8. Dredgemaster, James McCorkindale; secretary, H. F. M. Mercer, Dunedin.

Crewe No. 1, Nevis.—Area, 100 acres. The Crewe Gold-dredging Company was registered in September, 1902, and commenced work the same month. Ordinary river-wash is operated on to a depth of 20 ft. to 25 ft.; average quantity raised per hour, 50 to 60 tons. During the twelve months an area of 10 acres was worked, the yield of gold being 543 oz. 10 dwt., valued at £2,081 8s. 9d. Total quantity of gold produced since dredge first commenced work, 1,697 oz. 13 dwt. 7 gr., valued at £6,494 9s. 10d.; capital called up, £3,000. Cost of dredge, £2,081; average weekly cost of working, £50; yearly cost of repairs, £500. Length of pontoons 66 ft., depth 5 ft., beam 26 ft.; ladders capable of dredging 15 ft.; capacity of buckets (29), 4½ cubic feet; rate of discharge per minute, 12½. Length of elevator, 40 ft.; height of unworked face, 2 ft. to 10 ft. Average number of weeks worked, 40; average number of men employed, 7. Dredgemaster, J. Williamson; secretary, W. S. Laidlaw, Alexandra.

Crewe No. 2, Upper Nevis.—Area, 100 acres. This dredge is owned by the Crewe Gold-dredging Company. Ordinary river-wash is operated on to a depth of 25 ft.; quantity raised per hour, 50 tons. During the twelve months an area of about 3 acres was worked, yielding 43 oz. of gold, valued at £168. Cost of dredge, £2,078; average weekly cost of working, £50; average yearly cost of repairs, £500. Ladders capable of dredging about 35 ft.; capacity of buckets (30), 4½ cubic feet. Average number of weeks worked, 37; average number of men employed, 7. Dredgemaster, J. Bardsley; secretary, W. S. Laidlaw, Alexandra.

Charlton Creek, Charlton Valley.—Area, 100 acres. The Charlton Creek Gold-dredging Company was registered in May, 1899, and commenced work in January, 1900. Quartz gravels and boulders are dredged from a depth of 18 ft.; average quantity raised per hour, 30 yards of gravel, and 30 yards of stripping done. During the year 1905 an area of 8⅙ acres was worked, the quantity treated being 403,200 cubic yards; yield of gold, 866 oz. 10 dwt., valued at £3,365 0s. 8d. Total quantity of gold obtained since dredge first commenced work, 5,378 oz. 7 dwt., valued at £20,846 8s., out of which dividends amounting to £4,875 have been disbursed; capital called up, £4,000. Cost of dredge, £3,256 11s. 1d.; average weekly cost of working, £35; average yearly cost of repairs, £500; yearly cost of fuel, £515. Length of pontoons 66 ft., depth 5 ft., beam 21 ft.; ladders capable of dredging 22 ft.; capacity of buckets (30), 3¾ cubic feet; rate of discharge per minute, 11. Length of gold-saving tables, 60 ft.; breadth, 4 ft. Average number of weeks worked, 49; average number of men employed, 9. Dredgemaster, Charles Bennett; secretary, Andrew Hamilton, Dunedin.

Electric No. 1 (Lady Ranfurly), Cromwell.—Area, 75 acres 3 roods 32 perches. The Electric Gold-dredging Company was registered on the 2nd September, 1899, but the syndicate that sold to the company began work in October, 1898. Quartzose gravel and schist, with hard wash, stones, and ironsand are dredged from depths varying from 30 ft. to 50 ft., the average quantity raised per hour being 75 cubic yards. During the year 1905, 4 acres of ground was worked, and 380,250 cubic yards treated by the two dredges, for 4,704 oz. of gold, valued at £18,241 12s. 3d., making a total of 41,196 oz., valued at £160,092, for the two dredges; and dividends were disbursed amounting to £116,350. The capital called up is set down at

£26,000, which represents on the company's books the value of claim and two dredges. The ladder is capable of dredging to a depth of 44 ft., and the elevator has a length of 35 ft. Thirty-six buckets, aided by three grabs, discharge at the rate of 10 per minute over gold-saving tables 17 ft. by 18 ft., each bucket having a capacity of 5 cubic feet. The pontoons are 108 ft. long, with a depth of 7 ft., and a beam of 25½ ft. The materials treated are about equal portions of fine sand, fine gravel, and heavy stones, the depth from which they are dredged varying from 25 ft. to 50 ft. below water-line. Dredgemaster, William M. Orr; secretary R. T. Wheeler, Dunedin.

Electric No. 2, Cromwell.—The Electric No. 2, originally the Magnetic dredge, and sister ship to the Electric No. 1 (Lady Ranfurly), was built in 1898, and commenced work in February, 1899, on the Magnetic Claim, immediately above the Electric Claim, and gave very good results for the first year or so; but the returns gradually got poorer as the dredge worked ahead. Eventually the Magnetic Company went into liquidation, and the dredge was purchased for £2,750 by the Electric Company in 1902, and worked for some months on the old claim with indifferent results. She was then shifted down to the Electric Claim, and commenced work there in March, 1903, winning 2,126 oz. of gold for the season's dredging. Right at the start of the following season the dredge struck very rich gold, and on the 5th February, 1904, broke the record for the best week's return with 1,265 oz.; also establishing the following other records:—

	Oz.	dwt.	gr.
Fortnight ending 5th February, 1904 ...	1,885	15	0
Month ending 19th February, 1904 ...	3,025	17	0
Twelve months ending 31st December, 1904	7,366	18	0

The week's record was lost to the sister ship (Lady Ranfurly) on the 4th November, 1904, with 1,273 oz., but the other records still remain unbroken. The later operations of the Electric No. 2 dredge have not been so successful. The season of 1905 only yielded 1,037 oz., while the results for the 1906 season have so far been only moderate. Dredgemaster, Andrew Hedley.

Endeavour, Roxburgh.—Area, 80 acres. The Endeavour Gold-dredging Company was registered in May, 1906. The material operated on is very hard and tight, and is dredged from a depth of 40 ft. During 1905 only fourteen weeks were worked, the value of gold obtained being £1,793 15s. Cost of dredge, £1,300; cost of coal, £60 per month. Length of pontoons 110 ft., depth 7 ft., beam 30 ft.; ladders capable of dredging 45 ft.; capacity of buckets (40), 6 cubic feet; rate of discharge per minute, 11. Length of elevator, 80 ft. Number of men employed, 8. Dredgemaster, August Magnus; secretary, P. R. Parker, Roxburgh.

Ettrick, Ettrick.—Area, 99 acres. The Ettrick Gold Steam Dredging Company was registered in August, 1890, and commenced work in September, 1891. Fine gravel wash is dredged from a depth of about 25 ft.; average quantity raised per hour, 150 yards. During the year 1905, 750,000 cubic yards was treated, yielding 865 oz. 18 dwt. 7 gr. of gold, valued at £3,333 14s. Total quantity of gold since dredge first commenced work, 8,868 oz. 16 dwt. 11 gr., valued at £34,137 15s. 7d., out of which dividends have been paid amounting to £5,240; capital called up, £8,366 5s. Cost of dredge, £8,259 9s. 5d.; average weekly cost of working, £54 10s.; average yearly cost of repairs, £425; yearly cost of fuel, £687. Length of pontoons 100 ft., depth 7 ft., beam 31 ft.; ladders capable of dredging 35 ft.; capacity of buckets (40), 4½ cubic feet; rate of discharge per minute, 12; length of elevator, 75 ft. There are five gold-saving tables, each 16 ft. in length and 3 ft. in width. Average number of weeks worked, 40; average number of men employed, 8. Dredgemaster, Arthur P. Burton; secretary, Jabez Burton, Roxburgh.

First Chance, near Alexandra.—Area, 21 acres. The First Chance Gold-dredging Company was registered in June, 1902. River-gravels are dredged from depths varying from 10 ft. to 48 ft.; average quantity raised per hour, 120 cubic yards. Yield of gold during 1905, 559 oz. 12 dwt. 9 gr.; value,

£2,165. Total quantity of gold since dredge first commenced work, 2,825 oz.; value, £9,944. Total dividends declared, £3,150; capital called up, £7,006. Cost of dredge, £7,000; average weekly cost of working, £115; yearly cost of repairs, £1,158; yearly cost of coal, £445. Length of pontoons 104 ft., depth 6 ft., beam 11 ft. 10 in.; ladders capable of dredging 42 ft.; capacity of buckets (40), 4¾ cubic feet; rate of discharge per minute, 11. Length of gold-saving tables, 14 ft. by 17 ft. Average number of weeks worked, 22; average number of men employed, 9. Dredgemaster, Samuel Hoy; secretary, C. S. Reeves, Dunedin.

Golden Bed, Miller's Flat.—Area, 98 acres 3 roods. The Golden Bed Dredging Company was registered in May, 1899. Alluvial and river wash was operated on to a depth of 50 ft. to 60 ft., 50 per cent. passing through ⅜ in. holes; average quantity raised per hour, 3,000 cubic feet. During the twelve months an area of 5½ acres was worked; quantity treated, 16,743,000 cubic yards; yield of gold from the 1st June, 1905, to the 31st May, 1906, 2,682 oz. 17 dwt. 16 gr., valued at £10,440 8s. 4d. Total quantity of gold since dredge first commenced work on 21st December, 1900, to the 31st May, 1906, 7,854 oz. 6 dwt. 21 gr., valued at £30,556 4s. 5d.; dividends declared to that date, £7,004 16s., equal to 11s. per share on the capital, the amount actually called up being £12,736. Cost of dredge, £9,126 13s. 11d.; cost of other plant and claim, £3,195 16s. 5d. Average weekly cost of working, £88; average yearly cost of repairs, £1,300; yearly cost of coal, £890. Length of pontoons 102 ft., depth 6 ft., beam 27 ft.; ladders capable of dredging 45 ft.; length of elevators, 110 ft. (centres); capacity of buckets (42), 5½ cubic feet; rate of discharge per minute, 13; height of unworked face above water-line, about 25 ft. Length of gold-saving tables, 12 ft.; breadth, 21 ft. Average number of weeks worked, 40; average number of men employed, 8. Dredgemaster, A. E. Maitland; secretary, Edward Trythall, Dunedin.

Golden Gate, Miller's Flat.—Area, 45 acres. The Golden Gate Dredging Company, which was registered in March, 1895, commenced work in November of the same year. The wash is dredged from a depth of 25 ft.; average quantity raised per hour, about 100 cubic yards. During the year 1905 an area of 6 acres was worked, the quantity treated being about 500,000 cubic yards, yielding 732 oz. 17 dwt. 17 gr. of gold, valued at £2,821 10s. 10d. Total quantity of gold since dredge first commenced work, 13,049 oz. 0 dwt. 11 gr., valued at £50,250 1s. 3d., out of which dividends have been disbursed amounting to £23,250, while the called-up capital has only been £2,500. Cost of dredge, £2,986 13s. 6d.; average weekly cost of working, £44; average yearly cost of repairs, £250; yearly cost of fuel, £462 11s. 3d. Length of pontoons 90 ft., depth 5 ft., beam 9 ft. each; ladders capable of dredging 30 ft.; capacity of buckets (39), 4¼ cubic feet; rate of discharge per minute, 12. Length of elevator, 30 ft.; height of unworked face above water-line, 30 ft. Average number of weeks worked, 50; average number of men employed, 7. Dredgemaster, David Ballintyne; secretary, Jabez Burton, Roxburgh.

Golden Run, Miller's Flat.—Area, 80 acres 2 roods 35 perches. The Golden Run Dredging Company was registered in June, 1891, and commenced work in 1892. The materials operated on, dredged from a depth of about 33 ft., consist of fine gravel with heavy body of sand, the richest ground carrying red wash on a soft yellow bottom; average quantity raised per hour, 400 cubic yards. During the year 1905, 2,128,000 cubic yards was treated, yielding 2,740 oz. 16 dwt. 13 gr. of gold, valued at £10,552 2s. 7d. Total yield since dredge first commenced work, 16,983 oz. 2 dwt. 3 gr. of gold, valued at £65,383 12s. 3d., out of which dividends have been disbursed amounting to £13,718 15s.; capital called up, £9,414. Cost of dredge, £10,528 16s. 4d.; cost of dam, £664 6s. 7d.; water-race and dam, £182 1s. 11d.; cost of electric plant, £400. Average weekly cost of working, £88; average yearly cost of repairs, £1,284; yearly cost of fuel, £1,017. Length of pontoons 112 ft., depth 8 ft., beam 35½ ft.; ladders capable of dredging 35 ft.; capacity of buckets (39), 6½ cubic feet; rate of discharge per minute, 12. Length of elevator, 90 ft.; height of unworked face above water-line, 30 ft. Average number of weeks worked, 37; average number of men employed, 10. Dredgemaster, Charles H. Monson; secretary, Jabez Burton, Roxburgh.

Golden Treasure, Miller's Flat.—Area, 90 acres 3 roods 6 perches. The Golden Treasure Dredging Company was registered in July, 1893, and commenced work in June, 1894. Cement, loose gravel, and clay are the materials operated on, and are dredged from a depth of 34 ft. below water-line and 20 ft. above; average quantity treated per hour, 70 tons. During the year 1905 an area of 5 acres was worked; quantity treated, 435,600 cubic yards; yield of gold, 1,732 oz. 13 dwt. 20 gr., valued at £6,670 15s. 6d. Total quantity of gold obtained since the dredge first commenced work, 12,615 oz. 17 dwt. 19 gr., valued at £48,570 1s. 2d., out of which dividends have been disbursed amounting to £17,831 4s., while the called-up capital has only reached £1,384 5s. 4d. Cost of dredge, £2,231 9s. 7d.; cost of other plant, £147 7s. 3d. Average weekly cost of working, £45; average yearly cost of repairs, £600; yearly cost of fuel, £717. Length of pontoons 100 ft., depth 6 ft., beam 28 ft.; ladders capable of dredging 40 ft.; capacity of buckets (40), 5 cubic feet; rate of discharge per minute, 12; length of elevator, 75 ft. Average number of weeks worked, 45; average number of men employed, 8. Dredgemaster, John C. Cornish; secretary, Jabez Burton, Roxburgh.

Gold King, Dumbarton, Tuapeka County.—Area, 87 acres. This dredge is owned by the Gold King dredging party, who commenced work on a bank claim in August, 1905. River-wash is dredged from a depth of 50 ft.; average quantity raised per hour, 120 tons. During the year 1905 an area of half an acre was worked, yielding 386 oz. of gold, valued at £1,491. Total yield of gold since dredge began operations, 854 oz., valued at £3,291. Capital actually called up (fully paid), £10,500. Cost of dredge, £2,000; average weekly cost of working, £50. Length of pontoons 113 ft., depth 7½ ft., beam 33 ft.; ladders capable of dredging 52 ft.; capacity of buckets (50), 6 cubic feet; rate of discharge per minute, 12.

Length of elevator, 105 ft.; height of unworked face above water-line, 40 ft.; depth of auriferous gravel or wash below water-line, 35 ft. Dredgemaster, David Mitchell; chairman, Edward Hart, Roxburgh.

Graham and Party, Waikaka Valley.—Area, 90 acres. Work was commenced by the owners in July, 1903. White-quartz wash is operated on to a depth of 10 ft. to 18 ft.; average quantity raised per hour, 80 yards. Yield of gold during 1905, 602 oz.; value, £2,408. Total yield of gold, 1,758 oz.; value, £7,032. Cost of dredge, £3,000; cost of land, £1,000. Average weekly cost of working, £35; average yearly cost of repairs, £500; yearly cost of fuel, £360. Length of pontoons 80 ft., depth 6 ft., beam 27 ft.; capacity of buckets (34), 4¼ cubic feet; rate of discharge per minute, 10. Length of gold-saving tables, 64 ft.; breadth, 5 ft. Average number of weeks worked, 46; average number of men employed, 8. Dredgemaster, John Bradbury.

Grogan and Party, Miller's Flat.—Area, 56 acres. This dredge commenced work in June, 1904. The material operated on consists of drift wash, dredged from a depth of 30 ft. During the year 1905 an area of 6 acres was worked, the quantity treated being 5,806,080 cubic yards. The dredge, which was purchased second-hand, cost £200; average weekly cost of working, £34; average yearly cost of repairs, £514; yearly cost of fuel, £368. Length of pontoons 90 ft., depth 5 ft., beam 10 ft.; ladders capable of dredging 45 ft.; capacity of buckets (40), 4 cubic feet; rate of discharge per minute, 12; length of elevator, 40 ft. Average number of weeks worked, 42; average number of men employed, 6. Dredgemaster and secretary, E. T. Kitto, Miller's Flat.

Harris and Party, Tuapeka Flat.—Area, 25 acres. Blue gravels and clay are dredged from a depth of 10 ft. to 14 ft.; average quantity raised per hour, about 120 cubic yards. During the year 1905 an area of 17 acres was worked; yield of gold, 274 oz., valued at £1,059. Cost of dredge, £450; average weekly cost of working, £27; average yearly cost of repairs, £90; yearly cost of fuel, £260. Length of pontoons 70 ft., depth 5 ft., beam 25 ft.; ladders capable of dredging

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20 ft. to 25 ft.; capacity of buckets (29), 3¾ cubic feet; rate of discharge per minute, 12. Average number of weeks worked, 44; average number of men employed, 7. Dredgemaster, John Harris.

*Hartley and Riley,** Cromwell.—Area, 32 acres. The Hartley and Riley Beach Dredging Company was registered in July, 1897. The nature of the material operated on varies, and is obtained at an average depth of 35 ft., the quantity raised per hour being about 100 yards. During 1905 an area of 2 acres was worked, yielding 674 oz. 13 dwt. 18 gr. of gold, valued at £2,608 0s. 6d. Total quantity of gold since dredge started up to the 31st December, 1905, 27,564 oz.; value, £106,625. Dividends were paid amounting to £79,625, equal to £12 5s. per share; while the capital called up was only £6,300. Two of the most successful week's returns from this dredge were in March, 1900, 1,187 oz. 14 dwt., and in October, 1903, 1,158 oz. 19 dwt. 11 gr. Cost of dredge, £6,300; cost of other plant and claim, £200. Average weekly cost of working, £65; yearly cost of repairs, £665; yearly cost of coal, £589 2s. Length of pontoons 96 ft., depth 6 ft. 3 in., beam 26½ ft.; ladders capable of dredging 36 ft.; capacity of buckets (42), 4½ cubic feet; rate of discharge per minute, 11 (about 100 yards). Length of elevator, 40 ft.; height of unworked face above water-line, 20 ft. The dredge works about nine months out of the year, and gives employment to nine men. Dredgemaster, George McLay; secretary, D. Crawford, Dunedin.

Hessey's Waikaia, Waikaia.—Area, 100 acres. Hessey's Gold-dredging Company was registered in July, 1902. During the year 1905 an area of 12 acres was operated on, yielding 1,222 oz. 7 dwt. 10 gr. of gold, valued at £4,810 15s. 6d. Total yield since the dredge first commenced work in July, 1903, 3,134 oz. 13 dwt., valued at £12,346 17s. 3d., out of which dividends have been disbursed amounting to £4,000; capital called up, £3,700. Cost of dredge, £3,700; average

* Spelt Reilly in Blue-book at the period of early gold discoveries in Otago.

weekly cost of working (including fuel, repairs, maintenance, &c.), £59 8s.; average yearly cost of repairs, £378 2s. 5d.; yearly cost of coal, £675 17s. 10d. Length of pontoons 81 ft., depth 5 ft., beam 25 ft.; ladders capable of dredging 23 ft.; capacity of buckets (37), $3\frac{3}{4}$ cubic feet; rate of discharge per minute, 13. Average number of weeks dredge worked, 49; average number of men employed, 10. Dredgemaster, George Pettigrew; secretary, W. E. C. Reid, Dunedin.

Hydraulic Motor Dredge, Waipori, Tuapeka County.—Area, 54 acres. The Hydraulic Motor Gold-dredging Company was registered in February, 1904, and during the following year an area of 8 acres worked gave 357 oz. 10 dwt. of gold, valued at £1,376 8s. 10d.; but as the ground did not prove suitable for dredging the company changed to hydraulic elevating.

Ibbotson and Party, Little Waikaka.—Area, 64 acres. This party commenced dredging in September, 1903. The material is very difficult to work, as the greater portion is heavy clay, only a small quantity of wash being available. During the year 1905 an area of 7 acres was worked, the quantity treated being 33,000 cubic yards, yielding 622 oz. 19 dwt. of gold, valued at £2,491 16s. Total quantity of gold produced, 1,300 oz. 16 dwt.; value, £5,203. No dividends have been paid, profits being devoted towards building two new dredges. The first dredge owned by the party was purchased for £500; its original cost was £2,500. Average weekly cost of working, £33; yearly cost of repairs, £354 11s. 2d.; yearly cost of fuel, £374 13s. Length of pontoons 66 ft., depth 3 ft. 5 in., beam 24 ft.; ladders capable of dredging 22 ft.; capacity of buckets (30), 3 cubic feet; rate of discharge per minute, 10. Length of gold-saving tables, 60 ft.; breadth, 3 ft. Average number of weeks worked, 50; average number of men employed, 7. Dredgemaster and secretary, Donald McKenzie, Little Waikaka.

Junction-Electric, Cromwell.—Area, 31 acres. The Junction-Electric Gold-dredging Company was registered on the 2nd September, 1899, but work was commenced on this claim in June, 1897. The company had three dredges working up to Christmas, 1905; but in March, 1906, one of the dredges was lost through foundering in the river, and another dredge was sold a month previously. The dredge at present owned by the company is working the No. 2 claim; the dredge that was lost was working on No. 1 claim. Total quantity of gold obtained by the three dredges, 16,469 oz., valued at £63,753; the yield for the year 1905 being 2,650 oz. 10 dwt., valued at £10,277. Dividends have been disbursed amounting to £22,750, as against a called-up capital of £26,000. The materials operated on are very rough, consisting of two parts of gravel, one part of fine sand, and one part of heavy stones, and are dredged from depths varying from 15 ft. to 35 ft., the quantity raised per hour by one dredge being 100 cubic yards; and for the year 1905 about 100,800 cubic yards was treated. The present dredge (formerly known as the Cromwell Company's No. 2 dredge) was purchased for £750. The ladder is capable of dredging to a depth of 51 ft.; the buckets have a capacity of 5 cubic feet, and discharge at the rate of 12 per minute. The elevator is 33 ft. in length, and the pontoons 100 ft., with a depth of 7 ft. and a beam of 26 ft. At the highest point the unworked face is 25 ft. above water-line, the depth of the wash below water-line varying from 8 ft. to 20 ft. Average cost of working, £75; number of weeks worked during year, 42; number of men employed, 9. Dredgemaster, Alexander Ross; secretary, R. T. Wheeler, Dunedin.

Kelso, near Kelso, Tuapeka County.—Area, 32 acres. The Kelso Dredging Syndicate was registered in August, 1905, but did not commence work until the following March. Heavy gravel wash is operated on, the material being dredged from a depth of 18 ft. Cost of dredge, £1,275; average weekly cost of working, £40; average yearly cost of repairs, £200. Length of pontoons 85 ft., depth 5½ ft., beam 25 ft.; ladders capable of dredging 16 ft.; capacity of buckets (33), 3½ cubic feet; rate of discharge per minute, 11. Dredgemaster, George Linklater; secretary, Charles Todd, Heriot.

Lady Annie, Waikaia.—Area, 55 acres. The Lady Annie Gold-dredging Company was registered in November, 1904, and commenced work a few days after registration. Quartz gravels are dredged from a depth of 25 ft., the average quantity raised per hour being 2,100 cubic feet. During the year 1905 an area of 12 acres was worked, the quantity treated being about 640,000 cubic yards, yielding 1,539 oz. 11 dwt. 11 gr. of gold, valued at £6,127 17s. 10d. Total yield of gold since dredge first commenced work, 1,682 oz. 10 dwt. 3 gr., valued at £6,681 15s. 1d., out of which dividends have been disbursed amounting to £2,520. The company's nominal and subscribed capital is £4,200, but only £14 was actually called up in cash. Cost of dredge, &c., £4,200; average weekly cost of working (including fuel, repairs, and maintenance), £75 2s. 10d.; average yearly cost of repairs, £727 16s. 7d.; yearly cost of fuel, £615 0s. 1d. Length of pontoons 76 ft., depth 5 ft., beam 25 ft.; ladders capable of dredging 21 ft.; capacity of buckets (32), 3½ cubic feet; rate of discharge per minute, 12½; length of elevators, 42 ft. (centres). Average number of weeks worked, 49; average number of men employed, 8. Dredgemaster, W. A. Johnston; secretary, W. E. C. Reid, Dunedin.

Lee and Party, Waikaka Valley.—Area, 100 acres. Work was commenced in August, 1902. The wash consists of fine gravel drift, dredged from a depth of 9 ft. to 11 ft.; average quantity raised per hour, 65 yards. During the year 1905, 266,000 cubic yards was treated, yielding 788 oz. of gold, valued at £3,224. Total quantity of gold since dredge first commenced work, 2,295 oz., valued at £9,166, out of which dividends have been paid amounting to £518. Cost of dredge, £3,000; average weekly cost of working, £50; average yearly cost of repairs, £700; yearly cost of fuel, £500. Length of pontoons 89 ft., depth 7 ft., beam 18 ft.; ladders capable of dredging 18 ft.; capacity of buckets (38), 3½ cubic feet; rate of discharge per minute, 10½. Average number of weeks worked, 45; average number of men employed, 8. Dredgemaster, S. W. Wilson; secretary, Miss C. Burns, Dunedin.

Lilliesleaf, Waikaka Valley.—Area, 166 acres. The Lilliesleaf Gold-dredging Syndicate commenced work in April, 1901, the material operated on consisting of loose wash dredged from an average depth of 11 ft. During the year 1905 an area of about 15 acres was worked. Cost of dredge, £3,450; cost of other plant, £90. Average weekly cost of working, £44; average yearly cost of repairs, £540; yearly cost of fuel, £720. Length of pontoons 72 ft., depth 5 ft., beam 24 ft.; ladders capable of dredging 20 ft.; capacity of buckets (32), 3¾ cubic feet; rate of discharge per minute, 11. Dredgemaster, R. S. White; secretary, W. Crawford, Waikaka Valley.

Loch Lomond.—Area, about 20 acres on the Fraser River. The Loch Lomond Gold-dredging Company was registered on the 20th February, 1903. Ordinary river-wash is operated on from an average depth of 10 ft. or 12 ft., the deepest ground dredged being about 16 ft. Six acres was worked during the year 1905 for 609 oz. 17 dwt. 5 gr. of gold, valued at £2,350 7s. 5d., making a total to the 31st December, 1905, of 1,001oz., value £3,860 3s. 3d.; whilst the called-up capital amounts to £1,975, and paid-up shares have been issued to the value of £500. The dredge, which was originally known as the Shepherd's Creek dredge, at Bannockburn, was purchased for £500, and was taken to pieces and rebuilt on the claim, lying back in the hills between Bannockburn and Clyde, on the Fraser River. The dredge is rather small for the claim she has to work, as the river is full of heavy stones; but if the machine can manage to drop back from where she is now working, near the head of the claim, there is a piece of ground, lately bought by the company from a private party, which is expected to turn out well; the difficulty in the way is the tailings that have been stacked up along the course of working, which may prevent the dredge getting down. The ladder is capable of dredging to a depth of 20 ft., and there are 26 buckets and two grabs, the buckets having each a capacity of 3¾ cubic feet, and discharging at the rate of 10 per minute. The elevator is 45 ft. in length; pontoons, 70 ft., with a depth of 5 ft. and a beam 26 ft. Average number of weeks worked during year, 34; number of men employed, 7. Average weekly cost of working, about £60; yearly cost of repairs, £300. Dredgemaster, Alexander McLean; secretary, James Goodger, Cromwell.

Lone Star, Cardrona.—Area, 100 acres. The Lone Star Dredging Company commenced work in February, 1902, and registered the following month. Rough, heavy wash and gravels are dredged from a depth of 8 ft. to 20 ft.; average quantity raised per hour, 45 cubic yards. The yield of gold up to the end of the financial year (30th April, 1906) was 829 oz., valued at £3,269 16s. 6d. Total yield up to same date, 2,746 oz. 2 dwt. 6 gr., valued at £10,772 18s. 8d., out of which dividends were paid amounting to £540; capital called up, £600. Cost of dredge, £4,260; cost of other plant, £189 14s. 9d. Average weekly cost of working, £44 17s. 9d.; yearly cost of repairs, £386 8s. 6d.; yearly cost of coal, £766 2s. 10d. Length of pontoons 70 ft., depth 5 ft., beam 24 ft.; ladders capable of dredging 24 ft.; capacity of buckets (33), 3½ cubic feet; rate of discharge per minute, 10. Average number of weeks worked, 40; average number of men employed, 10. Dredgemaster, John Williamson; secretary, W. T. Monkman, Dunedin.

McGeorge Bros.' Freehold No. 1, Waikaka River.—Area, 198 acres. This dredge commenced work in November, 1902. Fine quartz gravel is dredged from a depth of 12 ft., and during the year 1905 an area of 20 acres was worked. Cost of dredge, £5,000; average weekly cost of working, £50; average yearly cost of repairs, £500; yearly cost of coal, £600. Length of pontoons 80 ft., depth 6 ft., beam 27 ft.; ladders capable of dredging 20 ft.; capacity of buckets (30), 6 cubic feet; rate of discharge per minute, 10. Average number of weeks worked, 48; average number of men employed, 8. Dredgemaster, J. B. C. Watt; secretary, Joseph McGeorge, Dunedin.

McGeorge Bros.' Freehold No. 2, Waikaka River.—Area, 400 acres. This dredge commenced work in May, 1904. Fine quartz gravel is dredged from a depth of 12 ft. to 14 ft., and during the year 1905 an area of 20 acres was worked. Cost of dredge, £5,000; average weekly cost of working, £50; average yearly cost of repairs, £500; yearly cost of coal, £600. Length of pontoons 80 ft., depth 7½ ft., beam 27 ft.; ladders capable of dredging 20 ft.; capacity of buckets (28), 6 cubic feet; rate of discharge per minute, 10. Average number of weeks worked, 48; average number of men employed, 8. Dredgemaster, George McVicker.

Manuherikia, Coal Creek, Alexandra Gorge.—Area, 27 acres 2 roods. The Manuherikia Gold-dredging Company was registered in November, 1899, and commenced work in October, 1900. River-wash is dredged from a depth of 45 ft. to 50 ft.; average quantity raised per hour, 40 tons. During the year 1905 an area of 1½ acres was worked, yielding 778 oz. 17 dwt. of gold, valued at £2,924 6s. 4d. Total yield of gold since dredge first commenced work, 14,939 oz. 2 dwt., valued at £45,568 2s. 6d., out of which dividends have been disbursed amounting to £26,700; capital called up, £6,000. Cost of dredge, £9,487 5s. 8d.; average weekly cost of working, £50; average yearly cost of repairs, £450; yearly cost of fuel, £366. Length of pontoons 105 ft., depth 6½ ft., beam 27 ft.; ladders capable of dredging 54 ft.; capacity of buckets (44), 5 cubic feet; rate of discharge per minute, 13; length of elevator, 46 ft. Average number of weeks worked, 15; average number of men employed, 8. Dredgemaster, Louis Anderson; secretary, Andrew Hamilton, Dunedin.

Marshall's Freehold, Waimumu, near Mataura.—Area, 134 acres. Work was commenced in June, 1903. River-wash and clay are dredged from depths varying from 4 ft. to 20 ft., heavy timber being sometimes met with during operations. About 12 acres was worked during the year 1905, yielding 787 oz. of gold, valued at £2,939 13s. 5d. Total yield of gold since dredge commenced work, 1,682 oz., valued at £6,376, out of which dividends have been disbursed amounting to £1,575 up to the 31st December, 1905, and £700 since that date; capital called up, £3,500. Cost of dredge (purchased second-hand) and erection, £1,950; cost of other plant, £70. Average weekly cost of working, £34; average yearly cost of repairs, £400; yearly cost of fuel, £421 7s. Length of pontoons 66 ft., depth 5 ft., beam 25 ft.; ladders capable of dredging 20 ft.; capacity of buckets (30), 3½ cubic feet; rate of discharge per minute, 12. Average number of weeks worked, 49; average number of men employed, 9. Owners, Marshall Bros., Waimumu.

Masterton, Waikaia.—Area, 97 acres 2 roods. The Masterton Gold-dredging Company was registered in January, 1904. The materials operated on are marine, lake, and alluvial river-wash, the depth varying from 14 ft. to 24 ft. During the year 1905 an area of about 22 acres was worked, yielding 2,112 oz. 4 dwt. 23 gr. of gold, valued at £8,295 8s. 10d.; and since first commencing work in September, 1904, 2,810 oz. 4 dwt. 4 gr., valued at £11,014 12s. 2d., out of which dividends have been disbursed amounting to £6,500; capital called up, £3,500. Cost of dredge, £3,100; average weekly cost of working (including fuel, repairs, maintenance, &c.), £60 6s. 3d.; yearly cost of repairs, £646 4s. 8d.; yearly cost of fuel, £726 12s. 4d. Length of pontoons 81 ft., depth 7 ft., beam 30 ft.; ladders capable of dredging 26 ft.; capacity of buckets (30), $4\frac{1}{2}$ cubic feet; rate of discharge per minute, 13. Average number of weeks worked, 45; average number of men employed, 8. Dredgemaster, Edward Lawson; secretary, W. E. C. Reid, Dunedin.

Matau, Molyneux River, below Clyde.—Area, 99 acres and 33 perches. The Matau Dredging Company was registered in October, 1897. The gravels operated on are dredged from various depths, and about 100 tons per hour are raised. During the year 1905, 864 oz. of gold, valued at £3,311 7s. 9d., was obtained, making a total of 9,460 oz., valued at £36,438 5s. 11d. Dividends disbursed amounted to £15,225, being at the rate of £2 3s. 6d. per share, while the capital actually called up in cash amounted to £6,200. Cost of dredge, £6,450 6s. 3d.; cost of electric-light plant, £220. About 15 oz. of gold pays all weekly expenses; average yearly cost of repairs, £479; yearly cost of fuel, £629. Length of pontoons 100 ft., depth 6 ft., beam 29 ft.; ladders capable of dredging to a depth of 40 ft. below water-level; capacity of buckets (38), 4 cubic feet; rate of discharge per minute, 12; length of elevator, 48 ft. Average number of weeks worked, 35; average number of men employed, 8. Dredgemaster, John Sanders; secretary, E. R. Smith, Dunedin.

Mill Creek, Charlton.—Area, 100 acres. The Mill Creek Freehold was registered in November, 1903. Quartz wash,

MacGeorge Bros.' No. 1 Dredge, showing Extended Sluice-box.—The Heavy Materials are seen falling at the First Drop, while the Fine Materials are being carried out and spread on the Surface.

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mixed with grey and black sand, is dredged from depths ranging from 10 ft. to 32 ft., the average quantity raised per hour being 1,350 cubic feet. During 1905 an area of about 10 acres was worked, the number of cubic yards treated being 290,822, yielding 715 oz. of gold, valued at £2,849 16s. Total quantity of gold produced since dredge first commenced work, 1,121 oz. 9 dwt.; value, £4,475 12s. Capital called up, £4,000. Cost of dredge, £2,747 13s.; cost of other plant, £43 6s. The average weekly cost of working is set down at £59 2s. 4d.; average yearly cost of repairs, £671 17s. 5d.; and the yearly cost of coal at £677 11s. 11d. The length of pontoons is 85 ft., and the depth 6½ ft., beam 24 ft.; ladders capable of dredging 25 ft.; capacity of buckets (37), 4½ cubic feet; rate of discharge per minute, 10. Average number of weeks worked, 46; average number of men employed, 8. Dredgemaster and secretary, James Brownlie, Gore.

Moa No. 2, Alexandra.—Area, 54 acres 2 roods 16 perches This dredge is owned by the Clyde Dredging Company, which was registered in May, 1895. Ordinary river-gravel, intermixed with rough boulders, is dredged from various depths. The yield of gold for 1905 was 1,307 oz., valued at £5,058 14s. 8d., making a total of 13,504 oz., valued at £52,012 5s. 1d.; out of which dividends were disbursed amounting to £22,700, being at the rate of £4 0s. 6d. on 4,000 shares, and £1 2s. on 6,000 shares, as against a called-up capital of £6,000. About 15 oz. of gold covers all weekly working expenditure, including rent and office expenses. Cost of dredge, £5,160 17s.; yearly cost of repairs, £543; yearly cost of coal, £619. Length of pontoons 108 ft., depth 7 ft., beam 30 ft.; ladders capable of dredging 45 ft.; capacity of buckets (46), 4½ cubic feet; rate of discharge per minute, 11 Length of gold-saving tables, 15 ft.; breadth, 18 ft.; save-all, 14 ft. by 2 ft.; length of elevator, 77½ ft. Average number of weeks worked, 30; average number of men employed, 8. Dredgemaster, W. C. Nicholson; secretary, E. R. Smith, Dunedin.

Molyneux Hydraulic, Alexandra.—Area, 63 acres 1 rood 25 perches. The Molyneux Hydraulic Dredging Company was registered in May, 1900. River-wash is operated from a depth of 30 ft., the dredge being capable of raising 90 tons per hour. During the year 1905 an area of 1½ acres was worked, yielding 839 oz. 3 dwt. 6 gr. of gold, valued at £3,246 14s. 8d. Total quantity of gold since dredge first commenced work in May, 1897, 5,899 oz., valued at £22,599 12s. 9d., out of which dividends amounting to £2,800 12s. have been disbursed, as against a called-up capital of £5,896. Cost of dredge, £5,000; average weekly cost of working, £51 7s. 6d.; average yearly cost of repairs, £605 5s. 3d.; yearly cost of fuel, £509 19s. 6d. Length of pontoons 85 ft., depth 6 ft., beam 10 ft. and 12 ft.; ladders capable of dredging 32 ft.; capacity of buckets (40), 4½ cubic feet; rate of discharge per minute, 12. Length of elevator, 80 ft.; height of unworked face above water-line, 30 ft. Average number of weeks worked, 44; average number of men employed, 8. Dredgemaster, Samuel Cameron; secretary, Lawrence Ryan, Alexandra.

Molyneux Kohinoor, Coal Creek Flat, near Roxburgh.—Area, 59 acres 2 roods 30 perches. The Molyneux Kohinoor Dredging Company was registered in January, 1900, and commenced work in March, 1902. The material operated on consists of river-bed formation, dredged from an average depth of 30 ft., the quantity raised per hour being 75 cubic yards. During the year 1905 an area of 3½ acres was worked; quantity treated, 200,000 cubic yards, yielding 314 oz. 3 dwt. 6 gr. of gold, valued at £1,207 8s. 7d. Total yield of gold, 3,358 oz. 7 dwt. 22 gr., valued at £12,976 3s. 3d. Dividends disbursed, £4,571 17s. 6d.; capital called up, £6,523 15s. Cost of dredge, £3,000; average weekly cost of working, £45; average yearly cost of repairs, £350; yearly cost of coal, £560. Length of pontoons 60 ft., depth 8 ft., beam 20 ft.; ladders capable of dredging 25 ft.; capacity of buckets (37), 4½ cubic feet; rate of discharge per minute, 11; length of elevator, 25 ft. The average number of weeks worked was 42; and the average number of men employed, 7. Dredgemaster, David Hepburn; secretary, Harry Shrimpton, Dunedin.

Muddy Creek, near Riversdale, Southland.—Area, 65 acres. The Muddy Creek Dredging Company was registered in November, 1902, and commenced work in April, 1903. The material dredged consists principally of mica schist, and is taken from an average depth of 22 ft., at the rate of 2,000 ft. per hour. During the year 1905 an area of 6 acres was worked, yielding 1,512 oz. 18 dwt. of gold, valued at £5,946 5s. 7d., making a total of 4,638 oz. 19 dwt. and £24,059 1s.; out of which dividends were disbursed amounting to £2,767 10s., as against a called-up capital of £1,845. Cost of dredge, £2,277; cost of other plant, £250. Average weekly cost of working, £50; yearly cost of repairs, £500; yearly cost of fuel, £1,000. Length of pontoons 80 ft., depth 4½ ft., beam 28 ft.; ladders capable of dredging 22 ft.; capacity of buckets (33), 4 cubic feet; rate of discharge per minute, 11; length of elevator, 50 ft. Length of gold-saving tables, 40 ft.; breadth, 5 ft. Average number of weeks worked, 48; average number of men employed, 8. Dredgemaster, F. Hamer; secretary, H. G. Horn, Gore.

Mystery Flat, Waikaia.—Area, 98 acres 3 roods. The Mystery Flat Gold-dredging Company was registered in July, 1900, and work was commenced in January, 1902. The material is dredged from a depth of 16 ft., the quantity raised per hour being 2,700 cubic feet. During the year 1905 an area of 10 acres was operated upon, the quantity treated being 807,300 cubic feet, yielding 1,874 oz. 9 dwt. 19 gr. of gold, valued at £7,406 8s. 4d. Total amount of gold obtained since dredge first began work, 4,862 oz. 10 dwt. 14 gr., valued at £19,100 6s.; out of which dividends amounting to £5,787 12s. have been disbursed, as against a called-up capital of £4,512. Cost of dredge, £4,512; average weekly cost of working, £62 5s. 5d.; average yearly cost of repairs, £420 19s. 6d.; yearly cost of coal, £787 9s. 7d. Length of pontoons 75 ft., depth 5 ft., beam 24 ft.; ladders capable of dredging 24 ft.; capacity of buckets (36), 4½ cubic feet. Average number of weeks worked, 48; average number of men employed, 8. Dredgemaster, W. J. F. Ayson; secretary, W. E. C. Reid, Dunedin.

Nevis Crossing, Lower Nevis.—Area, 100 acres. This dredge is owned by James Horn and Co. The nature of the material operated on is quartz and schist-gravel, taken from a depth of 15 ft. to 20 ft. During the twelve months an area of 5 acres was worked, the quantity treated being 216,000 cubic yards; yield of gold, 424 oz.; value, £1,633 14s. 10d. Total quantity of gold produced since dredge first commenced work, 1,139 oz.; value, £4,386. Cost of dredge, £1,200; cost of other plant, £300; average yearly cost of repairs, £150. Length of pontoons 66 ft., depth 5 ft., beam 10 ft.; ladders capable of dredging to a depth of 20 ft.; capacity of buckets (26, and one grab), 3½ cubic feet; rate of discharge per minute, 11; length of elevator, 45 ft. Average number of weeks worked, 32; average number of men employed, 7. Dredgemaster, Archibald Ritchie; secretary, James Horn.

New Alpine Consols, near Cromwell.—Area, 84 acres. The New Alpine Consols Gold-dredging Company was registered in July, 1902, and commenced work the same month. River-wash is dredged from a depth of 50 ft. During the year 1905 an area of 6 acres was worked; quantity treated, 300,000 cubic yards, yielding 1,046 oz. of gold, valued at £4,050. Total quantity of gold obtained since dredge first commenced work, 2,422 oz.; value, £9,400. Capital called up, £3,750. Cost of dredge, £3,378; average yearly cost of repairs, £450; yearly cost of fuel, £372. Length of pontoons 96 ft., depth 6 ft., beam 22 ft.; ladders capable of dredging 50 ft.; capacity of buckets (40), 4½ cubic feet; rate of discharge per minute, 12. Average number of weeks worked, 18; average number of men employed, 9. Dredgemaster, George Goodger; secretary, C. S. Reeves, Dunedin.

New Cromwell, Kawarau River, between Cromwell and Bannockburn.—Area, 30 acres. A private company was formed to work the claim formerly held by the Cromwell Dredging Company, and purchased the Junction-Electric dredge for £600 at the beginning of March, 1906. The dredge was taken up from Cromwell to the claim, but the high river has prevented much work being done this season. The ladders are capable of dredging 38 ft., and there are 36 buckets, each having a capacity of 4 cubic feet, and an average discharge of 12 per minute. Dredgemaster, William Wood; secretary, James Goodger, Cromwell.

New Era, Nevis.—Area, 94 acres. The present owners commenced dredging operations in April, 1903, the early miners having previously worked the claim by hand-labour. The materials operated on consist of alluvial wash, dredged from a depth of 8 ft. to 15 ft.; average quantity raised per hour, 2,000 cubic feet. During the year 1905 an area of 12 acres was worked, the quantity treated being 296,000 cubic yards, yielding 483 oz. 10 dwt. of gold, valued at £1,865 2s. 9d. Dividends declared, £1,074; capital called up, £540. Cost of dredge and claim, £500 (original cost, £5,000); average weekly cost of working, £39; yearly cost of coal, £222 11s. Length of pontoons 66 ft., depth 5 ft., beam 20 ft.; ladders capable of dredging 18 ft.; capacity of buckets (25), 3¾ cubic feet; rate of discharge per minute, 11; length of elevator, 30 ft. Average number of weeks worked, 32; average number of men employed, 7. Dredgemaster, Thomas Omond; secretary, A. P. Bremner, Coal Creek Flat.

New Fourteen-mile, Molyneux River.—Area, 47 acres 2 roods, situated between Alexandra and Roxburgh. The New Fourteen-mile Beach Gold-dredging Company was registered in March, 1904. The materials operated on are a soft and hard reef, dredged from a depth of 40 ft. to 45 ft.; average quantity raised per hour, about 85 tons. During the year 1905, 700 yards of the river was dredged, and yielded 1,335 oz. 6 dwt. of gold, valued at £5,196 10s. 5d. Total quantity of gold obtained since dredge first commenced work on the 28th April, 1904, 3,110 oz. 18 dwt. 16 gr., valued at £12,060 8s.; out of which dividends have been disbursed amounting to £5,991 5s., as against a called-up capital of £4,193 17s. 6d. Original cost of dredge, about £9,000; average weekly cost of working, £85; yearly cost of repairs, £400; yearly cost of coal, £745 12s. Length of pontoons 110 ft., depth 6½ ft., beam 30 ft. 6 in.; ladders capable of dredging 35 ft. to 36 ft.; capacity of buckets (42), 3½ cubic feet; rate of discharge per minute, 11. Length of gold-saving tables, 16 ft.; breadth, 16 ft. 4 in. Average number of weeks worked, 26; average number of men employed, 8. Dredgemaster, George Poulter; secretary, David Crawford, Dunedin.

New Monte Christo, Molyneux River, near Clyde.—Area, 32 acres. The New Monte Christo Dredging Company was registered on the 21st July, 1904, to work the Monte Christo Claim, situate at the mouth of the Clyde-Cromwell Gorge. This claim has been worked for the past five or six years, but with little or no success; during the two years the present company has been working the quantity of gold obtained has been 470 oz. 8 dwt. 16 gr., valued at £1,545 16s. 1d., the capital called up amounting to £1,500. Three-quarters of the claim is shallow, with patches of gold, but no lead has yet been met with, and all attempts so far made to bottom it have failed. The ladder has just been extended by 8 ft., and every effort will be made this season to get at the bottom. The depth of the wash operated on is 30 ft. to 40 ft., 122 cubic yards being raised per hour, and the ladder is now capable of dredging to a depth of 50 ft. There are 45 buckets, each having a capacity of 5½ cubic feet, and a rate of discharge of 10 per minute, the gold being saved on tables 18½ ft. by 13 ft. The dredge was purchased by the present company for £1,500, but the original cost was £6,000. The average weekly cost of working is £42; yearly cost of repairs, £600; yearly cost of fuel, £325. Average number of weeks worked, 35; average number of men employed, 8. Dredgemaster, Hans Olsen; secretary, George Fache, Clyde.

Otago No. 1 and No. 2, Miller's Flat.—Area, 99 acres and 100 acres. The Otago Gold-dredging Company was registered in May, 1895, and the first dredge commenced work that month. Ordinary river-wash is dredged from a depth of 30 ft. to 35 ft.; overburden, 25 ft. During the year 1905 the two dredges worked 19 acres, and treated 1,100,000 cubic yards for gold to the value of £11,086. The total quantity of gold won by both dredges since commencing operations was 12,533 oz., valued at £48,357; out of which dividends were disbursed amounting to £11,875, as against a called-up capital of £2,000. No. 1 dredge cost £8,000, and No. 2

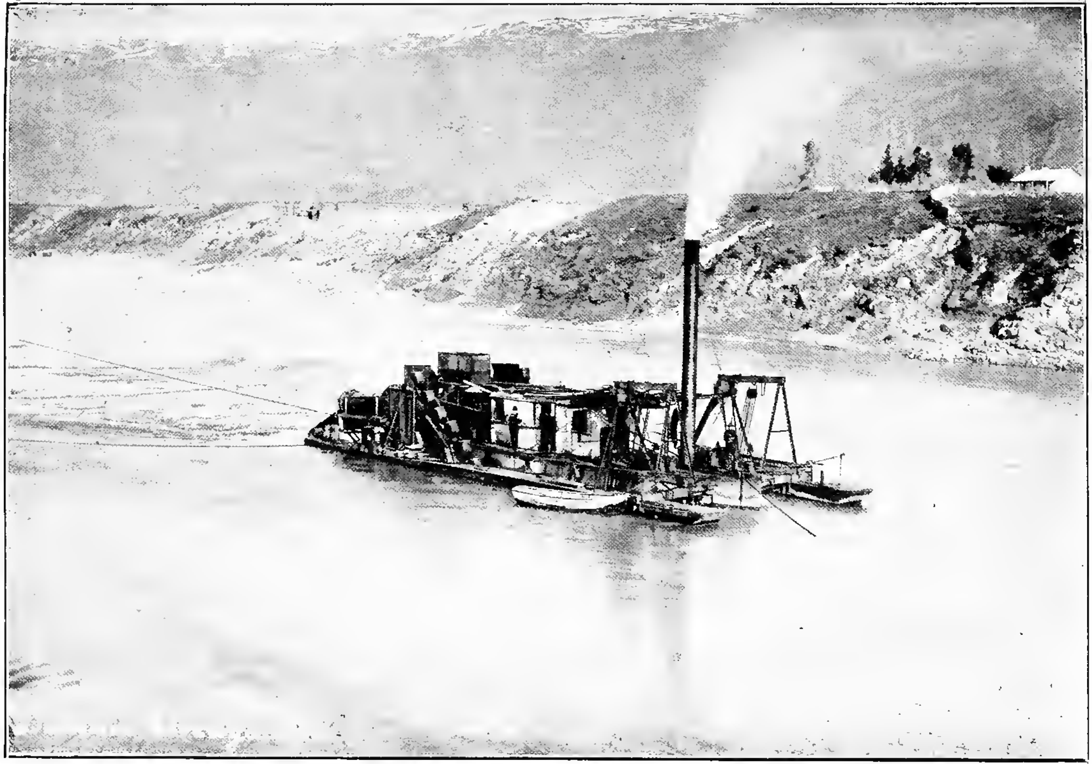
£8,500. The average weekly cost of working both dredges is 30 oz. of gold, or about £112; yearly cost of repairs, £1,200; yearly cost of coal, £1,829. Both dredges work about 45 weeks in the year, and employ sixteen men. The two dredges are fitted with 78 buckets, those in No. 1 having a capacity of 5 cubic feet and those in No. 2 6 cubic feet, with a rate of discharge per minute of 60 ft. and 72 ft. No. 1 elevator is 75 ft. and No. 2 elevator 80 ft. in length. No. 1 pontoons 105 ft. and No. 2 pontoons 108 ft. in length. Gold-saving tables in No. 1 are 17½ ft. by 16 ft., in No. 2 30 ft. by 12 ft. Dredgemasters: No. 1, E. Reiderer; No. 2, E. L. Westcombe. Secretary, A. G. Fenwick, Dunedin.

Perseverance, Waipori.—Area, 66 acres. This dredge is owned by McNeil and party, who commenced work in January, 1897. During the year 1905 an area of 11 acres was worked and 212,960 cubic yards treated, yielding 1,129 oz. of gold, valued at £4,347 11s. Total quantity of gold obtained since dredge first commenced work to the 31st December, 1905, 8,645 oz., valued at £33,285 10s.; out of which dividends have been disbursed amounting to £13,500, as against a called-up capital of £1,500. Cost of dredge, £3,500; average weekly cost of working, £40; average yearly cost of repairs, £420; yearly cost of coal, £700. Length of pontoons 75 ft., depth 5 ft., beam 22 ft.; ladders capable of dredging 20 ft.; capacity of buckets (32), 3½ cubic feet; rate of discharge per minute, 11. Average number of weeks worked during year, 45; average number of men employed, 6. Dredgemaster, Thomas Aiken; secretary, N. O. Potts, Lawrence.

Phœnix, Waikaka.—Area, 78 acres. The Phœnix Dredging Company was registered in September, 1902, and commenced work the following month. Clay and fine gravel, in the proportion of three to one, are dredged from a depth of 14 ft. to 16 ft. About 9 acres has been worked during the year 1905 to an average depth of 15 ft., yielding 453 oz. 15 dwt. of gold, valued at £1,888 3s. 8d., making a total since dredge first commenced work of 2,375 oz. and £9,500; out of which dividends were disbursed amounting to £3,300, as against a called-up capital of £1,500. Cost of dredge, £1,500; average weekly cost of working, about £40; yearly cost of repairs, £1,621; yearly cost of coal, £459. Length of pontoons 70 ft., depth 5 ft., beam 24 ft.; ladders capable of dredging 24 ft.; capacity of buckets (34), $3\frac{3}{4}$ cubic feet; rate of discharge per minute, 11. Length of gold-saving tables, 70 ft. by $3\frac{1}{2}$ ft. Average number of weeks worked, 46; average number of men employed, 7. Dredgemaster and secretary, Malcolm McCorkindale.

Pioneer.—First commenced work in April, 1905, on an area of 40 acres, situate on the Waikaka River, the dredge being owned by Mrs. M. H. Grey. The material operated on is a white-quartz gravel, and is dredged from a depth of 12 ft., the quantity raised per hour giving an average of 60 yards. In 1905, 5 acres of ground was treated, yielding 168 oz. 13 dwt., valued at £655. The original cost of the dredge was £1,500. Average weekly cost of working, £120; yearly cost of repairs, £200; yearly cost of fuel, £300. Length of pontoons 78 ft., depth 5 ft., beam 24 ft.; ladders 18 ft., which carry 33 buckets of the capacity of 3 cubic feet; rate of discharge, 13. Dredgemaster and secretary, Hugh Rankin, Waikaka.

Pride of the Clutha, Miller's Flat.—Area, 31 acres. This dredge is owned by Pringle and party, who commenced work in October, 1903. River shingle and gravel are dredged from an average depth of 30 ft., the quantity raised per hour being 100 cubic yards. During the year 1905 the yield of gold was 1,019 oz., valued at £3,926, making a total of 4,727 oz. 8 dwt. 9 gr. and £18,700 10s.; out of which dividends have been paid amounting to £6,000, as against a called-up capital of £4,000. Cost of dredge, £3,000; average weekly cost of working, £50; yearly cost of repairs, £50; yearly cost of coal, £625. Length of pontoons 100 ft., depth 5 ft. 7 in., beam 31 ft.; ladders capable of dredging 48 ft.; capacity of buckets (40), 5 cubic feet; rate of discharge per minute, 11. Length of elevator, 77 ft.; height of unworked face above water-line, 6 ft. to 12 ft. Length of gold-saving tables, 16 ft.; breadth, 16 ft. Average number of weeks worked, 40; average number of men employed, 7. Dredgemaster, Thomas R. Jones; secretary, John Pringle, Crookston.



DUNEDIN DREDGE, 1891.

Quilter and Party, Waipori.—Area, 20 acres. Quartz gravel and clay are dredged from a depth of 9 ft., the yield of gold during 1905 being 70 oz., valued at £270. Cost of dredge, £500; cost of other plant, £100. Average weekly cost of working, £14; yearly cost of repairs, £20. Length of pontoons 51 ft., depth 3 ft., beam 21 ft.; ladders capable of dredging 15 ft.; capacity of buckets (26), 2½ cubic feet; rate of discharge per minute, 9. Average number of weeks worked, 44; average number of men employed, 2. Dredgemaster and secretary, W. Carr, Waipori. [In a note it is stated that the claim is worked out and the dredge dismantled.]

Revival, Lowburn, near Cromwell, Upper Clutha River.—Area, 67 acres 3 roods. The Revival Gold-dredging Company was registered in August, 1903, and commenced work in October of the same year. The wash operated on consists of 20 per cent. of sand, 55 per cent. of gravel, and 25 per cent. of stones, the materials being dredged from a depth of 35 ft. During the year 1905 an area of 2 acres was worked, the quantity treated being 265,700 cubic yards, yielding 568 oz. 18 dwt. of gold, valued at £2,220 3s. 9d. Total yield of gold since dredge first commenced work, 1,615 oz., valued at £6,283 10s., out of which dividends were disbursed amounting to £650; while the capital called up has amounted to £1,800. Cost of dredge, £1,000; average weekly cost of working, £40; yearly cost of repairs, £550; yearly cost of fuel, £600. Length of pontoons 84 ft., depth 6 ft., beam 24 ft.; ladders capable of dredging 35 ft.; capacity of buckets (30), 3½ cubic feet; rate of discharge per minute, 11; length of elevator, 30 ft. Average number of weeks worked, 41; average number of men employed, 8. Dredgemaster, Frank Kitto; secretary, Andrew Hamilton, Dunedin.

Rise-and-Shine No. 1, Lowburn, near Cromwell.—Area, 100 acres. The Rise-and-Shine Gold-dredging Company was registered in February, 1900, and commenced work in January, 1902. The material operated on contains a considerable amount of stones, and an average quantity of 73 cubic yards is dredged per hour from a depth of 50 ft. The yield of gold for the financial year ending the 31st March, 1906, was 1,376 oz. 18 dwt. 12 gr., valued at £5,323 1s. 4d., making a total of 7,102 oz. 18 dwt. 11 gr. and £27,369 5s. 5d. Dividends have been disbursed from the proceeds of both dredges amounting to £2,400; capital called up, £10,000. Cost of dredge, £9,410; average weekly cost of working, £85; average yearly cost of repairs, £1,100; yearly cost of fuel, £917. Length of pontoons 114 ft., depth 5½ ft., beam 30 ft. 8 in.; ladders capable of dredging 52 ft.; capacity of buckets (39, and 3 grab-hooks), 6 cubic feet; rate of discharge per minute, 11; length of elevator, 66 ft. (centres). Average number of weeks worked, 40; average number of men employed, 10. Dredgemaster, C. D. Brent; secretary, W. T. Monkman, Dunedin.

Rise-and-Shine No. 2, Lowburn, Clutha River, near Cromwell.—Area, 42 acres. This dredge, which is owned by the same company as the No. 1, commenced work in January, 1904. The materials operated on consist of ordinary fine sand, river-gravel, and heavy stones in equal proportions, dredged from a depth of 36 ft. to 46 ft.; average quantity raised per hour, 2,500 cubic feet. The yield of gold for the financial year ending the 31st March, 1906, was 1,342 oz. 11 dwt., valued at £5,190 4s. 3d., making a total of 2,459 oz. 11 dwt. 2 gr. and £9,468 7s. 7d. Cost of dredge, £5,269; average weekly cost of working, £85; average yearly cost of repairs, £960; yearly cost of fuel, £879. Length of pontoons 100 ft., depth 7 ft., beam 27½ ft.; ladders capable of dredging 44 ft.; capacity of buckets (41), 5 cubic feet; rate of discharge per minute, 11; length of elevator, 65 ft. Average number of weeks worked, 40; average number of men employed, 10. Dredgemaster, N. P. Kloogh; secretary, W. T. Monkman, Dunedin.

Riverview (late Sheddan Rex), Mataura River.—Area, 100 acres. The Riverview Dredging Company, with a called-up capital of £1,537 10s., has been formed for the purpose of dredging a claim of 100 acres on the Mataura River. The pontoons have a length of 80 ft., a depth of 5 ft., and a beam of 24 ft., fitted with ladders capable of dredging to a depth of 24 ft., and there are thirty-two buckets, each having a capacity of 4¼ cubic feet. Secretary, John Latham, Gore.

Rosedale, Waikaka Valley.—Area, 100 acres. This dredge, which is owned by the Rosedale Syndicate, numbering ten shareholders, commenced operations in March, 1906. Cost of dredge, £2,500; cost of other plant, £130. Average weekly cost of working, £44. Length of pontoons 78 ft., depth 6 ft., beam 25 ft.; ladders capable of dredging 20 ft.; capacity of buckets (32), 4¼ cubic feet; rate of discharge per minute, 9. Average number of men employed, 8. Dredgemaster, Thomas Falconer; secretary, William Crawford, Waikaka Valley.

Sailor Bend, Alexandra Gorge.—Area, 1 mile. The Sailor Bend Dredging Company was registered in September, 1899, to work a gorge claim situate betwixt the Manuherikia and the Last Chance Claims, both of which have given good returns and paid dividends. Under favourable circumstances, the Sailor Bend Claim gives a yield of from 80 oz. to 100 oz. for a week's dredging; but coaling is a heavy item, as the distance from the pit is over three miles, and the coal has to be boated down the river to the dredge by a special crew for a mile and a quarter. The Sailor Bend is known to contain payable deposits right through the claim, having been tested by the dredge in several parts of the property. Unfortunately, the Sailor Bend, in common with a number of dredges whose claim is in the Alexandra Gorge, has for the past four winters only worked on an average on the *bottom* about four to six weeks, which has crippled the finances and placed the company's dredges in the power of the mortgagee or the debenture-holder. When the dredging boom was in full swing some years ago, it was thought that the gorge dredges would be able to work for at least six months; but during the past four seasons the average has only been eight weeks, and of these two or three weeks have been taken up with opening a paddock or dredging at a loss on a rising river, and it was not expected that dredging would commence this season before the second week in July. Provided there are no heavy rains or warm winds to melt the snow on the ranges, causing the river to rise, the dredging season goes on to the last week in September or the first week in October; and if the frost does not set in the latter end of February a short dredging season may be expected. For the year 1905 the Sailor Bend dredge won 380 oz. 10 dwt. of gold, valued at £1,468, making a total since work commenced of 2,908 oz., valued at £11,239; out of which £2,800 was paid in dividends; while the capital called up amounted to £8,000. The dredge cost £6,674 9s. 11d., and the average weekly cost of working has been £70. In dredging, rocks and large stones are met with, the gravels being taken from a depth of 25 ft. to 30 ft.; the ladders are capable of dredging to a depth of 35 ft. There are 41 buckets, each having a capacity of 4½ cubic feet, discharging at the rate of 12 per minute, the gold being saved over tables 14 ft. by 17 ft. The pontoons are 105½ ft. in length, with a depth of 6 ft. 7 in., and a beam of 25 ft. 10 in. Average number of men employed, 8. Dredgemaster, Dugald McGregor; secretary, R. T. Wheeler, Dunedin.

Star, Waikaka Valley.—Area, 100 acres. This dredge is owned by the Star Gold-dredging Syndicate, which commenced work in February, 1904. The material operated on consists of gravel wash and white and grey stones (40 per cent. of fine sand, 40 per cent. of fine gravel, and 20 per cent. of heavy stones), dredged from a depth of 13 ft., the quantity raised per hour being 50 cubic yards. An area of 18 acres was worked during the year 1905, the quantity treated being 377,520 cubic yards, which yielded 1,691 oz. of gold, valued at £6,610. Total quantity of gold produced since dredge first commenced work in February, 1904, 4,046 oz. 3 dwt.; value, £15,952 16s. Dividends paid, £9,192; capital called up, £2,208. Cost of dredge, £2,500; average weekly cost of working, £40; yearly cost of repairs, £400; yearly cost of lignite, £450. Length of pontoons 82 ft., depth 5 ft., beam 25 ft.; ladders capable of dredging 22 ft.; capacity of buckets (37), 3¾ cubic feet; rate of discharge per minute, 9½. Length of gold-saving tables, 66 ft.; breadth, 4 ft. Average number of weeks worked, 50; average number of men employed, 8. Dredgemaster, John A. S. Aitken; secretary, F. R. Blue, Knapdale, Gore.

Success, Waipori.—Area, 18 acres. This dredge, which is owned by Wilson and party, commenced work in May, 1905. Gravel, clay, and soil are dredged from a depth of 12 ft.; average quantity raised per hour, 75 yards. Yield of gold during 1905, 273 oz. 6 dwt. 19 gr., valued at £1,052 7s. 2d. Total quantity of gold produced since dredge first commenced work, 677 oz. 2 dwt. 6 gr.; value, £2,607 13s. Cost of dredge, £160; cost of plant, &c., £30. Average weekly cost of working, £33; yearly cost of coal, about £450. Length of pontoons 90 ft., depth 5 ft., beam 24 ft.; ladders capable of dredging 20 ft.; capacity of buckets (31), 3½ cubic feet; rate of discharge per minute, 12. Plain box, 50 ft. long and 4 ft. wide, used for saving gold. Average number of weeks worked, 29; average number of men employed, 6. Secretary, G. McCluskey.

Teviot, Roxburgh.—Area, 50 acres. Work was commenced in August, 1904, by Mr. Joseph Sparrow, the present owner. The material operated on consists of river-wash (stones and cement) taken from a depth of 18 ft., the average quantity raised per hour being 60 tons. During 1905 an area of 4 acres was worked; quantity treated, 11,520,000 cubic yards; yield of gold, 830 oz., valued at £3,202. Total quantity of gold produced since dredge first commenced work for present owner, 2,004 oz.; value, £7,572. Original cost of dredge, £7,800; bought by present owner at £2,030. Average weekly cost of working, £50; average cost of repairs, £800; yearly cost of fuel, £576. Length of pontoons 103 ft., depth 6 ft. 9 in., beam 31 ft.; ladders capable of dredging 40 ft.; capacity of buckets, 4¾ cubic feet; rate of discharge per minute, 11. Length of elevator, 60 ft.; height of unworked face above water-line, 20 ft. Length of gold-saving tables, 16 ft.; breadth, 15 ft. Average number of weeks worked, 40; average number of men employed, 8. Dredgemaster, James Richmond.

Waikaia Venture, Wendon District, near Waikaia.—Area, 100 acres. The Waikaia Venture Gold-dredging Syndicate has not yet commenced operations, the dredge being in course of erection. The pontoons will have a length of 82 ft., a depth of 7½ ft., and a beam of 31 ft., fitted with ladders capable of dredging a depth of about 18 ft.; each bucket will have a capacity of 5 cubic feet. Dredgemaster, James McErlean; secretary, Alexander Mutch, Waikaka Valley.

Waikaka No. 1 and No. 2, Waikaka Valley.—The Waikaka Syndicate was registered in December, 1901; the first dredge commenced work in February, 1903, and the second in July, 1905. No. 1 dredge worked 10 acres during the year 1905, and No. 2 turned over a similar area for the six months, the yield of gold won by both dredges being 1,654 oz. 8 dwt., valued at £6,484 18s. 7d., making a total (both dredges) to the 31st December, 1905, of 3,755 oz. 13 dwt., valued at £14,800 3s. 8d. The called-up capital is £3,000, and £2,800 has been paid in dividends. The profits are now devoted to purchase of second dredge. In the No. 1 claim the material, dredged from a depth of 11 ft., consists of 6 ft. of yellow clay and 5 ft. of light wash, and in No. 2 the material consists of one-quarter fine sand, one-half fine gravel, and one-quarter heavy stones. The No. 1 dredge cost £3,360 2s. 1d.; the No. 2, purchased from the Sheddan Company for £1,100, originally cost about £4,000. The average weekly cost of working both dredges (including repairs, maintenance, &c.) is £126 18s. 9d.; repairs on No. 1 cost for the twelve months £496 14s. 4d., and on No. 2 for six months £558 4s. 3d.; cost of fuel on No. 1 for twelve months £590 15s. 8d., and on No. 2 for six months £328 18s. 3d. Both dredges are fitted with ladders capable of dredging to a depth of 20 ft., fitted with 32 buckets, having a capacity of 4½ and 4¾ cubic feet each, and discharging at the rate of 9 and 11 buckets per minute. Each pontoon has a length of 80 ft., a depth of 5 ft., and a beam of 25 ft. For saving the gold No. 1 has a sluice-box 50 ft. by 3 ft. 4 in., and No. 2 has tables 28 ft. by 3 ft. 9 in. and 38 ft. by 6 ft. Average number of men employed, 18; the number of weeks worked during year 1905 on No. 1 was 49. Dredgemasters: No. 1, R. Henderson; No. 2, Thomas Stevenson. Secretary, W. E. C. Reid, Dunedin.

Waimumu Venture, Waimumu.—Area, 52 acres. This dredge is owned by the Waimumu Venture Syndicate, which commenced work in March, 1905; and up to the end of the year an area of 13 acres was operated on, 209,729 cubic yards being treated at a cost of 2¼d. per cubic yard, for 800 oz. of gold, valued at £3,207 17s., out of which dividends were disbursed amounting to £504; capital called up, £1,325. The pontoons are 80 ft. in length, 5 ft. in depth, with a beam of 26 ft.; ladder capable of dredging to a depth of 11 ft.; capacity of buckets (29), 3½ cubic feet; rate of discharge per minute, 9. Length of gold-saving tables, 60 ft.; breadth, 4 ft. 3 in. Cost of dredge, about £1,800; average weekly cost of working, £44; average number of men employed, 8. Dredgemaster and acting-secretary, James Currie.

NOTE.—In statements as to cost of fuel, repairs, and number of weeks worked, the average cost is generally meant. Forms, soliciting information, were sent out to all secretaries and dredgemasters in Otago and Southland. The above detailed particulars have been compiled from the information courteously furnished by secretaries and dredgemasters. In some instances the forms have not been returned, and in others the information was of too meagre a character. Tabulated returns will be found in the larger edition of present work, entitled "New Zealand Mines and Minerals." Space does not permit of the tables being given in this edition.—Editor, MINING HANDBOOK.

THE UTILISATION OF DREDGED GROUND,

For Agricultural, Pastoral, or Other Purposes.

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In connection with the publication of the Mining Handbook, forms were sent out to dredgemasters and secretaries of companies, asking for information, and amongst the questions submitted were the following:—

(1.) *How much of surface soil is put by and placed on the tailings after ground is dredged?*

(2.) *Can the ground be utilised afterwards for fruit or vegetable culture, or for agricultural or pastoral purposes?*

Where answers have been given in the affirmative to either question, they are herewith appended.

Otago and Southland.

Ardmore, Scrubby Flat, near Kelso, Tuapeka County.—(2.) Yes; trees would do well.

Argyle, Waikaka Valley.—(2.) Yes.

Central Charlton, near Gore.—(2.) Either.

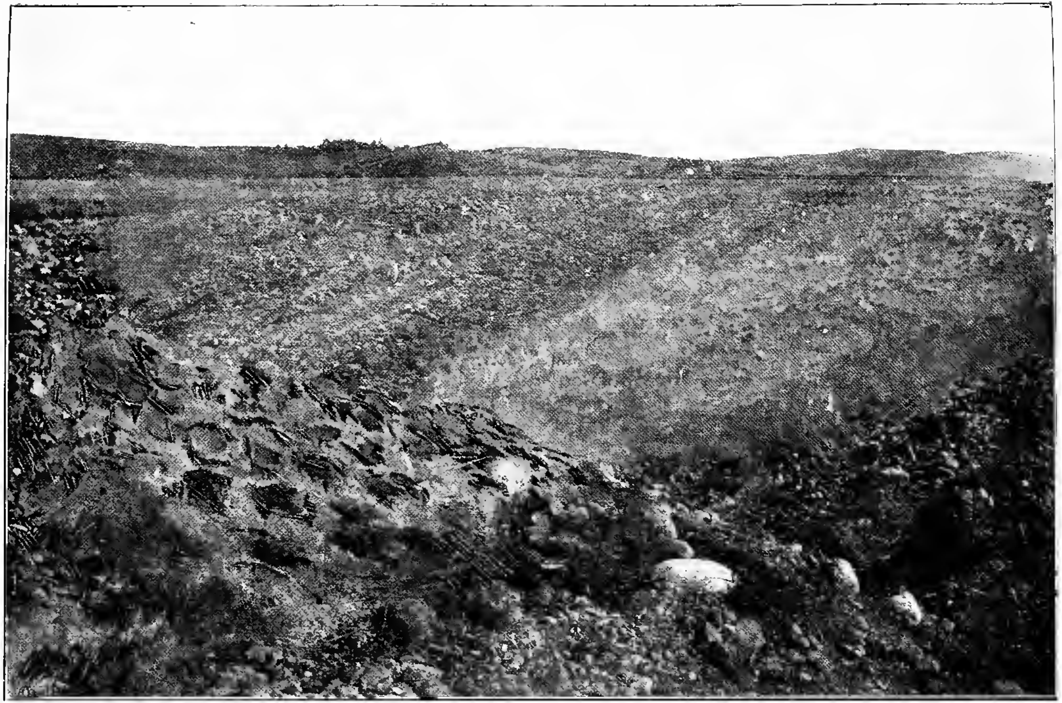
Charlton Creek, near Gore.—(1.) Mixed with gravel. (2.) Good for pasture and forestry.

Graham and Party, Waikaka Valley.—(1.) Mixed. (2.) For forest trees or pastoral purposes.

Hessey's Waikaka.—(2.) Pastoral.

Ibbotson and Party, No. 2, Little Waikaka.—(1.) Most of the surface remains on the top. (2.) Yes; good pastoral, and with a little labour can be made good agricultural land.

Lady Annie, Waikaia.—(1.) Not any; all is mixed together. (2.) Yes; the stones are for the most part rotten, and will break up in time.



MacGeorge Bros.' No. 1 Claim, Waikaka.—View showing Junction of Tailings deposited by Old Method, and Regular Surface made by the New System.

Lee and Party, Waikaka Valley.—(1.) Very little, unless we are in clay. (2.) Pastoral purposes and tree-growing.

Lilliesleaf, Waikaka Valley.—(1.) Three inches. (2.) Yes.

McGeorge Bros., Waikaka Valley.—(1.) Surface soil and wash was treated together; but, by means of a sand-shoot, about 6 in. to 1 ft. of soil and sand is distributed over the surface. (2.) Yes; when sown, is good grazing.

Marshall Bros.' Freehold, Waimumu.—(1.) Depends on various circumstances; average perhaps one-half. (2.) Fair feed, although uncultivated; should do well for flax.

Masterton, Waikaia.—(1.) All mixed. (2.) Yes; fruit and pastoral purposes.

Mill Creek, Charlton.—(2.) Could be used for pastoral purposes; grows clover and grasses.

Muddy Creek, Wendonside, ten miles from Riversdale, Southland.—(2.) Pastoral.

Mystery Flat, Waïkaia.—(2.) Fruit and forest trees.

Nevis Crossing, Lower Nevis.—(2.) Not for a long period; country only fit for pasture.

Otago, Miller's Flat.—(2.) Yes, portions of it.

Phœnix, Waikaka.—(2.) Yes; in this part the grass does very well on the tailings, as there is very heavy clay.

Pioneer, Waikaka.—(2.) For pastoral purposes.

Pride of the Clutha, Miller's Flat.—(2.) Portion of bank claim may be utilised after working.

Rosedale, Waikaka Valley.—(2.) Yes.

Star, Waikaka Valley.—(1.) Not much surface soil is left on top, but we leave 4 in. or 5 in. of silt, which grows good clover, &c. (2.) Good for pastoral purposes.

Success, Waipori.—(2.) Pastoral purposes.

Waikaka Syndicate No. 1, Waikaka Valley.—(1) and (2). Varies according to circumstances. Would grow good grass, timber or fruit trees.

Waikaka Syndicate No. 2, Waikaka.—(1.) None; it is all mixed up. (2.) Yes.

Waimumu Venture Syndicate, Waimumu, near Mataura.—(2.) For agricultural purposes.

West Coast.

North Beach, near Greymouth.—(2.) Yes; grows grass in places.

Prince of Wales, Robinson's Creek, Donoghue's, near Ross.—(2.) Yes, for grazing purposes.

Stafford, Waimea Creek, Stafford, Westland.—(2.) Fruit-culture.

Answers from Hydraulic Elevating and Sluicing Claims to Question No. 2 only.

Otago and Southland.

George Guilford, Carrick Range.—For pastoral purposes only.

Golden Rise, Weatherstone's, Tuapeka.—Not for some years, on account of its gravelly nature, unless by digging holes and filling same with soil, when fruit or other trees might be grown.

Island Block, Beaumont Riding, Tuapeka.—Ground could be levelled and top-dressed with silt from elevators.

Jewett's Gully, Round Hill, Colac Bay, Southland.—Yes, to a moderate extent.

Matakanui, Matakanui (or Tinkers).—Parts of it would grow trees.

New Skipper's Sluicing Company, Skipper's.—Pastoral.

Norwegian Sluicing Claim, Waitahuna Gully, Tuapeka.—Grazing.

Ourawera, Round Hill, Colac Bay.—It might at a future date be suitable for pastoral purposes, but not for a long time.

Private Enterprise, Cardrona Valley, Lake County.—Pastoral.

Round Hill, Round Hill, Colac Bay.—Yes.

Tallaburn, Currie's Flat, near Beaumont, Tuapeka County.—Part fit for pastoral purposes.

Undaunted, Matakanui.—Yes.

United M. and E. Water-race, St. Bathan's.—When worked out, ground could be used for grazing or tree-growing.

West Coast.

Barrytown, Barrytown Flat, Grey Valley.—Yes.

Macleod's Terrace, Mokihinui River, Westland.—Grasses will grow on tailings.

Minerals (Limited), Arahura, Blue Spur, Westland.—Yes.

Mont d'Or, Sailors' Gully, Ross, Westland.—Yes; 150 acres tailings-site, used for grazing cattle, carries 50 head all year round.

New Nine-mile Creek, near Ten-mile Creek, Grey Valley.—Tailings-site greatly improves the land.

Republic, Healey's Gully, Moonlight, Grey Valley.—Part of it.

Ross United, Jones's Flat, Ross.—Yes; for fruit-growing and grazing.

MINERALS OCCURRING IN OTAGO.

By E. R. Green, Inspector of Mines for the Southern Mining District.

Cinnabar.

Samples of cinnabar were found in the early alluvial diggings in Nevis, Nokomai, Waipori, and Waitahuna. A sample assayed in 1875 from the Carrick Range contained 82 per cent. of the metal, while samples from Waipori and Waitahuna were found to contain 70 to 75 per cent. of mercury. Some promising samples were discovered at the Upper Nevis in 1883. It is here found associated with gold in the alluvial washings. When tested the samples yielded 84 per cent. of quicksilver. Some prospecting was done for the lode at Nevis, but it was never found. A discovery of this mineral was made in the year 1899 between Waipori and Waitahuna, in Tuapeka County. Systematic prospecting was undertaken, and a low-level tunnel was being driven in 1900. This level met the lode in 1901 at a distance of 231 ft., but as the capital of the company was exhausted the mine was locked up pending company reconstruction. A contract was let in 1901 to drive 300 ft. along the lode. This was done, but no ore was met with in the lode-formation. The mine was closed down during 1903. As there were 190 ft. of backs available, it would have proved the property better had a rise been put through to the surface. The mine has not been reopened since 1903.

Antimony.

According to Hutton and Ulrich's "Geology of Otago," samples sent from the Carrick Range prior to 1875 yielded 50 to 54 per cent. of antimony, while a sample assayed from Miller's Flat, Tuapeka, contained 58 per cent. metallic antimony. A specimen sent from Arrowtown contained only

34 per cent. In October, 1875, about 60 tons of antimony was shipped to England from the mine at Waipori. In 1879 a new lease was applied for, as the trial shipment to England gave a satisfactory return of gold. A company was formed, but after raising and exporting some ore the work was suspended in 1880. The drawback was the general inaccessibility of the mine. During the summer of 1881 work was resumed, twenty-eight men being employed; machinery was erected, and a payable lode proved. In 1882 operations were again at a standstill. In 1883 a bonus of £500 was offered by the New Zealand Government for the production of the first 250 tons of antimony regulus to be sold in a foreign market at a fair market price, but no application was made for it, and it lapsed. In 1886 two licenses were granted to search for antimony in the Silver Peak and Mount Hyde Survey Districts respectively. Two additional licenses were granted in 1887—one in each of these districts. In 1888 Johnson and party took up the Waipori lode, on the Lammerlaw Ranges, and proved the extension of the lode from the original shaft. Two tons and a half of ore was sent to London for assay, with a view to floating a company in that market. There is a good supply of water and peat on the ground. Nothing further was done to prospect the antimony-lode at Hindon during 1889, but in that year the Lammerlaw Antimony Company took up an area of 59 acres on the original claim. James Campbell was granted a mineral license over 320 acres adjoining the company's licensed holding.

The Antimony Company, Waipori, was registered in 1891, and contracts were let for sinking a new shaft and cutting a water-race. In the early part of 1890 a parcel of 3½ tons, which yielded 47 per cent. of antimony, was sent to the Dunedin Exhibition; this was afterwards shipped to England for sale. Some of the ore will go as high as 80 per cent. In 1891 a lode, 2 ft. to 5 ft., was struck at a depth of 60 ft. in the company's area, the yield from which was from 70 to 80 per cent. of antimony. The company carried on continuous operations during 1892.

Antimony was also found on the Carrick Range.

The existence of an antimony lode on the west bank of the Molyneux River, at Alexandra, was known years ago, but very little attention was paid to it. In 1900 the shaft was cleaned out, and a few tons taken out and sent to Melbourne for assay. Some samples taken from the lode were assayed at the Otago and Thames Schools of Mines, and by the Government Analyst. According to the latter, these contained 73·5 per cent. sulphide of antimony, equal to 52·8 per cent. metallic antimony. The Thames School of Mines reported the ore equivalent to 50 per cent. of metallic antimony, and the Otago School of Mines found that the sample sent there contained 65 per cent. metallic antimony. The Antimony Exploration Syndicate continued to prospect the lode by shafts and tunnelling during 1901. Several trial shipments were made to Melbourne during that year. However, it was found that the cost of production and the heavy freights in conveying the mineral to a seaport town had absorbed the profits, and the mine was closed down.

Although lodes occur at Alexandra, Waipori, Mount Stoker, and the Carrick Range, none of them has been worked since 1901. These lodes are in out-of-the-way localities, and the cost of production and transit, together with the fluctuating nature of the antimony market, has so far prohibited the profitable working of the ore.

Copper.

Prior to 1875 copper-ore containing 13·5 per cent. of metallic copper was found on the Carrick Range. Samples from the Arrowtown district yielded 11 per cent. of metallic copper. Copper-ore containing 24 per cent. metallic copper was discovered at Moke Creek, while gold was found in samples sent from Moke Creek, Wakatipu, and Waipori. (Hutton and Ulrich's "Geology of Otago.")

Copper was discovered at Reedy Creek, near Waipori, in 1866. This lode was prospected during 1880 by a shaft 50 ft. in depth and by tunnels. A parcel of undressed ore sent to New South Wales was reported to have yielded 11 per cent. of copper. Machinery was erected in 1881, and thirteen men employed to thoroughly test the lode. The drainage was heavy, and for various causes the work was discontinued in 1882. A discovery of a copper-lode was made in 1882 in the Wakatipu district. An attempt was made to float a company in Australia, but, although the lode was proved, the expense of placing it on the market in a proper state was then too great, and the lode was allowed to lie idle. Some further prospecting was done on this lode during 1900; but no copper was mined in Otago during 1901.

Several licenses were granted to prospect for copper on the Malvern Hills, Canterbury, during 1902, but nothing eventuated.

In 1904 a quantity of ore was taken from the Wakatipu lode, and parcels sent to Dunedin and Thames for valuation of the ore; but development was not continued. None of the lodes at Carrick, Wakatipu, or Waipori is now being worked.

Platinum.

This metal is associated with the auriferous deposits at Round Hill, Southland, and is found on the black-sand beaches south-west of the Waiau River. About 20 oz. of platinum was sold by the Round Hill Gold-mining Company during 1903; 8 oz. 11 dwt. 10 gr. was recovered from the above claim in 1904; and during 1905, 14 oz. 6 dwt. 12 gr. was saved. This is a metal that should be looked for in other places, as it has a high value at the present time.

Silver.

It is recorded that a sampl of native silver was found at the Matatapu, Lake Wanaka, many years ago; also in the Wakatipu district and Kawarau Gorge.

Manganese.

Manganese was found in Waipori in 1864, but the samples tested did not yield more than 8 per cent. Rich samples were found near the mouth of the Taieri River, Otago, in 1873.

Owing to the low and variable price ruling for this mineral the search for deposits has never been carried on for any length of time. The mineral at Taieri Beach contains 90 per cent dioxide of manganese.

Scheelite.

Coarse pieces of scheelite were found in the alluvial workings in Waipori in 1865. A lode was discovered in Nardoo Creek in 1887. A sample sent to London gave an assay value of 77 per cent. tungstic acid. Some attention was given towards prospecting during 1899, as London firms were offering £22 per ton, delivered in Dunedin. This mineral also occurs at Macrae's in the quartz reefs, and in 1891 Messrs. Kitchener and Donaldson sent Home a trial shipment of 6½ tons. The mineral was also found on the Lammerlaw Heights, at the Antimony Mine, and at the head of Burnt Creek. A large lode was discovered at the head of Lake Wakatipu.

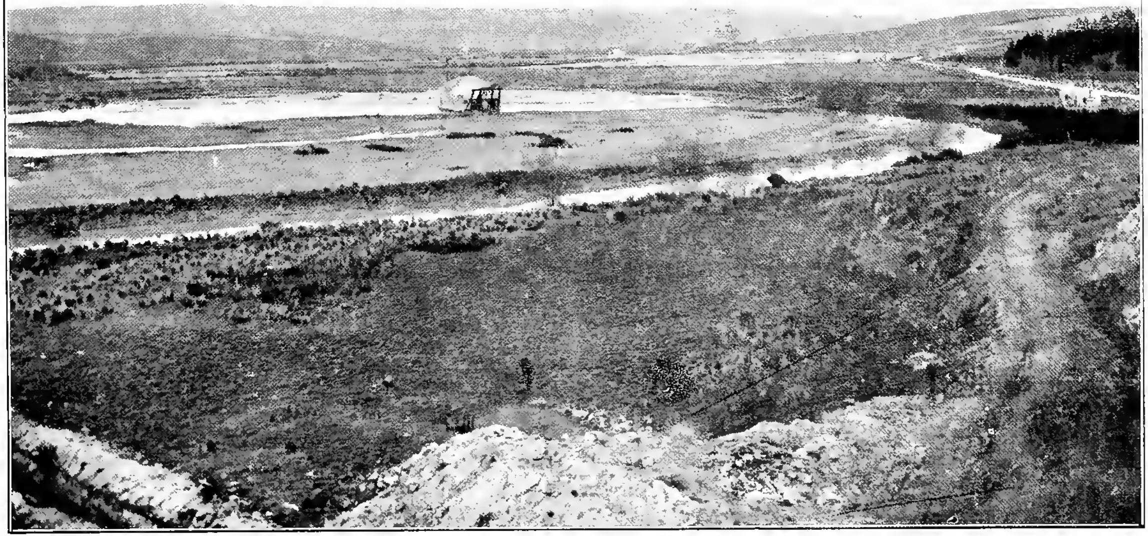
Messrs. Donaldson Bros., of Macrae's, have been consistent producers of this mineral during the past few years, and several hundred tons have been exported from this mine, the total value aggregating to about £24,000. Special concentrating appliances are installed at this mine.

Scheelite also exists in the Alta Mine, Bendigo, but none has been produced for export.

The lode at Glenorchy, Lake Wakatipu, was reopened in 1906, and scheelite is now being produced.

Tin.

Reports had been circulated from time to time that tin had been discovered in the colony, but it was not until 1888 that tin-stone (cassiterite) was discovered in the Remarkables, Stewart Island. The country rock is a granitoid gneiss. The ore was found in bands of quartz running through a micaceous rock. Wolfram was found in connection with the cassiterite. Both these minerals were found associated in the stream deposits in Pegasus Creek. About 7,000 acres were held in 1889. Many claims were worked in that year, both on the



Gold-dredging in the Waikaka Valley.

Sheddan's Rex Dredge in centre, Sheddan's Freehold Dredge on right, Argyle Company's Dredge on left, and Waikaka Syndicate's Dredge lower down the Valley.

lode-formation and in the alluvial drifts. It was, however, found that the deposits were not large, and the supposed rich discoveries were not verified. Only small areas of drift ground could be found, and there was a scarcity of water for sluicing purposes. Very little ore was produced, and operations have never risen above the prospecting stage.

Graphite.

Graphite, in various stages of purity, is found at Malvern Hills, Canterbury, and Gibbston, Otago, where it is of fair average quality.

Complex Ores.

A complex ore occurs at Tarawera Mine, Isthmus Sound, Preservation Inlet. It is an admixture of iron, copper, lead, zinc, gold, and silver. When dressed to a high percentage this ore yields 100 oz. to 120 oz. of silver to the ton, and as much as 7 dwt. of gold. Refractory ores occur in the deep levels of the mines on the Carrick, Bendigo, Nenthorn, and Hindon; the foreign mineral present may be iron, antimony, or arsenic. Some of the quartz in the Rough Ridge Reef is heavily charged with iron-pyrites and zinc-blende.

Auriferous Ironsands.

Auriferous ironsands (chiefly magnetic oxide) are, for the most part, confined to the west, south, and south-east coasts of the Middle Island of New Zealand. These beach sands have afforded profitable employment for very many years, and continue to do so. Not only gold, but platinum, iridium, and other valuable minerals occur in these sands. There is a vast field here for research as to the most suitable means of treating these sands to recover a maximum percentage of their values at a minimum cost. A bonus of £2,000 was offered by the New Zealand Government in November, 1901, and the offer was continued up to January, 1904, for a suitable machine or appliances to treat these sands, but was unclaimed, although many inquiries were received by the Mines Department from various parts of the world.

Greenstone.

The deposit of marmolite, or tangiwai, in lode-formation, long known to occur at Anita Bay, Milford Sound, was exploited in 1904. A quantity of the stone has been brought to Dunedin for lapidary treatment, and is now being prepared for the market. The demand for this class of stone ornament in a manufactured state is said to be fairly large, especially among the Natives of the North Island; also amongst tourists, and others outside the colony.

Mica.

Mica occurs at an altitude of 12,000 ft. above sea-level in the mountains at the head of George Sound, Western Otago. Samples were produced, and a company was formed for the exploitation of the deposit, but full developments were not proceeded with.

Asbestos.

A license was granted in 1886 to search for this mineral in the vicinity of Milford Sound. The deposit was discovered, but apparently its position was too inaccessible for economic working. This mineral has also been found on Mount Cairnmuir and Mount Pisa, in Otago Central, but none has ever been produced.

Marble.

A very pretty grey marble, streaked with white, is found in abundance at Blue Mountain, in the Horse Range, where it is burnt for lime. Although much jointed at the surface, it may improve as the quarry is developed, and I think that blocks of sufficient size to make chimney-pieces, pillars, &c., could be obtained.—Hutton and Ulrich's "Geology of Otago." It is recorded in the "Handbook of New Zealand Mines, 1887," that a marble was found outcropping on the Nokomai.

Retinite.

The occurrence of this fossil resin in abundance in some of the lignites of Otago and Southland was indicated in Hutton and Ulrich's "Geology of Otago." It was suggested that it would probably pay to collect it for the manufacture of varnish.

Grinding and Polishing Materials.

According to Hutton and Ulrich's "Geology of Otago," good sharp sandstone, or gritstone, suitable for grindstones, is found in the Horse Range, while whetstones and scythe-stones could probably be supplied from some of the more arenaceous mica-schists, as at Mount Alta. Hone-slate and Lydian stone are not uncommon in the Kakanui and Kaikoura formations, and polishing-powder (diatomaceous earth) is found in Strath Taieri, and probably in some of the other old lake-basins.

THE AURIFEROUS IRONSANDS OF NEW ZEALAND.*

By ALEXANDER McKAY, F.G.S., Government Geologist.

AURIFEROUS ironsands (chiefly magnetic oxide) are for the most part confined to the west, south, and south-east coasts of the Middle Island of New Zealand, commonly known and hereafter to be spoken of as the South Island.

The titanic ironsands of the west coast of the North Island, though mixed with magnetite, are not usually gold-bearing, and south of Auckland have not been ascertained to contain gold in sufficient quantity to pay for working such deposits. For the most part these sands have been derived from volcanic rocks of younger Tertiary date, associated with which, except on the western flanks of Mount Egmont, there are no lodes carrying gold.

On the east coast of Cape Colville Peninsula, at Mercury Bay, there are deposits of black sand that contain gold, and which it has been proposed to work for the precious metal. Possibly, also, there are other similar deposits on the west shore of the Bay of Plenty, where such sands have been derived from auriferous rocks. The magnetic and titanic ironsands of the North Island are, however, not usually regarded as a repository of gold in paying quantities.

On the west coast of the South Island, from near Cape Farewell to Preservation Inlet, the sea-beaches, formed of material of moderate fineness of grain for the most part, show the presence of magnetic ironsands, and often such sands form a considerable part of the total material of the beach between

* These notes on the auriferous ironsands of New Zealand were written a few years ago in reply to a request for information by a resident of Victoria, British Columbia, who stated that he was the inventor of a process for extracting gold from black sand and other earthy bodies.

high- and low-water mark. Such sands are at almost all places auriferous, and for the past thirty years have been worked for gold. At first these deposits were extremely rich, and were worked again and again, as often as the material was acted upon by a heavy surf during storms, or rearranged more slowly by the ordinary action of the tides. Often the auriferous sands would be covered by a variable depth of grey-quartz sand, which, if not too deep, would be removed to reach the auriferous layer; but as frequently the auriferous sands would appear at the surface, varying from a few inches or a mere skimming to a foot or more in thickness. Such deposits, when formed, were treated as rapidly as possible, or, at all events, removed beyond the action of the tide, as they are apt to be suddenly swept away by a change in the direction of the wind or by a varying force or direction of the tide and sea-currents. Gradually, in the course of years, these beach deposits became less auriferous; but they still yield, on all the more important beaches, a profitable return to miners expert at this form of mining.

Beach-workings of this description are carried on from thirty miles north of the mouth of the Buller River to the southern extremity of the Island, and east along the northern shore of Foveaux Strait and the south coast of Otago to the mouth of the Molyneux River, and along the east coast in a northerly direction to the boundary of the Otago Provincial District.

Usually, where magnetic ironsands are found on the beach, deposits of the same kind, now no longer acted upon by the tide, are present on the higher grounds inland, or lie buried under grey sands between tide-mark and the foot of the first terrace. These beach leads have been a great source of gold at many parts on the west coast of the South Island. At many places, near the mouths of rivers and large creeks, the ground is wet, and by dredging or other means it is that considerable areas have yet to be worked. This first horizon above or inland of tide-mark has deposits of ironsand in all favourable situations along the west and south coasts of the Island, and these are notably developed near the mouths of the larger rivers. Usually they have proved very rich in gold, and but for difficulties such as have been alluded to most of them had already been worked out. At many places they are covered by flood deposits from rivers or by æolian sands drifted back from the beach, and thus it is that discoveries are likely yet to be made.

At higher levels successive terraces of auriferous ironsands are met with, principally between the mouths of the Buller and Hokitika Rivers, and some of the larger rivers in South Westland. These have been more particularly described in the "Geological Reports" for 1892–3 and 1895–6, and the descriptions of the blocks reserved for mining purposes, for which see joint report by Messrs. Gordon and McKay. Here it will suffice to mention Addison's Flat, Charleston, and Brighton; Darkie's Terrace and Rutherglen, near Greymouth; Ballarat Hill, in the Waimea Valley; and the Houhou Lead, near Hokitika.

On Addison's Flat and at Charleston the ironsand deposits are developed on a most extensive scale, and have yielded, and still yield, great quantities of gold. At both places further oxidation of the magnetite has taken place, and rusty-coloured ironsand cements are the results. This fact has entailed an enormous loss of gold to the claim-holders working the cement, as the gold coated with iron-oxide escapes being caught by the means employed for that purpose, and, finding its way into the tailings-channels and streams, a part of such escaped gold is again recovered by various contrivances placed so as to intercept it, and a part carried to the seaboard tends to enrich the black-sand deposits within tide-mark. Between Charleston and Brighton these deposits rise to a height of 600 ft. above the sea; more to the south they gradually attain to lesser elevations, and south of Hokitika are but little above sea-level.

On the shores of Foveaux Strait, it is only at Orepuki and near the mouth of the Waiau River that these deposits reach any distance inland, or more than a very moderate height above the level of high-water mark. East of the Bluff, and from the vicinity of Dunedin to the northern boundary of the Otago Provincial District, the auriferous black-sand deposits are confined to the limits between high- and low-water mark, or to less than 25 ft. above that.

Along the east coast, within the Canterbury Provincial District, it is only between Lake Ellesmere and the mouth of the Rakaia River that auriferous sands payable to work are found. These, however, do not contain notable quantities of magnetic ironsand, but for the most part they are grey or garnetiferous. North of Christchurch, while at places it is evident that great elevation (in modern times) of the land has taken place, and old beaches can be traced up to at least 400 ft. above the sea, only traces of gold have been found, and black sand does not abound.

The great richness in gold of these sands enabled them to be worked with profit when the means employed were both costly and of a rude description. At many places the yield was phenomenal, and thus there has been impressed on the New Zealand miner the full importance of the deposits, and black-sand claims are still in favour. Many deposits are rich only in particular parts, or are poor generally, and any means that tended to lessen the cost of extraction of the gold would be a boon to the black-sand miner, and should be hailed accordingly.

AURIFEROUS IRONSANDS ON THE WEST COAST.

By Alexander McKay, F.G.S., Government Geologist.

North Westland.—Littoral Deposits.*

These comprise the black-sand beaches at low levels along the present coast-line. Generally they are limited by a terrace escarpment of the more elevated lands on the inward side, which runs nearly parallel to the coast-line, but near the mouths of the larger rivers they recede inland, and become

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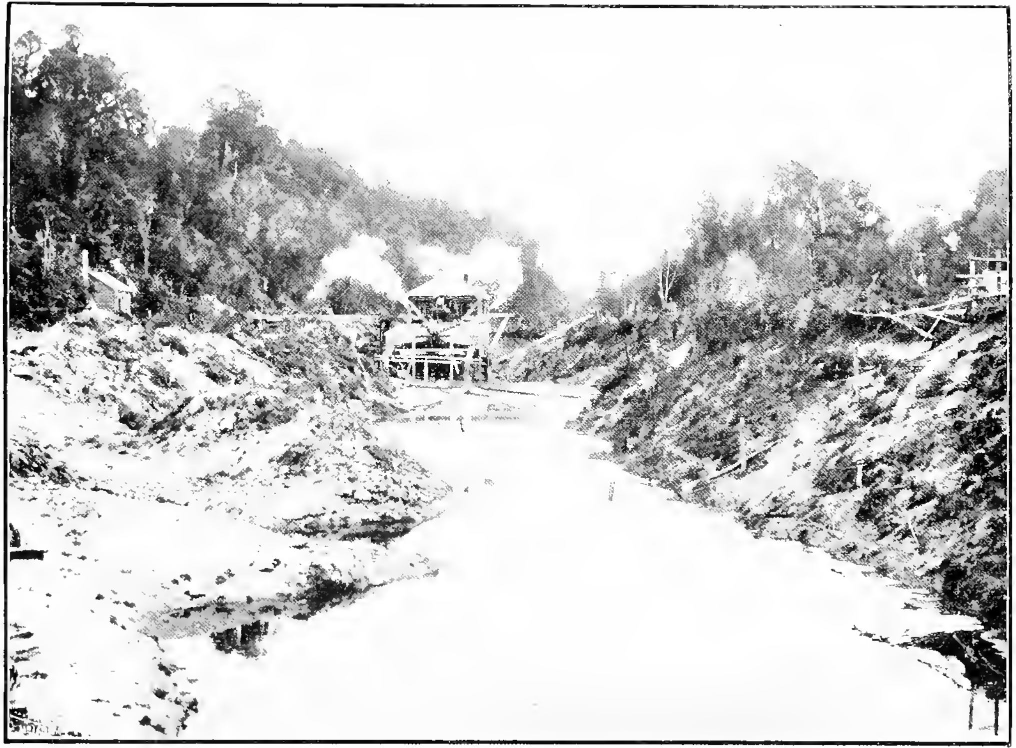
* "Geological Explorations of the Northern Parts of Westland," Mines Reports, 1893, C.-3, p. 161.

less marked, and here the deposits of the littoral zone blend with those brought down by the rivers.

These littoral deposits have been a great source of gold on the West Coast. From the mouth of the Grey River to the Mikonui the active living beaches at all places yield gold, and at many localities have proved extremely rich. By the continued action of the surf the heavier materials—gold and black sand—are associated together, and there, between high- and low-water mark, accumulate to what appears as a stratum of black sand, which, varying in thickness, may be either exposed at the surface or buried under a variable thickness of ordinary grey sand. The gold usually is very fine, and special means for saving and collecting the same had to be devised. At one time a large population of miners were remuneratively employed on this and the other inland beaches between the tide-mark and the terrace escarpment marking the limits of Pleistocene erosion and the last elevation of the land. This elevation has been but slight, and the strip of low land between the terrace escarpment and the sea indicates rather a cessation of erosion than an elevation of more than a few feet. As a consequence—the rivers supplying the material—the beaches were built out from the foot of the cliffs, and the auriferous black-sand beds, whether at the surface or covered to a variable depth as above described, were further covered up by deposits of drift sand carried inland from the beach within tide-mark by the westerly winds. There has thus been formed a line, and often a double line, of low sandhills between the present beach and the higher grounds. These æolian deposits are underlain by old black-sand beaches, not differing from and often continuous with that formed and exposed by the action of the sea at the present time. Where the sandhills form a double line the depression between is sometimes bared of drift sands by subsequent action of the winds, or swamps and shallow lagoons may be present. Between the sandhills and foot of the terrace escarpment, where present, there is usually a swampy depression, on the inland edge of which, so far as it could be worked seawards, gold under similar conditions to that on the beach and under the sandhills has occurred, but



Gold-dredging, Lake Mahinapua, near Hokitika, Westland.

Mining Handbook.

the water at present prevents this being further worked without the application of special dredging and pumping appliances. It is not the function of this report to point out how the remaining gold is to be won; but, being well satisfied that a large amount of gold is yet to be obtained from these deposits, the appliances in use will have to be perfected so far as to cope with the difficulty of its extraction in a satisfactory manner.

Along the different lines that have been worked these deposits are usually spoken of as "black-sand leads," but to me the term is misleading, as I am well satisfied that a more or less continuous stratum of gold-bearing sand will be found from the foot of the cliffs to the present beach, or, where these are absent, from the point where the fluviatile deposits of the rivers give place to the deposits of the littoral zone.

The source of the black-sand gold within high-water mark, and the lower black-sand leads parallel thereto, is supposed to be mainly the fine gold carried along the beds of the larger rivers and distributed to the different beaches by the action of the sea. That gold in this manner does reach the coast-line, and is so distributed, is not to be doubted; and as an instance in illustration the Arahura River may be cited, the beaches of which for the first ten miles up the valley were rich in gold. The New River also is proof of the same thing. However, in the one case—to wit, the Arahura—the gold may have been directly derived from the rocks *in situ;* in the other case, that of the New River, it has been derived from pre-existing auriferous gravels. But, apart from such considerations, to refer the whole of the beach gold to the golden sands carried along the beds of the rivers to the sea implies a greater richness of these than seems to be borne out by the facts which have already been cited, and such rivers as the Teremakau and the Hokitika, apparently, do not play an important part in the accumulation of gold upon the beaches—that is, if we judge of them by the comparative barrenness of their gravels along the greater part of their courses. It is more probable that no inconsiderable part of the gold found on the beaches must be referred to the action of the sea in cutting away and reassorting the older deposits of the more elevated black-sand leads, and the auriferous gravels of older Pliocene or Miocene date, where these latter have been or are exposed to its action Where the high-level marine gravels are absent, as, for instance, between the mouths of the Hokitika and Totara Rivers, and glacier deposits are present, to these latter must be referred no inconsiderable part of the gold found on the black-sand beaches.

Nelson-Westland.—Littoral.*

These deposits consist of the moving sands and shingle of the tide-way 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 25 ft. 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; those on Craig's Freehold, on the south side of the river, have yielded during the last three years (1892–95) 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 tideway 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

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* "Geology of the South-west Part of Nelson and the Northern Part of the Westland District," Mines Reports, 1895, C.–13, pp. 17, 18, 21, 22, 23.

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 rivers, 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 though "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.

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.

On the opposite side of the valley it was traced in Scotty'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 reason 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 was here very rich in gold, probably richer than at any other point of the line to the southward.

* * * * * *

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 Scandinavian 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 terraces. 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 Houhou 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 200 ft. to 300 ft. 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 Mountain, to the north-east of Barrytown, 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 200 ft. 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 500 ft. and 600 ft. above the sea. Between the Four-mile and Candlelight the highest point reached by the black-sand deposits is somewhat less, some 450 ft., and this height is practically maintained to Bald Hill, overlooking the Lower Buller Valley.

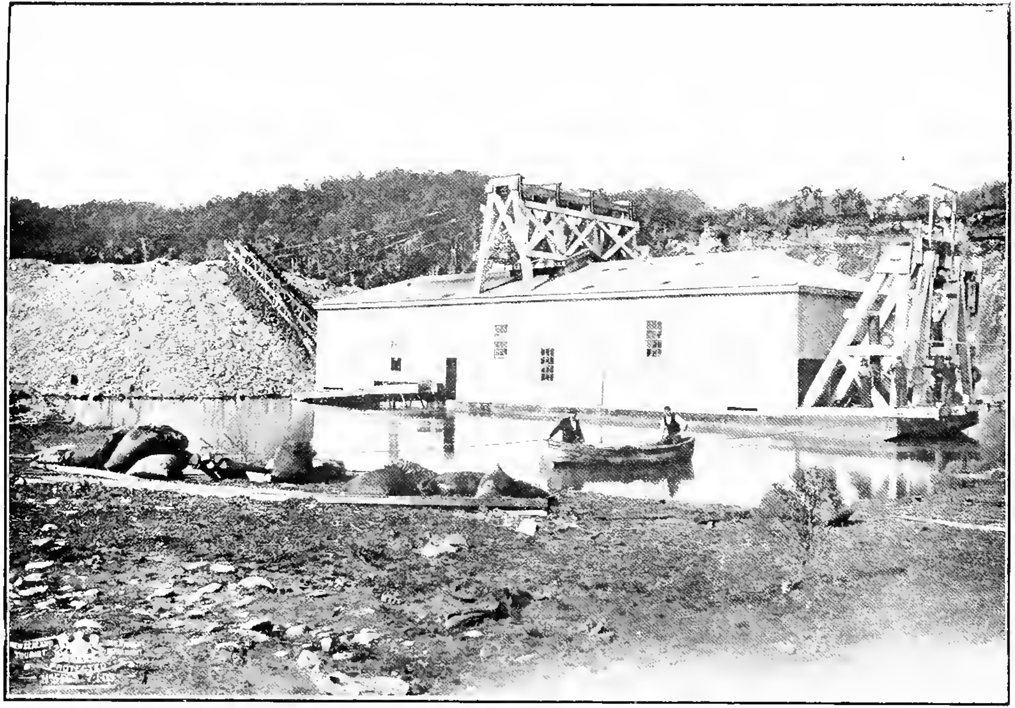
In the neighbourhood of Charleston these deposits are of great extent, and occur at all levels up to that stated, and from them an enormous quantity of gold has been obtained. The "Back Lead" at Charleston lies along the foot of the limestone range between the Nile River and the Four-mile Creek. Along 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," "Lamplough 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.

NOTE.—For more detailed information the reader is referred to "Mines Reports," 1893 and 1895, to be obtained from the Government Printer, Wellington; price, 5s.



Kohinoor Dredge, Ross, Westland.

TREATMENT OF AURIFEROUS BLACK SANDS.

Bonus of £2,000 offered by the New Zealand Government.

It has been frequently asserted that, whilst the Mines Department has done a great deal for the encouragement and development of quartz-mining and hydraulic elevating and sluicing, it has ignored the dredging industry, and particularly that branch of it relating to the saving of the fine gold lost in the tailings. To show how groundless these assertions are, it may be stated that an offer of a bonus of £2,000 was made for an invention to save the gold from black sands, and a notification to that effect was published for a period of two years in the *New Zealand Gazette* and *New Zealand Mines Record*, and this notification was widely copied by mining and technical journals in Australia, the United States, Canada, Great Britain, and the Continent of Europe. The first notice was published in the *Gazette* of the 14th November, and the *New Zealand Mines Record* of the 16th November, 1901, and the bonus was made payable up to the 1st January, 1904. Although a very large number of inquiries were received from many different parts of the world, the bonus was never claimed. It is clear, therefore, that those who charge the Department with negligence in this matter must either not be aware of the facts or else totally ignore them. It may also be stated that in the annual reports of the officers of the Mines Department, laid before Parliament and widely circulated, attention was called year after year to the loss of fine gold that occurred in connection with dredging operations, and it is probably due to the efforts of the Department that more attention is now being paid to this important matter.

QUARTZ-MINING IN NEW ZEALAND.

Quartz-mining has for some years past been gradually assuming the position of a steady industry, and the yields from the principal mines have been increasing, and are likely to still further increase in the future. Some interesting details are appended of the operations and yields of the various mines, and other particulars are given in the earlier portions of the Handbook by the Inspectors of Mines and Wardens.

Hauraki Goldfields.

Auckland, Whangamata.—Area, 349 acres. The mine is opened by four tunnels driven a total distance of 2,080 ft., and crosscuts have been driven 450 ft. There is a 10-stamp mill and one rock-breaker. The gold is saved by amalgamation and cyanide, three tailings-vats, 20 ft. by 4 ft., being in use. During the year 1905 about 1,000 tons was crushed, yielding 2,186 oz. of bullion; value, £4,368 8s. 2d. Total capital actually called up, £1,875; total expenditure to 31st December, 1905, £3,140 11s. 10d. Forty-seven men employed in the mine, battery, and surface works. Value of mining plant, &c., £1,500. Owners, Auckland Gold-mining Company; mine-manager, D. Sheehan; battery-superintendent and metallurgist, G. S. Orbell; secretary, H. Gilfillan, jun., Auckland.

Day Dawn and Norfolk, Tararu.—Area, 159 acres. The reef operated on is from 3 ft. to 4 ft. in width, opened by tunnels driven a distance of 1,000 ft.; old levels and adits were driven 5,000 ft. The battery consists of 30 stamps, 1,000 lb. each, with an average duty per stamp of 2 tons per diem. The gold is saved by amalgamation and cyanide; there are four 100-ton vats and three 40-ton agitators. During the year 1905 the yield of gold from 865 tons was 441 oz. 17 dwt., value £1,257 17s. 6d. Total amount of expenditure by present holders, £12,500; value of plant, &c., £6,000. Twelve men employed. Owners, Agnes Graham Trower; superintendent, R. W. Powell; mine-manager, E. Cartwright; secretary, W. Barton, 34 Clement's Lane, Lombard Street, London, E.C.

Golden Drop, Punga Flat, Thames.—Area, 8 acres. The reef operated on is opened by two tunnels, driven a distance of 500 ft. During the year 1905, 3 tons of ore yielded 22 oz. of gold, value £57 10s. 1d. Total yield, 247 oz. 16 dwt; value, £622 13s. 3d. Owner, George Fisher.

Golden Pah, Kauri Block, Coromandel.—Area, 22 acres. There is a three-compartment shaft, 11 ft. by 7 ft., sunk to a depth of 200 ft. During the year 1905 about 16½ tons was crushed for a yield of 132 oz. of gold, value £368. The mine has been worked by six tributers. Value of plant, £1,200. Mine-manager, A. N. Jamieson; secretary, H. Gilfillan, jun., Auckland; owned by syndicate.

Great Barrier, Great Barrier Island.—Area, 188 acres. One reef, about 18 in. in width, is being operated on. There is a 5-stamp mill in use with an average duty per stamp of 2·8 tons per diem, and one rock-breaker. There are nine tailings-vats—four 22 ft. by 7 ft., three 14 ft. by 7 ft., and two 20 ft. by 4 ft. Total expenditure to 31st December, 1905, £30,000. Thirteen men employed. In the year 1901 the Barrier Reefs Company, which held this property, went into liquidation. Since then the mine has been privately owned, and early this year work was restarted. Mine-manager, J. G. Vivian; secretary, H. Gilfillan, Auckland.

Kapowai, Gumtown, Mercury Bay. — Area, 35 acres. Three reefs are operated on, varying in size from 6 in. to 16 ft. in width, and are opened by three tunnels driven a distance of 200 ft., and crosscuts 200 ft. The battery consists of 8 heads, the average duty per stamp being 2 tons per day. During the year 1905, 1,190 tons was crushed, yielding 969 oz. 6 dwt. 20 gr. of gold; value, £2,469 17s. 7d. Total quantity of ore crushed 2,819 tons, yielding 2,333 oz. of gold; value, £5,599 4s. Total expenditure to 31st December, 1905, about £5,000. Value of plant, &c., £2,000. Thirteen men employed. Mine-manager, John Carroll; owner, Michael O'Connor.

Komata Reefs, Komata, Ohinemuri County.—Area, 144 acres—64 acres, Te-Ao-Marama; and 80 acres, Komata Reefs Special Claim. The mine is opened by one three-compartment shaft 800 ft. in depth. Five reefs are being operated upon, varying in width from a few feet to 20 ft., the distance driven on the course of the lodes being: Te-Ao-Marama No. 1 reef, 2,460 ft.; No. 2 reef, 3,460 ft.; Wilson's Lode, 4,920 ft.; Hartridge's Lode, 840 ft.; Lavington's Lode, 410 ft.; Komata Lode, 320 ft. The total length of crosscuts driven through country is 6,250 ft. The battery consists of 20 stamps, each weighing 1,000 lb., the average duty per stamp being 3½ short tons (2,000 lb.) per diem; two rock-crushers; and one tube mill: the capacity being 72 tons per day. Fourteen tailings-vats, 22 ft. in diameter and 8 ft. deep, are in use, seven of which are fitted with agitating gear for slimes, and there are two vacuum filters. The gold is saved by amalgamation over copper tables, and cyaniding of sands and slimes. During the year 1905, 16,820 tons (2,240 lb.) yielded 8,870 oz. 4 dwt. of gold and 39,629 oz. of silver, value £42,336 10s. 10d.; out of which dividends amounting to £13,333 6s. 8d. have been disbursed, making a total of £26,666 13s. 4d. The total quantity of ore crushed is 90,400 tons; total sands treated, 52,590 tons; slimes, 37,000 tons; yield, 37,831 oz. of gold and 181,257 oz. of silver; total value, £180,357. Expenditure to 31st December, 1905, £197,479 7s. 10d. Capital called up, £200,000. The first claim operated on by this company was the Komata Reefs, upon which active work was commenced in 1897. A 20-stamp dry-crushing battery was erected (driven by water-power), and this began running in September, 1897.

The manager of this property (Mr. F. C. Brown) furnishes the following further particulars: In March 1898, the process was changed to wet crushing. During the years 1898 and 1899 a low-level tunnel, 3,000 ft. in length, was driven to open up 400 ft. of new ground in the Komata Reefs Claim, and for a portion of the time that this tunnel was being driven the battery was closed down (from October, 1899, to March, 1901). Early in 1902 the company acquired the Te-Ao-Marama Claim, lying to the north of the Komata

Reefs Claim, and during the last three years most of the work has been confined to opening up this ground. The most important work done has been the extension of the Komata Reef low level to the Te-Ao-Marama shaft, and the connecting of this level with the bottom of the shaft. This has made available 400 ft. (vertical) of untouched ground. There are two reefs being worked in the Te-Ao-Marama ground, called Nos. 1 and 2. The chief levels at present are Nos. 3 and 4. At No. 3 level both reefs are being driven on northwards, and the outlook is very encouraging, as No. 1 reef is 7 ft. wide, and No. 2 reef 20 ft. wide, both reefs carrying payable ore. At No. 4 level the No. 2 reef is being driven on, and is carrying payable ore 6 ft. wide. Most of the ore now sent to the battery is at present being stoped from the No. 3 level. During the four months ending 26th June, 1906, a small electric rock-drilling plant (two rock-drills) has been in operation, and the results are so satisfactory that it is the intention to instal a complete drilling plant of this class. All the ore broken in the Te-Ao-Marama Claim is trucked out of the No. 8 level tunnel, and tipped over a "grizzly" into two storage-hoppers—one for the coarse and one for the fines. From these hoppers it is trammed to the battery, a distance of three-quarters of a mile. The tram-line is down grade (3 per cent.) to the foot of an incline at the battery, and the trucks are hauled up this incline by means of a friction-hoist operated by the battery machinery; each truck holds 4 tons. The battery consists of 20 stamps of 1,000 lb. each, two rock-crushers, and one tube mill. The capacity is 72 tons per day. The treatment is—(1) rock-crushers, (2) stampers, (3) tube-mill grinding, (4) amalgamation over copper tables, (5) separation of sands from slimes, (6) cyaniding of sands in percolation-vats, (7) filter-pressing (vacuum system) of the slimes before cyanide treatment, cyanide treatment by agitation method, and filter-pressing of slimes after treatment. The cyanide-solutions are precipitated in the usual way by zinc shavings. The clean-up is by the sulphuric-acid method, the bullion-slimes being melted in benzine furnaces. Power is supplied by a Marshall and Son horizontal steam-engine and by a 6 ft. Pelton wheel working under 175 ft. head. Arrangements are being made to increase the capacity of the battery by the addition of a suction-gas plant of 100-horse power and a second tube mill and extra treatment plant. Benzine is exclusively used for fuel at the assay office, and there is a benzine-furnace of special design at the mine for tool-sharpening, and is found to be highly satisfactory, as it is economical, and there is no danger of overheating the steel. One hundred and sixty men are employed in mine, reduction-works, and surface. Approximate value of plant, £20,000. General manager, F. C. Brown; mine-manager, James H. Benney; battery-superintendent, Samuel D. McMiken.

Kuranui, Shotover Creek, Thames.—Area, 73 acres 3 roods 5 perches. The reef operated on is 1 ft. to 5 ft. wide, opened by three tunnels, driven a total distance of 2,626 ft., and crosscuts 2,300 ft. There is a 20-stamp mill and ten berdans in connection with this mine, but the battery has not been worked for some years. Capital called up, £9,612 12s.; total expenditure to 31st December, 1905, £9,580 1s. 5d. Value of plant, £882. Mine-manager, G. W. Horn; secretary, J. W. Nichol, Auckland; owners, Kuranui Gold-mining Company.

Kuranui-Caledonian, Thames.—Area, 29 acres 3 roods 30 perches. The mine is opened by one three-compartment shaft 474 ft. in depth. Three reefs—18 ft., 2 ft., and 1 ft. 6 in. in width—are being operated upon, and very extensive drives and crosscuts have been carried out. During the year 1905, 196 tons yielded 396 oz. 14 dwt. of gold; value, £764 13s. Capital called up, £30,000. Eighteen men are employed in the mine. Value of plant, £1,000. Mine-manager, Matthew Paul; secretary, H. Gilfillan, jun., Auckland; owners, Kuranui-Caledonian (Limited).

Mahara-Royal, Waipotukahu, Tapu Creek.—The reef operated on is 6 ft. in width, opened by three tunnels, the distance driven on the course of the lodes being about 3,000 ft.; length of crosscuts through country, 2,500 ft. There is a 20-stamp mill and one rock-breaker. During the year 1905, 1,400 tons was crushed, yielding gold to the value of £1,364

Nine men are employed in the mine and reduction-works. Value of plant, £1,000. Mine-manager, W. G. Martin; secretary, J. B. Sheath, Auckland; owners, Mahara-Royal Gold-mining Company.

Miner's Right, Puriri, Thames County.—Area, 60 acres. Total length driven on course of leaders, 350 ft.; crosscuts, 540 ft. During the year 1905, 12 tons of ore yielded 31 oz. of gold, value £85. Total quantity of ore crushed, 629 tons; yield, 589 oz. of gold; value, £1,619 15s. There is a 6-head battery. Mine-manager and battery-superintendent, John McInnes; owners, George Greenaway and John McInnes.

New Bunker's Hill, Coromandel.—Area, 3 acres and 12 perches. The mine is opened by a tunnel driven a distance of 540 ft., and 93 ft. has been driven on a reef formation. There is a three-compartment shaft, 10 ft. by 4 ft., sunk to a depth of 280 ft. Mine-manager, Samuel Carlyon; acting-secretary, A. J. Denniston, Auckland; owners, New Bunker's Hill Gold-mining Company.

New Four-in-Hand, Kennedy's Bay, Coromandel County. —Area, 89 acres 3 roods 20 perches. The reef operated on is from 1 ft. to 5 ft. in width, opened by a tunnel carried a distance of 700 ft. During the year 1905 the battery (7 stamps) crushed 95 tons of ore, yielding 86 oz. of gold. Value of plant, &c., £2,000. Mine-manager, W. Moorcraft; secretary, R. A. Aicken, Auckland; owners, New Four-in-Hand Gold-mining Company.

New May Queen, Waiokaraka, Thames.—Area, 93 acres. This property is opened by a three-compartment shaft (12 ft. by 4½ ft.), which is sunk to a depth of 520 ft. During the year 1905, 69½ tons of ore yielded 237 oz. of gold; value, £679 8s. Total expenditure to 31st December, 1905, £2,770. Value of plant, £500. Ten men employed. Mine-manager, W. Baker; secretary, J. W. Nichol, Auckland; owners, New May Queen Gold-mining Company.

New Moanataiari, Moanataiari and Waiotahi Creeks, Thames.—Area, 77 acres 2 roods 20 perches. A three-compartment shaft, 12 ft. by 5½ ft., has been sunk on this property to a depth of 500 ft. The reef now being worked has a width of 20 ft. Total length of drives on course of lodes, 10,000 ft.; length of crosscuts, 4,000 ft.; estimated quantity of ore in sight, 20,000 tons. During the year 1905, 160 tons of ore yielded 106 oz. of gold; value, £280 2s. 7d. Average number of men employed, 16. Total expenditure to 31st December, 1905, £4,000. Value of plant, £1,300. Mine-manager, G. S. Clark; secretary, H. Gilfillan, jun., Auckland; owners, New Moanataiari Gold-mining Company.

New Saxon.—Area, 62 acres and 30 perches. A three-compartment shaft has been sunk to a depth of 452 ft. One reef, varying from 2 in. to 6 in. in width, is being operated upon; distance driven on course of lodes, 15,040 ft.; total length of crosscuts, 5,940 ft.; winzes sunk 1,400 ft. During the year 1905, 213 tons yielded 294 oz. of gold; value, £846 2s. 4d. Capital called up, £2,916 13s. 4d. Value of mining plant, £3,000. Mine-manager, J. Rickard; secretary, J. B. Sheath, Auckland; owners, New Saxon Gold-mining Company.

New Una, Karaka Creek, Thames.—Area, 54 acres. Three reefs are being operated on—No. 2, 15 in.; No. 3, 18 in.; No. 4, 2 ft. in width. The mine is opened by several tunnels, driven a distance varying from 300 ft. to 1,500 ft. The battery consists of 15 heads, with an average duty per stamp of 2 tons per diem. Tables, blankets, and berdans are used to save the gold. During the year 1905, 200 tons of ore yielded 163 oz. 6 dwt. of gold; value, £458 13s. 6d. Capital called up, £2,400. Total expenditure to 31st December, 1905, £3,082 16s. Mine-manager, James Thomas; secretary, H. Gilfillan, jun., Auckland; owners, New Una Gold-mining Company.

New Zealand Crown Mines, Karangahake.—Area, 404 acres. Two reefs, 4 ft. and 3 ft. in width, are being operated upon. Nineteen main tunnels have been driven, the total drivages on course of lodes being 24,910 ft.; while drives and crosscuts total 3,844 ft. The pump-shaft is down to a depth of 506 ft., and the pumps have a capacity of 36,000 gallons per hour. At the reduction-works there is a 60-stamp mill, each stamp having a daily capacity of 1 ton 18 cwt. when fully employed; two rock-breakers;

ROUND HILL GOLD-MINING COMPANY: NOZZLES AND HYDRAULIC ELEVATOR.
Mining Handbook.

thirty-four tailings-vats, 22 ft. 6 in. diameter; and three filter-presses. The ore is crushed wet, a small percentage of cyanide of potassium being used in the mortar-boxes. During the year 1905, 19,069 tons (2,240 lb.) yielded 8,906 oz. of gold and 6,679 oz. of silver; value, £38,662. The total quantity of ore crushed since 1891 was 274,559 tons, for a value of £625,434, and of this amount £532,380 was obtained since the year 1896, while dividends have been paid to the extent of £70,000 since 1896. Capital called up, £200,000, in 200,000 shares (principally held in Scotland and England) of £1 each fully paid, of which £50,000 was provided for working-capital. Total expenditure in connection with mining operations from January, 1896, to 31st December, 1905, £504,260. Approximate value of mining plant, reduction-works, &c., £77,000. One hundred and seventy men are employed in connection with the mine, reduction-works, and surface. General manager, F. R. W. Daw; mine-manager, George N. McGruer; battery-superintendent, James J. Barrett.

Old Alburnia, Thames.—Area, 191 acres and 2 perches. The mine is opened by a three-compartment shaft 400 ft. in depth. During the year 1905, 375½ tons was crushed, yielding 686 oz. of gold; value, £1,828 15s. 8d. Total capital called up, £8,250; total expenditure to 31st December, 1905, £8,368 5s. 11d. The mine is worked by twenty-eight tributers, and twelve men on wages. Value of plant, £3,000. Mine-manager, H. Kendall; secretary, J. B. Sheath, Auckland; owners, Old Alburnia Gold-mining Company.

Old Hauraki, Coromandel.—This mine, which had phenomenal yields in the past, and paid large dividends, is opened by a three-compartment shaft, 11 ft. by 7 ft., sunk to a depth of 400 ft. During the year 1905, 59½ tons yielded 258 oz. 6 dwt. of gold; value, £775 11s. 9d. The mine is being worked by nineteen tributers, who have confined their operations to the surface portion of the mine, where the leads are very small, and so far few of the tributers have made more than ordinary wages. The company has assisted some of them by paying half wages and taking half shares in their tributes; in other cases the company has taken one-third interest and paid one-third wages and other expenses. Until the mine is unwatered and mining operations are resumed at some depth, it is unlikely that anything of much importance will be discovered. Approximate value of plant, £4,000. Mine-manager, John Goldsworthy; secretary, H. Gilfillan, Auckland; owners, Old Hauraki Gold-mining Company.

Rising Sun, Owharoa, Ohinemuri County.—Area, 58 acres 1 rood 21 perches. The reefs operated on are from 18 in. to 3 ft. in width, opened by two drives, the top level crosscut being 200 ft. and the lower level 940 ft. Total length driven on course of various lodes: Main reef—top level 160 ft., low level 95 ft.; footwall reef—low level, 360 ft. Seven men employed. Mine-manager, Thomas Goldsworthy; secretary, J. H. Jackson, Auckland; owners, Rising Sun Gold-mining Company.

Royal Oak of Hauraki, Tokatea, Coromandel.—Area, 114 acres 3 roods 11 perches. During the year 1905 the company's 10-stamp mill crushed 219 tons of ore and 1,257 lb. of picked stone for a yield of 801 oz. 10 dwt. of gold, value £1,656. Total expenditure by present company to 31st December, 1905, £1,529 17s. Value of plant, £500. Twenty-eight tributers were at work during the last six months of the year 1905, and twenty wages-men for the previous six months. Mine-manager, George McNeil; secretary, H. Gilfillan, jun., Auckland; owners, Royal Oak Gold-mining Company (Limited), Auckland.

Sunbeam, Blind Bay, Great Barrier Island.—Area, 100 acres. The mine is opened by two tunnels, No. 1 being 550 ft. and No. 2 100 ft. on reef. The total distance driven on course of lode, which is 2 ft. 6 in. wide, is about 650 ft., and crosscuts driven through country 1,000 ft. There is a 5-stamp mill, one rock-breaker, three agitation-vats, and three sand-vats, each having a diameter of 16 ft. Amount of capital called up, £11,486 5s. Value of plant, £4,000. Mine-manager, James A. Gordon; secretary, J. H. Jackson, Auckland; owners, Sunbeam Gold and Silver Mining Company.

Talisman Consolidated, Karangahake.—Area, 507 acres. The mine is opened by tunnels and a four-compartment shaft, which is now 445 ft. below river-level. The reef at present operated on varies in width from 4 ft. to 20 ft., the distance driven by tunnels and crosscuts being 5,075 ft., while the rises and winzes total 1,953 ft. There is a 50-stamp mill, each stamp having an average duty of 3·17 tons per diem, four rock-breakers, and sixteen tailings-vats (diameter 22 ft.). The gold is saved by amalgamation, cyaniding, and concentration. During the year 1905, 44,725 tons yielded 290,786 oz. of bullion, value £129,088. Total quantity of bullion obtained, 993,055 oz.; value, £446,875. Dividends amounting to £30,000 were disbursed in 1905, the total dividends now paid amounting to £45,000. Amount of called-up capital, £270,000. Value of mining plant, &c., £50,000. Two hundred and thirty-five men employed in mine, reduction-works, and surface. General manager, H. Stansfield; mine-manager, J. McCombie; battery-superintendent, G A. Chappell; metallurgist, H. E. Phillips; owners, Talisman Consolidated (Limited), composed of colonial and English shareholders.

Tokatea Consolidated, Tokatea, Coromandel.—Area, 40 acres. The mine is opened by five tunnels, driven a total distance of 1,200 ft. Three reefs about 6 in. in width are operated upon, the various lodes being driven on for a distance of 600 ft. During the year 1905, 35 tons yielded 225 oz. 10 dwt. of gold, value £639 19s. There are 3 stamps and two berdans in connection with this mine, the value of plant being estimated at £350. Mine-manager and battery-superintendent, R. H. Harrison; secretary, C. R. Walker, Auckland; owners, Tokatea Consolidated Gold-mining Company.

Victoria, Thames.—Area, 41 acres 3 roods 10 perches The mine is opened by two shafts—Imperial, 600 ft., and Tookey, 400 ft. in depth. Two reefs are being operated on, varying in width from 1 ft. to 3 ft.; estimated length of crosscuts through country, 4,000 ft. During the year 1905, 162 tons was crushed, yielding 250 oz. of gold; value, £684 4s. 3d. Total quantity of ore crushed, 4,200 tons, yielding 5,150 oz. of gold; value, £14,075. Total expenditure to 31st December, 1905, £29,713 4s. 2d. Capital called up, £18,775 Value of plant, &c., £500. Eight men employed. Mine-manager, Thomas Moyle; secretary, J. J. Macky, Auckland; owners, Victoria Gold-mining Company.

Vulcan Extended and Eclipse, Tararu, Thames.—Area, 200 acres. This mine is now let on tribute. Gold obtained during the year 1905, 1,123 oz.; value, £3,154 9s. 9d. Total quantity of gold obtained, 1,423 oz.; value, £4,021 19s. 9d. Dividends paid, £1,250. Total capital called up, £10,000; total expenditure to 31st December, 1905, £6,792 1s. 11d. Value of plant, £2,000. Secretary, H. Gilfillan, jun., Auckland; owners, New Eclipse Gold-mining Company.

Waihi.—Area, 874 acres. Six shafts have been sunk on this property—No. 1 (winding), 708½ ft. in depth; No. 2 (pumping and winding), 732 ft.; No. 3 (winding, not in use), 348 ft.; No. 4 (winding), 703½ ft.; No. 5 (main pumping-shaft), 863 ft.; and No. 6 (winding), 553½ ft. in depth. The pumps have a capacity of 135,000 gallons per hour. Fourteen reefs are operated on, varying in width from 2 ft. up to 98 ft During the year 1905 drives, crosscuts through country, and winzes sunk totalled 18,678 ft., equal to 3·537 miles; the total drivage in mine to end of 1905 on reefs and main crosscuts (excluding crosscuts through reefs) being 18¼ miles. There is a 90-stamp mill at Waihi, 200 stamps at Victoria Mill, and 40 stamps at the Union Mill, the average duty per stamp being 3·124 tons per diem. There are eight rock-breakers (five at the Victoria Mill, two at Waihi, and one at the Union Mill), fifty-six tailings-vats at the Waihi Mill, seventy at Victoria Mill, and thirty-one at the Union Mill, and eighteen filter-presses. During the year 1905, 298,531 tons (2,000 lb.) was crushed, yielding 1,192,046 oz. of bullion; value, £728,521 10s. 2d., or an average of 12s. 6d. per ounce. Dividends were disbursed during the year amounting to £346,228 10s. 3d., making a total to 1st June, 1906, of £2,122,981. The value of gold and silver obtained from this mine to end of 1905 was £4,573,701; and during the year 1906 up to 19th May, £301,711. Amount of capital called up, £495,907. Total number of men employed in mine, reduction-works, tramways, and water-races, 1,396. The following table, compiled from the last annual report of the directors, gives a concise summary of the company's operations:—

—	Tons.	Value of Yield.	Total Distribution per Share.	Number of Dividends.	Amount of Dividends (including Interest on Instalments of Shares).	Income-tax.	Total.
		£	£ s. d.		£ s. d.	£ s. d.	£ s. d.
To 31st July, 1890	Unknown	13,628	..	..	..	..	..
31st July, 1890, to 31st Dec., 1891	"	36,458	..	..	..	..	..
For year 1892 ..	18,297	46,219	..	..	..	..	..
" 1893 ..	19,805	64,345	0 3 0	1, 2, 3	22,500 0 0	557 7 6	23,057 7 6
" 1894 ..	24,864	83,023	0 4 0	4, 5, 6, 7	30,000 0 0	829 10 6	30,829 10 6
" 1895 ..	33,670	120,335	0 8 0	8, 9, 10, 11	64,000 0 0	1,966 19 2	65,966 19 2
" 1896 ..	34,410	135,156	0 8 0	12, 13, 14, 15	64,000 0 0	2,531 3 3	66,531 3 3
" 1897 ..	40,764	144,041	0 8 0	16, 17, 18, 19	64,000 0 0	3,384 5 0	67,384 5 0
" 1898 ..	77.929	256,494	0 8 0	20, 21, 22, 23	98,363 16 9	4,250 0 8	102,613 17 5
" 1899 ..	102,381	302,525	0 8 0	24, 25, 26, 27	128,000 0 0	4,702 4 8	132,702 4 8
" 1900 ..	112,012	317,902	0 10 0	28, 29, 30, 31	160,000 0 0	12,225 0 4	172,225 0 4
" 1901 ..	159,325	461,205	0 10 0	32, 33, 34, 35	166,425 10 6	15,850 5 6	182,275 16 0
" 1902 ..	179,485	521,574	0 10 0	36, 37, 38, 39	209,900 10 3	15,980 5 0	225,880 15 3
" 1903 ..	231,323	658,393	0 12 0	40, 41, 42, 43*	297,544 4 0	15,211 19 4	312,756 3 4
" 1904 ..	259,978	683,882	0 12 0	44, 45, 46, 47*	297,544 4 0	19,469 1 0	317,013 5 0
" 1905 ..	298,531	728,521	0 13 0	48, 49, 50, 51*	322,339 11 0	23,888 19 3	346,228 10 3
Totals ..	..	4,573,701	5 18 0*	51*	1,924,617 16 6	120,847 1 2	2,045,464 17 8

* And bonuses.

The amount of income-tax is added to the total dividends, as it is virtually a saving of that amount to the shareholders Secretary, Charles Rhodes, Auckland; attorney, Berkeley H. Stafford, Auckland; superintendent, H. P. Barry, Waihi; mine-superintendent, R. E. Williams; mine-manager, J. L. Gilmour; battery-engineers, S. E. Fraser (Victoria Mill), and W. M. Russell (Waihi and Union Mills); metallurgist, E. G. Banks; owners, Waihi Gold-mining Company, shares being principally held in England.

Waihi Beach.—Area, 216 acres. The mine is opened by a shaft, 4 ft. by 3 ft. 10 in., sunk to a depth of 365 ft. The reef, which has been driven on a distance of 465 ft., averages 36 ft. in width. Total expenditure to 31st December, 1905, £2,303 17s. 6d. Twelve men employed. Mine-manager, H. W. Moore; secretary, Henry J. Lee, Auckland; owners, Waihi Beach Gold-mining Company (No Liability), Auckland.

Waihi Consolidated.—Area, 300 acres. The Waihi Consolidated (Limited) holds three claims (the Favona, Brilliant, and Key West), each containing 100 acres. The shaft is a three-compartment one, 11 ft. by 6 ft., and is down a depth of 350 ft. Total amount of capital actually called up, £16,875; total expenditure up to 31st December, 1895, in connection with mining operations, £3,531 13s. 2d. Twenty men are employed, nine being engaged in sinking shaft. Mine-manager, J. H. Evans; secretary, J. H. Jackson, Auckland.

Waihi Extended.—Area, 100 acres. The mine is opened by a three-compartment shaft 650 ft. in depth. One reef, 5 ft. in width, is being operated on, the distance driven on course of lodes being 285 ft., while crosscuts total 700 ft. The underground work carried on during the past twelve months has been the driving of two crosscuts and driving on the ore-bodies. The crosscut known as the No. 2 was driven in a south-westerly direction. When a distance of 300 ft. had been driven an ore-body was intersected. At the point where this ore-body was touched it was found to be passing underfoot on its easterly trend. The reef was driven on for a length of 176 ft., the width averaging about 5 ft., and the ore being heavily mineralised. At this distance another lode was pierced at an angle, and was followed for a length of 109 ft. The ore showed highly mineralised contents, and looked remarkably well, the full width of the drive being in ore. The general appearance of the ore-bodies is considered very encouraging by the management. Total expenditure to 31st December, 1905, £20,052 5s. 3d.; called-up capital, £27,181 10s. 4d. Value of plant, £1,473 14s. Twelve men employed. Mine-manager, Thomas Johns; secretary, J. W. Nichol, Auckland; owners, Waihi Extended Gold-mining Company.

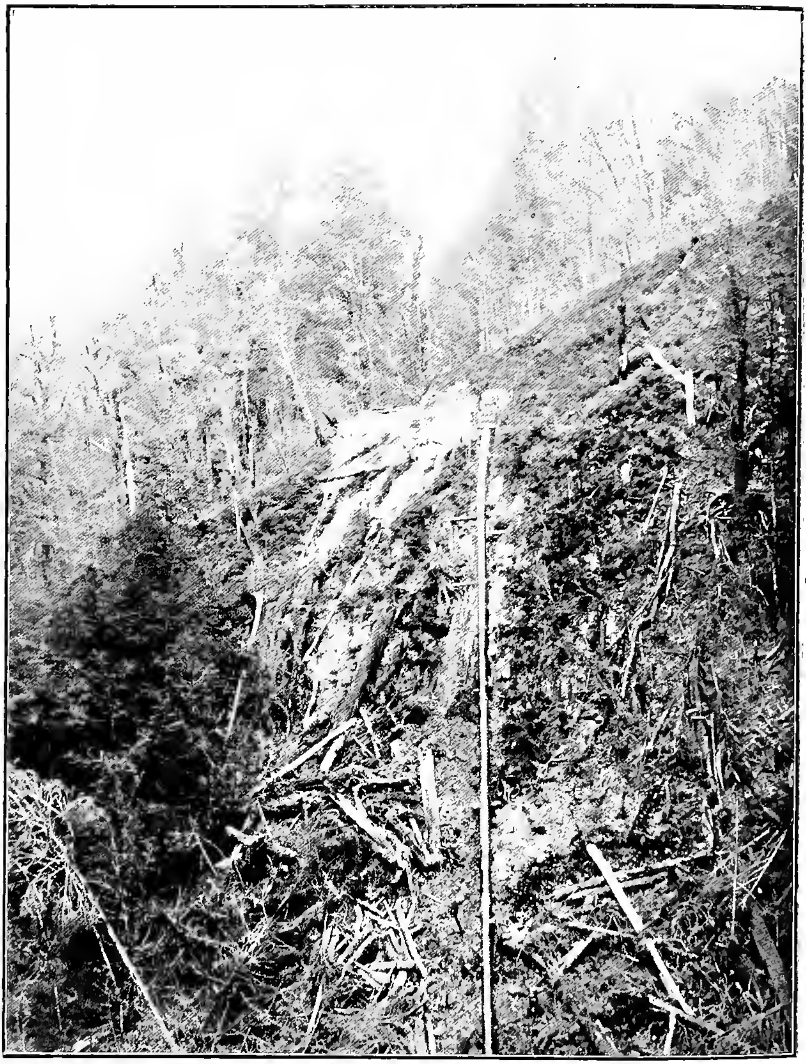
Waimangu, Whangamata, Thames County.—Area, 100 acres. Four tunnels and crosscuts have been driven a distance of 280 ft., 200 ft. being on the course of the lode, which varies from 1 ft. to 7 ft. in width, and a winze has been sunk 50 ft. Capital called up, £6,800. Six men employed since February, 1906. Mine-manager, H. P. Hornibrook; battery-superintendent, H. H. Adams; secretary, J. H. Jackson, Auckland; owners, Waimangu Gold-mining Company.

Waiotahi, Thames.—Area, 23 acres. This mine, which has been on the dividend-list for a long period, is opened by two three-compartment shafts, the main one being 428 ft. and Mary Ann 390 ft. in depth. Two reefs, 12 ft. and 2 ft. in width, are worked, the distance driven on the course of lodes being 1,055 ft., while drives and crosscuts total 1,377 ft. and depth of winzes sunk 495 ft. There is a 60-stamp mill, each stamp having an average capacity per diem of 1·37 tons, and two rock-breakers. During the year 1905, 4,986 tons, and 54 cwt. and 40 lb. of picked specimen-stone, yielded 27,148 oz. 6 dwt. of gold; value, £73,884 9s. 7d.; out of which dividends amounting to £51,300 have been disbursed, making a total of £91,800. The value of the gold obtained from this mine up to 31st December, 1905, was £266,997 15s. 9d.; while the total expenditure was £173,513 12s. 4d. The called-up capital amounts to only £15,000. During the year 1905 fifty-two men were employed in mine, reduction-works, and surface. Mine-manager, George Warne; battery-superintendent, Frederick Challis; secretary, G. S. Kissling, Auckland; owners, Waiotahi Gold-mining Company.

Waitaia and Waitaia Extended, Kuaotunu, Coromandel County.—Area, 106 acres 3 roods 16 perches. Fourteen tunnels have been driven on this property for a total distance of 7,750 ft., while the various lodes have been driven on 6,220 ft., and crosscuts through country 1,500 ft. The reef at present operated on varies considerably, from 3 in. to 7 ft. During the past year 718 tons was milled for a yield of 991 oz. 12 dwt. of bullion, valued at £2,941 11s. 6d. The total quantity of ore crushed up to 31st December, 1905, was 5,130 tons, which, together with 3,122 tons of sands cyanided, yielded 7,872 oz. 12 dwt., valued at £22,867 12s. 6d. The value of the cyanide bullion varies from £1 17s. 8d. to £2 14s. 3d. per ounce, and the battery bullion from £3 1s. 5d. to £3 5s. 6d. per ounce. Before the present company bought the Waitaia Claim the old company and tributers took out, between the years 1891 and 1898, 483 tons of ore, yielding 859 oz. 19 dwt. of bullion, valued at £2,437 15s. 2d. The company has a 10-stamp mill; also one tailings-vat, 17 ft. in diameter and 3 ft. 9 in. deep. The total expenditure up to 31st December, 1905, was £27,394. During the past four years nineteen men have been constantly employed. Mine-manager, C. H. Bennett; battery-superintendent and metallurgist, Eugene Draffin; secretary, W. H. Churton; owners, Waitaia Gold-mines (Limited).

Waitangi, Wiseman's Gully, Thames.—Area, 63 acres. The mine is opened by a tunnel driven a distance of 700 ft. Two reefs, about 3 ft. in width, are at present operated on. Mine-manager, Robert Wilson; secretary, H. J. Lee, Auckland; owners, Waitangi Gold-mining Company.

NOTE.—These mines do not by any means cover the ground; they merely represent those whose managers had the courtesy to forward information asked for. In addition to the mines enumerated, there is a further area of 6,249 a. 1 r. 17 p. held under special claims, 17 a. 1 r. 20 p. under licensed holdings, and 62 a. 2 r. 7 p. as special sites, &c.



Progress Mines of New Zealand, Reefton: Siphon of Water-race at Hut Creek.

Mining Handbook.

THE HAURAKI MINING DISTRICT.

Returns of Quartz crushed and Yield of Gold or Bullion in the Hauraki District.

District.	Quartz and Mullock crushed or sold.	Yield of Gold or Bullion.	Average Yield of Gold or Bullion per Ton.		
Coromandel—	Tons.	Oz.	Oz.	dwt.	gr.
Output for 10 years previous to 1st April, 1890	15,101	56,232	3	14	11
1st April, 1890, to 31st March, 1891 ...	5,650	9,838	1	14	19
„ 1891, „ 1892 ...	13,029	12,191	0	18	17
„ 1892, „ 1893 ...	15,163	12,954	0	17	2
„ 1893, „ 1894 ...	12,629	9,969	0	15	18
„ 1894, „ 1895 ...	15,451	22,632	1	9	7
„ 1895, „ 1896 ...	27,439	48,378	1	15	6
„ 1896, „ 1897 ...	18,848	35,886	1	18	2
„ 1897, „ 1898 ...	13,666	27,428	2	0	3
„ 1898, „ 1899 ...	12,269	20,139	1	12	19
„ 1899, „ 1900 ...	22,806	22,086	0	19	8
„ 1900, to 31st Dec., 1900 ...	16,106	14,446	0	17	22
1st Jan., 1901, „ 1901 ...	13,981	17,043	1	4	9
„ 1902, „ 1902 ...	22,589	19,167	0	16	23
„ 1903, „ 1903 ...	7,974	13,249	1	13	5
„ 1904, „ 1904 ...	5,072	8,759	1	14	3
„ 1905, „ 1905 ...	1,600	2,690	1	13	5
Totals	239,373	353,087	1	9	12

Returns of Quartz crushed, &c., in the Hauraki District—*continued.*

District.	Quartz and Mullock crushed or sold.	Yield of Gold or Bullion.	Average Yield of Gold or Bullion per Ton.		
Thames—	Tons.	Oz.	Oz.	dwt.	gr.
Output for 12 years previous to 1st April, 1890	441,388	556,878	1	5	6
1st April, 1890, to 31st March, 1891 ...	61,756	38,113	0	12	8
" 1891, " 1892 ...	86,150	45,735	0	10	15
" 1892, " 1893 ...	78,547	31,336	0	7	23
" 1893, " 1894 ...	62,444	34,637	0	11	2
" 1894, " 1895 ...	48,464	22,810	0	9	10
" 1895, " 1896 ...	44,342	26,332	0	11	21
" 1896, " 1897 ...	27,061	13,440	0	9	22
" 1897, " 1898 ...	20,850	13,482	0	12	22
" 1898, " 1899 ...	31,339	18,004	0	11	11
" 1899, " 1900 ...	36,156	33,681	0	18	15
" 1900, to 31st Dec., 1900 ...	33,367	25,117	0	15	1
1st Jan., 1901, " 1901 ...	23,870	20,473	0	17	3
" 1902, " 1902 ...	26,308	43,877	1	13	8
" 1903, " 1903 ...	22,144	23,057	1	0	20
" 1904, " 1904 ...	16,632	11,181	0	19	3
" 1905, " 1905 ...	25,007	41,074	1	12	20
Totals	1,085,825	999,227	0	18	9

	Tons.	Oz.	Oz.	dwt.	gr.
Ohinemuri—					
1st April, 1887, to 31st March, 1888 ...	2,388	3,406	1	8	13
" 1888, " 1889 ...	3,795	3,679	0	19	9
" 1889, " 1890 ...	4,773	8,564	1	15	21
" 1890, " 1891 ...	9,902	12,914	1	6	2
" 1891, " 1892 ...	13,865	23,659	1	14	3
" 1892, " 1893 ...	22,771	43,405	1	18	3
" 1893, " 1894 ...	31,281	35,666	1	2	19
" 1894, " 1895 ...	51,058	110,628	2	3	8
" 1895, " 1896 ...	57,008	147,499	2	11	18
" 1896, " 1897 ...	66,985	148,626	2	4	9
" 1897, " 1898 ...	105,126	280,708	2	13	9
" 1898, " 1899 ...	170,881	459,651	2	13	19
" 1899, " 1900 ...	212,282	489,276	2	6	2
" 1900, to 31st Dec., 1900 ...	141,638	323,603	2	5	16
1st Jan., 1901, " 1901 ...	253,664	558,626	2	4	1
" 1902, " 1902 ...	265,960	779,904	2	18	15
" 1903, " 1903 ...	283,652	968,256	3	8	6
" 1904, " 1904 ...	389,553	1,274,116	3	5	9
" 1905, " 1905 ...	377,793	1,525,263	4	0	18
Totals	2,464,375	7,197,449	2	18	10

Returns of Quartz crushed, &c., in the Hauraki District—*continued.*

District.	Quartz and Mullock crushed or sold.	Yield of Gold or Bullion.	Average Yield of Gold or Bullion per Ton.		
	Tons.	Oz.	Oz.	dwt.	gr.
Te Aroha—					
1st April, 1883, to 31st March, 1884 ...	4,262	4,629	1	1	17
" 1884, " 1885 ...	11,042	9,506	0	17	5
" 1885, " 1886 ...	6,552	4,489	0	13	17
" 1886, " 1887 ...	4,743	3,658	0	15	10
" 1887, " 1888 ...	7,166	2,918	0	8	3
" 1888, " 1889 ...	1,381	1,113	0	16	3
" 1889, " 1890 ...	4,894	20,416	4	3	10
" 1890, " 1891 ...	280	557	1	19	18
" 1891, " 1892 ...	2,722	979	0	7	5
" 1892, " 1893 ...	3,169	1,178	0	7	10
" 1893, " 1894 ...	2,270	833	0	7	8
" 1894, " 1895 ...	1,121	628	0	11	5
" 1895, " 1896 ...	172	168	0	19	12
" 1896, " 1897 ...	934	376	0	8	1
" 1897, " 1898 ...	...	...		...	
" 1398, " 1899 ...	325	279	0	17	4
" 1899, " 1900 ...	1,008	753	0	14	22
" 1900, to 31st Dec., 1900 ...	1,219	910	0	14	22
1st Jan., 1901, " 1901 ...	1,289	852	0	13	5
" 1902, " 1902 ...	502	839	1	13	12
" 1903, " 1903 ...	1,561	1,728	1	2	3
" 1904, " 1904 ...	483	281	0	11	15
" 1905, " 1905 ...	1,727	2,417	1	8	0
Totals	58,822	59,507	1	0	6

	Tons.	Oz.	Oz.	dwt.	gr.
Great Barrier Island—					
1st April, 1896, to 31st March, 1897 ...	3	219	73	0	0
" 1897, " 1898 ...	2	45	22	10	0
" 1898, " 1899 ...	...	...		...	
" 1899, " 1900 ...	38	134	3	10	12
" 1900, to 31st Dec., 1900 ...	3,038	3,712	1	4	10
1st Jan., 1901, " 1901 ...	13,542	15,734	1	3	5
" 1902, " 1902 ...	1	21	21	0	0
, 1903, " 1903 ...	782*	948	1	4	6
1904, , 1904 ...	3,119*	10,646	3	8	5
, 1905, " 1905 ...	2,070*	5,927	2	17	6
Totals	22,595	37,386	1	13	2
Grand Totals (North Island) ...	3,870,990	8,646,656	2	4	16

* Tailings treated by cyanide.

Marlborough Goldfields.

Quartz reefs are abundant in the country lying north of the Wairau River, and a great many carry gold. They are for the most part found at considerable altitudes above sea-level, and owing to the expense of working them have not so far been proved to any depth. Claims have been taken up at various times, but want of adequate capital has led to their abandonment. The following are some of the reefs known to exist:—At Top Valley: The Baden Powell Reef, averaging 6 in. to 1 ft., and estimated to yield 6 dwt. to the ton; the Albion Reef, 3 ft., gold-bearing; the Just-for-Luck Reef, 2 ft. in the face, gold and scheelite, gold said to average 8 dwt. to the ton. At Jackson's Creek: The Shotover Reef, averaging 1 ft.; gold, patchy. At Arm-chair Creek: The Duke of York Reef, 18 in. wide, gold and scheelite, gold 7 dwt. to 8 dwt. per ton; right-hand branch of Arm-chair Creek, a gold-bearing reef.

The only claims at present being worked are those owned by the Wairau Valley Gold-mining Company, whose property consists of the Jubilee Mine and Lord Hopetoun Claim, 180 acres in extent. The property has been worked at intervals during the past six years, want of capital having, however, greatly retarded its systematic development. Some 950 oz. of gold, of the value of £3,548 1s. 8d., has been won. During the past two years a low-level tunnel has been in course of construction, small contracts having been let as funds permitted, the object being to open up the reef and secure at least 400 ft. of backs. The estimated length of the tunnel required is 1,200 ft., and of this about 470 ft. has been driven, leaving 729 ft. to drive before reaching the point at which it is expected the reef will be reached. The estimated cost of completing the tunnel is £2 per foot, or £1,458. A winze sunk on the reef showed very rich gold, its estimated value being upwards of several ounces to the ton. A portion of the mine is let on tribute, and is being worked by the tributers for both gold and scheelite; their first return was 2 tons 6 cwt. of scheelite and 12 oz. of gold from 40 tons of stone. The company possesses a 10-stamp battery, aerial tram, cyanide plant, and all necessary adjuncts. It has also a 10-stamp battery on the Wellington Claim, and plenty of water supplied by water-races. For the purpose of pushing on operations in the low-level tunnel a rock-drill has been imported.

The Wakamarina, Waikakaho, and Jackson's Head may also be mentioned as likely fields for the capitalist interested in quartz-mining, the Wakamarina, where the Golden Bar Claim is situated, being considered especially worthy of examination. Waikakaho and Jackson's Head have been the scene of previous mining ventures of an unsuccessful nature; but with adequate capital to thoroughly test these localities, and the application of modern methods of treatment, the result might possibly be different.

Antimony.

Owing to the high price now obtainable for antimony, a good deal of attention is being devoted to the deposits at Endeavour Inlet. These were worked by different companies some years ago, and a very extensive crushing and concentrating plant was erected. Principally owing to depreciation in the price of antimony, success did not attend the operations of these companies, which then dropped out of existence, the machinery being for the most part removed. There is but little doubt that valuable lodes exist in this locality, but a good deal of capital is necessary for their development. To place the mine in the same order as before and supply the necessary mining plant and appurtenances would, in the view of one authority, entail an expenditure of over £20,000, and efforts are now being made to induce outside capitalists to embark on this venture.

Inangahua Goldfield.

Consolidated Goldfields of New Zealand (Limited).

This company, whose shares are principally held in Great Britain, hold the following properties:—

Wealth of Nations Mine, 118 acres 1 rood 13 perches, near Reefton.

Golden Fleece Mine, 238 acres 1 rood 20 perches, Black's Point, near Reefton.

Welcome Mine, 69 acres 3 roods 5 perches, Specimen Hill, near Capleston, Reefton.

Inkerman Mine, Merrijigs (not now working).

Humphrey's Gully Hydraulic Sluicing Claim, 344 acres 2 roods 12 perches, near Hokitika.

In addition to these holdings, the Consolidated Company is largely interested in the Progress Mine, at Devil's Creek, near Reefton, this being a separate company floated some years ago by the parent company. The following summary of results of the company's operations does not include the Progress:—

Total quantity of gold obtained up to 31st December, 1905, 64,767 oz. 2 dwt. 7 gr., valued at £267,594 7s. 2d.

Total amount of dividends paid to shareholders up to 31st December, 1905, £125,487 5s.

Amount of dividends paid during year 1905, £12,118 17s.

Total amount of subscribed capital, £242,378.

Total expenditure in connection with mining operations up to 31st December, 1905, £425,530 18s. 1d.

Wealth of Nations.—Quartz was discovered on the outcrop of this lease, at an altitude of 600 ft. above the Inangahua River, a few months after the discovery of the Ajax and Golden Fleece Reefs. Stimulated by the values exposed, the original shareholders continued to exploit the lodes by adits and otherwise, and in February, 1872, the Wealth of Nations Company was registered as a mining concern. Having thus obtained sufficient subscribed capital, water-race construction and other important works were soon in active progress, and in November of the same year crushing was commenced with a 15-stamp battery, the mill being further increased to 20 heads within the succeeding twelve months. By this time surface prospecting had exposed two separate lodes, 130 ft. apart east and west. The west reef having a northerly strike towards the north boundary adjoining the Energetic lease, it was eventually intersected by the Energetic shaft at a depth of 150 ft. From this point of intersection the lode was con-

Wealth of Nations Mine, Reefton, showing portion of old 50 ft. diameter Overshot

tinued, and worked by the Energetic Company on an unbroken line of underlie to a depth of 540 ft. At this depth the strike changed southward, and finally pinched out on a main fault-line, and the lode has not yet been intersected on any of the deeper levels. The east lode was practically vertical, and maintained an average width of 6 ft. for a length of 200 ft., but also pinched out within the boundary of the Wealth of Nations lease at a depth of 350 ft. below the outcrop. During the extraction of these ore-bodies the 20-stamp mill was constantly employed, yielding lucrative results for a period of five years. At this juncture prospecting was again vigorously maintained, absorbing about £25,000, of which £17,000 was called-up capital. Amongst the principal works done was the driving of the battery level for a distance of 1,600 ft. The proceeds of this development resulted in cutting a small block of quartz and some small leaders on line of adit. Sinking was then commenced on the reef-track at a distance of 800 ft. from the mouth of tunnel, and at a depth of 200 ft. the east lode was intersected at a driven distance of 700 ft. from the shaft, thus proving a vertical faulting of 450 ft. At this depth the width and grade of the lode showed a falling-off as compared with the surface values, but again indicated a decided improvement as depth was attained. The strike also turned southward, which is a very unusual occurrence in the district, and just below the 350 ft. level the strike changed north, leaving a vertical fault of 30 ft. and considerable disturbance in the underlie. In 1896, while working the lode on the 500 ft. level, the property was purchased by the Consolidated Goldfields of New Zealand. Future development was afterwards directed to the Murray Creek side of the field, and the Energetic shaft was sunk to a total depth of 1,600 ft. from the surface and 1,175 ft. below the battery level. The surface plant comprises powerful double-cylinder hoisting-engines of the Tangye type, air-compressors for actuating rock-drill machines, and complete electric-light plant, the light being chiefly used in the mine-chambers and surface works. It may be noted that, although the lode has been somewhat erratic at depth, and the strike has changed twice westward, the ore-body at a depth of 1,600 ft. maintains a higher-grade value than at a depth of 200 ft. from the surface, but not quite equal to the first blocks directly below the surface. During the year 1905, 11,970 tons of stone was milled for 3,304 oz. 12 dwt. 17 gr. of melted gold, valued at £13,662 19s. 6d., or at the rate of 5 dwt. 12½ gr. per ton; while the concentrates and slimes shipped to the smelter realised £764 14s. 10d. At the cyanide-works 8,320 tons of sands (representing 69½ per cent. of the tonnage crushed) were treated for 1,397 oz. 10 dwt. 9 gr. of precipitate, valued at £5,420 16s. 1d., or at the rate of 13s. 0⅓d. per ton, the cost of treatment being about 2s. 5⅕d., leaving a profit of 10s. 7⅕d. per ton. The total quantity of stone crushed since the present company took over the mine is 66,592 tons, and 41,719 tons of sands were cyanided, for 27,301 oz. 0 dwt. 14 gr., value £109,553 18s., the value of the gold being £4 1s. 2d. per ounce. Sixty-five men were employed during the year 1905—forty-four in mine, ten in reduction-works, and eleven on surface. Approximate estimate of the ore in sight, 24,000 tons; total length driven on course of lodes, 10,860 ft.; cross-cuts through country, 11,600 ft.; depth of winzes sunk, 1,600 ft. (vertical); depth of shaft, 1,606 ft.; number of stamps employed at battery, 20, averaging nearly 2½ tons (2,240 lb.) per diem. Mine-manager, Thomas Watson; battery-superintendent, Andrew P. Watson.

Golden Fleece Mine.—Operations were commenced in this mine by the Golden Fleece Company on the 1st December, 1871, and gold to the value of £121,542 was won up to 31st March, 1886, whilst dividends amounting to £55,000 were paid, as against a called-up capital of £6,773. Development on a large scale has gone on since the mine became the property of the Consolidated Goldfields. The shaft has been sunk to a depth of 1,700 ft.; the battery level has been extended to a distance of 8,500 ft.; crosscuts driven through country total 19,060 ft.; drivages on course of lodes total 11,060 ft.; and winzes sunk a total vertical depth of 3,350 ft. During the year 1905 the 20-stamp mill crushed 13,985 tons of stone for 5,670 oz. 5 dwt. 12 gr. of melted gold, valued at £23,165

11s. 8d., while the sulphurets and slimes shipped to smelter realised £1,955 8s. 8d. At the cyanide-works 9,475 tons of coarse sands (representing 67¾ per cent. of the tonnage milled) were cyanided, yielding precipitate to the value of £3,342 1s. 1d., or at the rate of 7s. 0¾d. per ton, the cost of treatment being nearly 2s. 3d. per ton, leaving a profit of a fraction over 4s. 9½d. per ton. The total quantity of ore crushed has been 71,517 tons, and of sands cyanided 50,045 tons, for 35,889 oz. 5 dwt. 6 gr., value £142,145 5s. 7d., the average value of the gold being £4 1s. 0½d. per ounce. Since commencing operations the present company employed an average of about ninety men, but only twenty men were employed last year. Mine-manager, P. H. Woods; battery-superintendent, Andrew P. Watson.

Welcome Mine.—Operations were first commenced in this mine on the 17th September, 1873, and up to the 30th September, 1886, gold to the value of £226,424 was obtained, enabling the old Welcome Company to pay £103,500 in dividends, as against a called-up capital of £3,750. The following is a summary of the work carried out by the Consolidated Goldfields of New Zealand (Limited): Depth of shafts sunk, 645 ft. and 285 ft.; total distance driven on course of lodes (varying from 1 ft. to 12 ft.), 10,650 ft.; crosscuts through country, 12,950 ft.; winzes sunk, 1,800 ft. (vertical); total quantity of stone crushed, 3,886 tons, and of sands cyanided, 2,593 tons, for 3,179 oz. 16 dwt. 7 gr., value £12,177 18s. 7d.—including 621 oz. 1 dwt. 3 gr., value £2,335 0s. 1d., won by tributers (F. McKenzie and party), who pay to the company a minimum of 10 per cent. There is a 5-stamp mill on this property, the average duty per stamp being 1½ tons per diem; two tailings-vats, 20 ft. by 6 ft., and one sump, 20 ft. by 6 ft.

Humphrey's Gully Hydraulic Sluicing Claim.—This property was taken over by the Consolidated Goldfields in 1896, but work was first started on the claim in 1883. During the year 1905 the gravels sluiced yielded 827 oz. 6 dwt. 4 gr. of gold, valued at £3,226 9s. 9d., making a total, since the present company began operations, of 12,966 oz. 15 dwt. 7 gr., value £50,171 13s. 2d., the gold being worth £3 18s. per ounce. The auriferous gravels vary in depth from 10 ft. to 200 ft., and are known under the designation of the "Humphrey's Gully gravels." The dam covers an area of 6 acres, and there are eighteen miles of water-races in use, 16 chains of fluming, and 10,000 ft. of pipes (including siphons), forty heads of water being available, giving a pressure at the face of 125 lb. Two and sometimes three nozzles are employed, the distance of the penstock from the claim being 1,200 ft. There are thirty-six gold-saving tables, each 8 ft. by 7 ft., covered with cocoanut matting, and 5,400 ft. of tail-races. The claim, which is estimated to last twenty to thirty years, is let on tribute to Messrs. Harris, Mills, and McCabe, and sixteen men are employed. Mine-manager, W. Greenbank.

The Progress Mines of New Zealand (Limited).

This company carries on operations at Devil's Creek, about four and a half miles from Reefton. The property includes the Globe, Progress, Progressive, Rose, Wedge, Ballance, Larnach, Carroll, and Deep Special Claims, the total area being 810 acres and 15 perches. The Globe Mine paid £40,000 in dividends, and the Progress £17,400, prior to being taken over by the present company. The Progress Company was floated in December, 1896, with a nominal capital of £275,000, in 275,000 shares of £1 each, of which £50,000 was provided for working-capital. The amount paid in dividends by the present company is £226,875, including £34,375 disbursed during the year 1905, when the company's 65-stamp mill crushed 60,000 tons (2,240 lb.) for 18,147 oz. 11 dwt., value £75,408 9s. 5d., and 37,000 tons of sands were cyanided for 4,032 oz. 17 dwt., value £10,204 14s. 7d., making a total for the year of £96,851 8s. 6d. The total quantity of ore crushed since the commencement of operations by the Progress Mines Company was 130,121 tons, which yielded 184,129 oz. 17 dwt. 14 gr. of gold, value £742,631 15s., or an average value of £4 3s. 1½d. per ounce; while 130,121 tons of sands were cyanided for 24,897 oz. 13 dwt. 15 gr. The following summary shows the working-cost of milling 60,000 tons, cyaniding 37,000 tons, and chlorinating 1,105 tons during the year 1905:—

Total working-cost, £53,977 18s. 9d.; or 17s. 11·911d. per ton.

Profit, £44,325 11s. 6d.; or 14s. 9·303d. per ton.

Total, £98,303 10s. 3d.; or £1 12s. 9·214d. per ton.

The gold is saved by amalgamation, concentration, cyanidation, and chlorination. There are 232 men employed in the mine, thirty-six at the reduction-works, and twenty-five on surface, making a total of 293. Three rock-breakers are worked in connection with the 60-stamp mill, the average duty of each stamp being 2·86 tons per diem. In the cyanide department there are fifteen tailings-vats, 25 ft. by 6 ft.; two sumps, 25 ft. by 6 ft.; and one sump, 20 ft. by 6 ft. Steam is used for hoisting, and water-power at the reduction-works. The total depth of shafts sunk is 3,102 ft.—viz., A, 836 ft.; B, 1,436 ft.; C, 230 ft.; Old Progress, 600 ft. The total length driven on course of various lodes is 26,520 ft.; cross-cuts through country, 34,270 ft.; and winzes sunk, 5,830 ft. (vertical). The ore in sight is approximately estimated at 96,310 long tons. General manager, Ernest W. Spencer, Reefton; mine-manager, James Martin; battery-superintendent, John E. Lovelock; metallurgist, Henry A. B. Leipner.

STATEMENT showing the COMPARATIVE RETURNS from the REEFTON QUARTZ-MINES for Twenty-one Years, ending 31st March each Year, and a similar Return for the Periods ending 31st December, 1901, 1902, 1903, 1904, and 1905.

Years ending		Calls made.			Dividends declared.	Quartz crushed.	Yield of Gold.			Value of Gold.		
		£	s.	d.	£	Tons.	Oz.	dwt.	gr.	£	s.	d.
31st March,	1881	10,218	17	6	19,650	25,926	17,597	14	10	68,630	13	10
″	1882	25,504	3	4	37,643	14,894	20,154	0	0	78,600	12	0
	1883	64,345	0	0	32,600	18,928	19,194	0	0	74,856	12	0
″	1884	49,456	0	0	16,500	23,433	16,547	0	0	64,533	6	0
″	1885	29,333	0	0	34,100	34,349	23,997	0	0	93,588	6	0
″	1886	24,565	0	0	14,500	27,198	14,591	0	0	56,904	18	0
″	1887	21,596	0	0	33,450	23,930	21,143	0	0	83,171	15	5
″	1888	30,432	0	0	17,550	24,403	16,775	0	0	66,030	11	5
″	1889	38,919	0	0	16,688	28,564	18,663	0	0	72,720	18	0
″	1890	27,531	0	0	18,250	32,394	17,780	0	0	69,676	12	1
″	1891	20,404	0	0	27,325	39,643	23,347	0	0	91,998	8	10
″	1892	25,956	0	0	30,743	35,562	23,390	0	0	95,885	5	1
″	1893	18,800	0	0	16,900	37,693	20,171	0	0	80,894	5	1
	1894	14,350	0	0	18,832	34,518	18,413	0	0	73,752	14	11
″	1895	10,153	0	0	11,012	26,602	13,426	10	0	53,509	5	1
″	1896	8,418	0	0	25,925	29,816	22,025	0	0	87,935	18	4
	1897	9,033	6	8	4,900	13,270	8,365	4	20	33,824	7	1
	1898	7,859	3	4	50	9,751	4,266	7	1	18,253	7	3
	1899	5,920	6	8	900	42,305	21,487	18	15	87,587	1	0
	1900	10,747	8	9	47,050	58,277	26,693	3	18	108,455	17	8
″	1901	5,826	9	7	35,300	82,618	33,979	5	5	134,557	7	11
31st December,	1901	6,233	6	8	58,199	97,870	46,066	16	12	186,719	6	7
″	1902	6,900	0	0	48,475	98,485	46,561	9	9	188,655	2	5
	1903	4,587	0	0	57,641	109,571	58,840	6	15	195,468	16	10
	1904	5,262	0	0	54,674	113,375	49,693	16	7	215,996	3	6
	1905	3,870	0	0	55,343	106,150	44,091	6	11	177,462	19	9
Totals		486,220	2	6	734,200	1,189,525	647,259	19	3	2,559,670	12	1

Otago Goldfields.

Barewood, Barewood, Nenthorn District.—Area, 57 acres 3 roods 2 perches. The mine is opened by a three-compartment shaft 250 ft. in depth One reef, varying in width from 4 ft. to 10 ft., is operated upon, the distance driven on the course of the lode being 1,280 ft. in the three levels. There is a 5-stamp mill, each stamp having an average duty of $2\frac{2}{5}$ tons per diem. The cyanide process is used to save the gold, four tailings-vats, two rectangular vats each 12 ft. by 9 ft. by 6 ft., and two round vats 6 ft. by 6 ft., being in use. During 1905, 2,653 tons was crushed, yielding 1,112 oz. of gold; value, £4,213 9s. 5d. Total yield from 7,706 tons, 4,603 oz. of gold; value, £17,872 4s. 5d. Total dividends paid, £2,800; total expenditure to 31st December, 1905, £16,071 5s. 5d. The foregoing information refers to the present owners of this property—the Barewood Gold-mining Company, which started operations in August, 1902. Seventeen men employed in the mine, battery, and surface works. Value of plant, £2,200. Mine-manager, Herbert S. Molineaux; secretary, S. E. Brent, Dunedin.

Bendigo, near Cromwell.—Area, 71 acres. The mine is opened by a three-compartment shaft 500 ft. in depth, and there is a 20-stamp mill on the claim. During the year 1905 42 tons was crushed, yielding 32 oz. 12 dwt. 10 gr. of gold; value, £111 2s. This mine yielded very rich returns in the early seventies. It was at that period one of the best gold-producers in the colony, and some of the shareholders were reported to have received in dividends amounts variously stated at from £50,000 to £80,000 each. Secretary, C. S. Reeves, Dunedin.

Hamilton and Party, Caledonia Gully, near Macetown.—Area, 20 acres. The reef, which is 15 in. in width, is opened by a tunnel driven a distance of 300 ft. During the year 1905, 103 tons yielded 81 oz. of gold; value, £303 15s. 8d. Total quantity of ore crushed, 439 tons; yield, 188 oz. of gold; value, £719 14s. 1d. There is a 10-stamp battery, the average duty per stamp being 2 tons per diem. Approximate value of plant, &c., £500. Secretary, D. McKay, Macetown.

Last Chance Mine, Table Hill, near Milton.—This mine has an area of 51 acres, and is owned by Messrs. Park and party. The property is opened by two shafts, 100 ft. and 40 ft., each shaft being 8 ft. by 4 ft. The reef worked is 6 ft. in width, and a 10-stamp mill crushes the ore. During 1905, 1,992 tons of ore yielded 1,088 oz., valued at £3,808. The total quantity of ore crushed was 2,774 tons, yielding 1,378 oz. of gold, valued at £4,823. The total expenditure up to 31st December, 1905, amounted to £3,923; dividends paid to shareholders, £600. Five men are employed in the mine, three in the reduction-works, and seven on surface. Value of mining plant, &c., £600. Mine-manager, J. L. Hawkins; secretary, John Park, Table Hill.

Mount Highlay, Hyde.—Area, 20 acres. This mine is owned by Messrs. Gilmour and Matheson. The reef operated on varies from 1 ft. to 4 ft. in width, and is opened by a tunnel driven a distance of 200 ft., the quantity of ore available being estimated at 400 to 500 tons. The battery (driven by steam) consists of 10 stamps, 5 of which are in use. The gold is saved by amalgamation on the ordinary copper plates. During 1905, 200 tons of ore yielded 33 oz. 6 dwt. 19 gr. of gold; value, £126 4s. Total expenditure to 31st December, 1905, £400. Value of plant, &c., £1,000. Mine-manager and secretary, J. O. Gilmour.

QUARTZ-MINING IN CANTERBURY.

By E. R. Green, Inspector of Mines for the Southern Mining District.

Quartz-mining in Canterbury has practically been confined to that region of the Southern Alps in the neighbourhood of Browning's Pass, Upper Rakaia district, where some prospecting and driving had been done in bygone days. After a period of abeyance closer attention has latterly been paid to the reef-systems there, but, being among the higher altitudes, continuous work in winter is impossible owing to the

Mr. Rivers's Dam at Speargrass Creek, near Alexandra, Otago.
Inner Face of Wall and Accumulating Water shown.

Mining Handbook.

inclement weather-conditions, frost and snow. In "The Geology of Canterbury and Westland," page 260, Haast describes the finding of a piece of auriferous quartz in the Opawa River in the year 1862, but search for other specimens was unsuccessful. Recently an Albury resident claimed to have discovered gold-bearing stone which, after careful analysis at the School of Mines, Dunedin, was found to contain gold to the value of 1s. to 1s. 3d. per ton of rock *en masse*. It was proved, however, that the gold occurred associated with thin films of iron-pyrites in the joints of the rock, but there was no gold in the rock itself—a kind of slate—in which no trace of lode-formation could be seen. Similar stone has also been sent for analysis from Waimate district, so that it appears this class of rock covers a considerable area. Gold-bearing quartz has also been reported from the Mount White district, but although inquiries were being made as to methods of acquiring prospecting licenses and mining leases, no parcels of stone from this locality have been forwarded for analysis, so far as is known, to the Mines Department.

NOTE.—The reader is referred for further information *re* quartz-mining to the papers contributed by the Inspectors of Mines, Wardens for the Goldfields, &c.

FINENESS AND VALUE OF NEW ZEALAND GOLD.

SOME years ago, in consequence of complaints made to the New Zealand Government that a fair price was not given by the banks for gold, five samples of about 12 oz. each were obtained from Reefton and Kumara, on the west coast of the South Island; from the Island Block Company's claim, Clutha Valley, Otago; from Mr. Leijon's dredging claim, Alexandra; and from St. Bathan's, Otago, and were forwarded to the Sydney Mint. The returns furnished by the Deputy Master of the

Mint showed that the gold from Reefton was worth £4 2s. 10¾d. per ounce; from Kumara, £4 1s. 4⅛d. per ounce; from Island Block, £4 1s. 7⅝d. per ounce; from Alexandra, £4 0s. 11⅞d. per ounce; and from St. Bathan's, £4 2s. 7¼d. per ounce. The whole of the samples were above the standard value, the Reefton gold being highest with 1·424 carats, and Alexandra lowest with 0·860 carats, over the standard of 22 carats. The expense of forwarding the gold to Sydney, including Mint charges, amounted to 1s. 6d. per ounce. The freight on the small quantity sent across, which was the heaviest item in the expense incurred, would have been no more had the quantity been 500 oz.; and as each parcel had to be assayed separately in order to ascertain its value, therefore the expense in connection with forwarding the gold to the Sydney Mint was far in excess of what it would be if large parcels were sent. In the following statement laid on the table of the House of Representatives in 1891 by the Hon. the Minister of Mines full particulars are given:—

Place from where Gold was sent.	Weight of Gold as taken at Colonial Laboratory.	Weight of Gold received at Sydney Mint.	Weight of Gold after Melting.	Loss of Gold in Melting.	Assay Report: Decimal. Gold.	Assay Report: Decimal. Silver.	Fineness of Gold.
	Oz. dwt. gr.	Oz.	Oz.	Oz.			Carats.
Kumara	11 19 21	11 99	11·84	0·15	0·9570	0·035	22·968
Island Block ..	12 0 14	12·04	11·50	0·54	0·9605	0·030	23·052
St. Bathan's ..	11 19 21	11·99	11·72	0·27	0·9730	0·020	23·332
Alexandra ..	12 0 5	12·01	11·79	0 22	0·9525	0·040	22·860
Reefton	12 0 20	12·04	11·77	0·27	0·9760	0·015	23·424
Totals ..	60 1 9	60·07	58 62	1·45	..	..	.

Place from where Gold was sent.	Standard Gold.	Mint Value per Ounce.	Value at Sydney Mint.	Mint Charges.	Net Value after deducting Mint Charges.	Purchase-money.
	Oz.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Kumara	12·361	4 1 4⅛	48 3 2	0 5 2	47 18 0	46 17 0
Island Block ..	12·050	4 1 7⅝	46 18 10	0 5 0	46 13 10	46 8 6
St. Bathan's ..	12·440	4 2 7¼	48 8 9	0 5 2	48 3 7	48 0 0
Alexandra ..	12·251	4 0 11⅞	47 14 11	0 5 1	47 9 10	46 4 0
Reefton	12·532	4 2 10¾	48 15 1	0 5 3	48 9 10	47 6 9
Totals ..	61·634	..	240 0 9	1 5 8	238 15 1	234 16 3

NOTE.—Expenses: Freight, £2 2s.; insurance, 18s. 3d.; incidental, 2s.; purchase-money £234 16s. 3d.; total, £237 18s. 6d.

COAL-DEPOSITS OF NEW ZEALAND.

All the formations in New Zealand which contain workable seams of coal may be said to belong to the Secondary or Mesozoic and to the Tertiary or Cenozoic epochs. The quality of the coal of the same class found in this colony is extremely varied, some of it being for all practical purposes equal, if not superior, to much of the coal used in other parts of the world; while, on the other hand, a great deal is of a comparatively inferior description, though it still has a great local value as a fuel in the districts where it occurs. The coals found in New Zealand have been divided into two groups, under the terms hydrous and anhydrous coals, or those which contain a large percentage of water chemically combined with them, and those which may be assumed to have been deprived of that water by a chemical change.

I. Hydrous Coals.

The hydrous coals may be conveniently distinguished as lignites, pitch-coals, and glance-coals. A point worthy of remark is that whereas in Europe the deposits of brown coal (or lignite, as it is usually termed) occur in beds of immense thickness, and are generally confined to limited areas, those of New Zealand form regular seams of moderate thickness, and associated with them are alternating beds of clay, shale, and sandstone, as is the case with the older coal formation of Carboniferous age elsewhere. As a rule, the hydrous coal-measures lie on the eastern slopes of the axial rocks in the South Island, and to the west of the main axis in the North Island; whereas the anhydrous coals are confined chiefly to the west coast of the South Island. The hydrous coal is of a brown colour, but hard and glossy, and frequently contains a quantity of fossil resin, this being due to the remains of an *Araucaria* somewhat allied to the kauri of the North Island.

The principal defect of the hydrous coal is its weight in proportion to bulk, and its tendency to crack and break into small fragments by desiccation and exposure to the atmosphere. The different varieties of hydrous coals, however, are not all equally subject to this defect, and some of the better qualities of glance-coal are scarcely affected in this way. Partly on this account the hydrous coals may be divided into three sub-groups:—

1. Lignite, or common brown coal, containing a high percentage of water, and in which a woody structure is very apparent.

2. Pitch-coal, in which there is still a high percentage of water, and frequently a woody structure to be seen. Its aspect is glossy, dark-brown, or black, and it does not soil the fingers. Usually this coal desiccates freely on exposure to the atmosphere.

3. Glance-coal is hard and semi-laminated with bright and dull laminæ, as in the case of bituminous coals; contains a smaller percentage of water generally than the other two sub-groups, and does not desiccate by exposure to the atmosphere; seldom shows woody structure; and constitutes an excellent steam-coal for stationary engines and railway purposes, but is inferior in this respect for ocean-going steamers to the anhydrous coals.

The hydrous coals are extensively developed throughout the coastal and interior regions of southern and eastern Otago, while an inferior but useful quality of lignite is abundant in Central Otago. The better-known fields are: Nightcaps, in Southland; Kaitangata, in Bruce County; Green Island, near Dunedin; Shag Point, in Waihemo County; in the Oamaru district, north-eastern part of Otago, at Big Hill; the Waiau Valley, in Southern Canterbury; the Ashburton district and Malvern Hills, in Central Canterbury; and, on the west coast of the South Island, the higher seams in the Brunner field. In the Inangahua Valley most of the seams must be regarded as pitch and glance coals; while the coals of Puponga and West Wanganui belong to these subdivisions, those of Puponga being a high-class glance-coal, or, according to some authorities, a bituminous coal.

On the west coast of the North Island the coals of the Mokau Valley are glance-coals: the field extends east to the Wanganui River, in which part the coals are not of quite equal value. Pitch-coals are found in the district of Kawhia, on the north-west side of the range from the Mokau Valley. In the Lower Waikato Valley there are extensive deposits of both glance and pitch coals, of which Taupiri exemplifies one form (glance-coal) and Miranda and Surrey Redoubt the other (pitch-coal). These coal-measures extend along the west coast of Auckland, between Kawhia Harbour and the Waikato Heads. Glance-coals are found abundantly in the neighbourhood of Whangarei, and from thence to Hikurangi, where, and also at Ngunguru, glance-coal of a superior description is found, and is sometimes classed as semi-bituminous. Lastly, the well-known coal of Kawakawa, which is semi-bituminous, is the most northerly of the hydrous coalfields of New Zealand.

II. Anhydrous Coals.

Under this group have been classed all the coals found in New Zealand which resemble in quality the coals imported from England and Australia. The composition of the coals comprised in this group is very varied, but is not more so than is usually found in different coal-seams in other countries. The only point in which as a class they are deficient in any of the characteristics which are laid down as requisite for a perfect steam-fuel is in the solidity and toughness which enables the coal to withstand the constant attrition it must experience from frequent handling. This defect is, however, comparatively insignificant, and is more than compensated for (except in a few instances) by the purity of the coal, its tendency to cake, and the facility with which complete combustion can be effected; so that the loss by the formation of cinders will be much below the average.

The most important development of the coal-seams in this class is on the west coast of the South Island, where the formation occurs resting on a surface generally of metamorphic and crystalline rock. Beginning in the south, the first development of this coal is between the Haast and Paringa Rivers; next, the Grey Valley coalfields, consisting of the Brunner area, Coal Creek, and Blackball, and an as yet unexplored area on the west side of Paparoa Range, near the source of Bullock Creek; then the Mount Rochfort, Ngakawau, and Mokihinui coal areas, lying between the lower parts of the Buller and the Mokihinui Rivers. The Wallsend and Pakawau Mines, in the Collingwood district, also contain bituminous coals, but the actual extent of the area has not yet been explored.

III. Anthracite Coals.

In connection with both the hydrous and anhydrous coals there are developments of anthracite. Associated with the hydrous coals there are the anthracite coals of the Acheron River, within the Rakaia Valley, in Canterbury, and of the Broken River, in the Waimakariri basin; these are, however, local and unimportant. In connection with the bituminous coals there is a 6 ft. seam of anthracite in the valley of the Fox River, ten miles south-west of Charleston; and it is reported that at Mount Davy, in the Paparoa Range, there is a considerable deposit of anthracitic coal.

COAL-MINING IN NEW ZEALAND.

By JOHN HAYES, F.S.Sc., late Inspecting Engineer, Mines Department, New Zealand.

ON his first introduction to the coalfields of New Zealand, the mining engineer whose experience has been confined to the coalfields of Great Britain or other countries where the coal-bearing strata are found in rocks of the Carboniferous era, is at once confronted with vastly different geological conditions, and also very varying characteristics and qualities of the coals themselves. It may at once be stated that in New Zealand no coal is so far known to exist in the deposits of the Carboniferous period. Thin seams of bituminous coal, having a very large percentage of ash, have been discovered in the Jurassic (secondary) rocks, which, forming an irregular triangle, cross a portion of the South (or Middle) Island from near Mount Hamilton, on the western side of the Island, to the east coast, the coast-line from a few miles south of the mouth of the Mataura River to the mouth of Catlin's River (northward) forming the perpendicular of the triangle. Nothing of commercial importance has yet been found in this belt of country.

The bulk of New Zealand coals is found in strata which have been classed by the late Director of the Geological Survey (Sir James Hector, K.C.M.G., F.R.S.) as belonging to the Cretaceo-Tertiary period. Large deposits of lignite of more recent date are also found in many localities.

The coals vary in quality from a dull-burning brown coal of low evaporative power—suited only for use in the locality in which it is obtained—to a splendid coal equal to many of the best British coals for steaming, gas, and coking purposes. They may be divided into two groups—viz., hydrous and anhydrous. By the first of these terms is meant those coals which contain a large percentage of water in chemical combination, and by the latter term the coals which have been deprived of a considerable portion of their water by chemical change.

Hydrous coals include glance-coal, pitch-coal, brown coal, and lignite, and are principally found on the eastern side of the mountain chain which traverses the Middle or South Island, and to the west of a line drawn from Cape Palliser, near Wellington, through Cape Colville (the head of the Hauraki Peninsula) in the North Island. Lignites and brown coals are light in proportion to their bulk, and, on account of the water contained, desiccate somewhat rapidly on exposure to sun and wind. Some of the pitch and glance coals stand the weather very well, and are comparatively little affected by exposure. These varieties are sometimes classed as "semi-bituminous," and are very useful for domestic purposes, locomotives, and land boilers generally, as well as for coastal marine work, but are not used to any extent on steamers making long voyages.

Anhydrous coals are those which may be said to compare with the coals of Great Britain. The deposits are chiefly confined to the west coast of the South Island, Westport and Greymouth being the ports of shipment. Ocean-going steamers obtain their supplies from these ports, and coals from this district are in demand for the use of the British Squadron in Eastern waters.

In explanation of the fact that both anhydrous and hydrous coals (recent lignites, of course, excepted) belong to the same geological era, it may be remarked that many parts of New Zealand have undoubtedly been subjected to great changes by volcanic and other forces, and it is not improbable that the varying characteristics and qualities of the coal-seams themselves are due, in some measure at least, to their being subjected to these influences. As an illustration of this, the conditions which exist in the Malvern Hills, Rakaia Gorge, and near Lake Coleridge, in Canterbury, may be mentioned. In those localities a brown-coal deposit of very ordinary

The Upper Incline, Denniston (Westport Coal Company, Limited).

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quality has been tilted by volcanic action, and the coals subjected to distillation by the molten lava ejected (which would retain its heat for a considerable time), and now overlies the coal-measures in the form of a thick sheet of dolerite. The resultant effect of this distillation has been to evaporate the hydrous constituents, and also the hydrocarbons, contained in the coal, leaving very little besides fixed carbon and ash. In this manner a brown coal has become altered into an anthracite, the roof strata immediately above the coal is found changed into a somewhat coarse plumbago (suitable, at all events, for foundry use), and the clay below the coal baked like pottery-ware. This is, perhaps, an extreme case of metamorphism, but serves to show very clearly how the quality of coal may be changed by mechanical and chemical processes. The comparative analyses given will further elucidate this point.

	Average of Four Samples of Ordinary Brown Coal.	Anthracite from Lake Coleridge, Canterbury.
Fixed carbons ...	43·28 per cent.	84·12 per cent.
Hydrocarbons ...	38·35 ,,	1·96 ,,
Water	15·68 ,,	1·80 ,,
Ash	2·69 ,,	12·12 ,,
	100·00	100·00

At Malvern Hills four seams of coal were cut in a tunnel which was driven for the greater part through a deposit of dolerite. The first seam cut (which was the highest in the series, and naturally the most recent of the four) was found altered into anthracite, as already described; the other three seams, being further from the molten lava deposited by the eruption, were altered to a lesser extent, but sufficiently so to show that the heat from the lava had a far-reaching effect, as these "altered brown coals" gave on analysis as high a percentage as 68·5 of fixed carbon and an evaporative power equal to that of a good average bituminous coal.

The coal-mining industry of New Zealand has, during the past few years, made rapid strides, the following figures showing the expansion at intervals of five years:—

		Tons.
Output for	1885...	511,063
,,	1890...	637,397
,,	1895...	726,654
,,	1900...	1,093,990
,,	1905...	1,585,756

Notwithstanding the production of coal within the colony, a considerable tonnage is imported from New South Wales, the imports for last year (1905) being 168,757 tons from that colony.

From the official statistics for last year it is found that employment was given to 3,269 persons at the various coal and lignite mines of the colony. These number 177 in the aggregate, but many are mere quarries—worked on a very small scale—for the supply of lignite for purely local requirements. The number of mines employing more than twenty persons was twenty-eight, and these require to be under the supervision of a manager holding a first-class certificate. Twenty-six mines employed over six but not more than twenty persons. At such mines a person holding a second-class certificate may act as manager, whilst at mines employing six persons and under the person in charge, if not the holder of a certificate of either class, must have an authority or permit from the Inspector of Mines for the district. Thus some reasonable guarantee is afforded that the persons upon whom the charge of mining operations devolves are qualified for the responsible nature of their work, and their supervision, together with careful examination by Government Inspectors of Mines, has resulted in the working operations of New Zealand collieries being conducted and maintained on very safe lines. Within the past five or six years more general attention has been paid to the better ventilation of underground workings, and, taken as a whole, the atmosphere of the mines more than favourably compares with that of the general run of workshops, mills, factories, &c. Explosions in the collieries of New Zealand have fortunately been few in number, and it is a significant fact that explosive gases are not met with at most of the pits in the colony. Still, the coal-mines of New Zealand are not by any means immune from the presence of inflammable gases in the coal or adjacent strata, and at a few collieries these are given off more or less; but, taken in comparison with what are admittedly "fiery" mines in Great Britain, the experience so far gained of New Zealand colliery workings is (with the single exception of a colliery not now in work) that the industry in this colony is not seriously troubled by reason of inflammable gases in large quantities. Two serious explosions have occurred in the colony—viz., at Kaitangata (Otago), in February, 1879, and at Brunner (West Coast), in March, 1896. The former is said to have been due to the ignition of an explosive mixture of inflammable gas and air, and the latter (which the writer very exhaustively investigated by instructions from the then Premier, the late Right Hon. R. J. Seddon) was undoubtedly caused by a blown-out shot, and carried on by coaldust.

The largest and most important collieries in the colony are those of the Westport Coal Company (Limited), situated at Denniston and at Millerton, near Westport, on the west coast of the South (or Middle) Island. Last year these collieries produced 500,231 tons. The conditions under which both collieries are worked are most interesting. Although situated near the sea, the workings are from 1,500 ft. to 2,000 ft. above the sea-level; consequently, instead of the coal having to be raised up deep shafts by powerful winding-engines, it is lowered down steep inclines to the main line of railway, which connects the collieries with the port. At Denniston Colliery the incline is constructed so that the railway-wagons go right up the hill, the loading-bins being at an elevation of 1,700 ft. above the railway-level at the foot of the incline, which is about a mile in length. This incline is in two divisions, the upper one being 33 chains long (horizontal measurement), with a vertical fall of 830 ft. The lower portion is 50 chains long, vertical fall 864 ft., and maximum gradient 1 in 2·2. The average grade throughout is 1 in 3·23. Fifteen wagons per hour are delivered at the foot of the incline, a single wagon being run at a time, the descending full wagon pulling the empty one up. For such steep grades special brake-power is necessary, and the lowering plant used appears, at first glance, not unlike an ordinary pair of horizontal winding-engines, with the drum in the usual position. The action, however, is quite different, water being used to check the motion of the pistons instead of steam to move them. These hydraulic brakes have proved most successful in use.

From the top of the upper incline communication with the adits which open into various sections of the colliery is by the ordinary mine-tubs hauled by endless rope, driven by steam-power, the main haulage-road being about two miles in length. There are also two branch roads leading to the two main sections of the colliery, and the "under-rope" system is adopted, the tubs being attached to the rope with lashing-chains.

The seam being worked is of excellent quality, and is from 15 ft. to 20 ft. thick as a general rule. Occasionally it has been found of much greater thickness, 35 ft. and upwards not being unknown. In mining, the bord-and-pillar system is adopted, holing being done by percussive coal-cutting machines actuated by compressed air. Electrically driven machines have been tried, and also coal-cutters on the chain principle, but these have been discarded in favour of percussive or "pick" machines and compressed air. Ventilation is maintained by fans.

At the company's Millerton Colliery the seam is thick, and the general mining arrangements are much the same as at Denniston Colliery, percussive machines actuated by compressed air being largely used for "holing." The mine is entered by adits, and divided into two distinct sections for the purposes of ventilation, fans of modern types being used for exhausting. The railway-wagons do not run up to the colliery (as in the case at Denniston), but the coal is conveyed to the bins and screens—1,500 ft. below the brake-head—adjoining Granity Railway-station, by means of a self-acting endless-rope tramway, hydraulic brakes being used. The storage-bins have a capacity of about 3,000 tons. The sidings, workshops, and offices are also situated at the foot of the incline. Hydraulic power is used for actuating the workshops machinery, hoists, rams for working the slides for loading wagons from the bins, the electric-light plant, &c., pressure being obtained from a reservoir several hundreds of feet higher up the hill.

The Westport Coal Company's collieries produce coal of excellent quality for gas-making and steam-raising purposes especially. The company hold a large area under lease from the Crown, and the mines have many years' working-life ahead.

In point of output, the collieries next in order are those of the New Zealand Government, at Seddonville, near Westport, and Point Elizabeth, near Greymouth. These form the subject of a separate article, to which the reader is referred.

The other principal collieries in the West Coast coalfields are those at Brunnerton and Blackball. At the former place, which is situated some seven or eight miles from the Port of Greymouth on the banks of the Mawhera (now known as the Grey) River, coal-mining operations have been conducted for upwards of forty years. Formerly, several companies were actively engaged in the industry—the Brunner, Coal-pit Heath, Tyneside, and Wallsend Mines—but eventually these all came under a general proprietary. The Tyneside and Wallsend Mines were closed down and their plants dismantled, the Coal-pit Heath Colliery—which adjoined the Brunner Colliery—being worked in conjunction with the latter. Coal-pit Heath Mine was practically worked out some years ago, and at the present time the same remark holds good in respect to the Brunner Mine so far as the known seam is concerned. At this colliery an important trade has been done in coke for smelting purposes and in high-grade fireclay goods. As already mentioned, Brunner Colliery was some ten years ago the scene of a disastrous explosion by which sixty-five persons lost their lives.

The Tyneside Colliery has been reopened within a comparatively recent date by a new proprietary, who have erected winding, pumping, screening, and ventilating plant. The seam, which is generally considered as being identical with that worked at the other collieries adjoining, is about 12 ft. thick, and the output last year was 44,047 tons. Generally speaking, the coal has practically the same characteristics as that of the Brunner Colliery, which has had an excellent reputation for steam, gas, and smithy purposes.

Blackball Colliery, situated on the eastern side of the Paparoa Range, is some eighteen miles from Greymouth. The coal is generally in two divisions aggregating something like 17 ft. in thickness, and is worked on the bord-and-pillar system—a method general on the West Coast coalfields. Its principal use is for steam purposes, large quantities being used on the ocean-steamers of the New Zealand Shipping Company (Limited). Pending the construction of a branch railway from Ngahere up the Blackball Valley, connection is made with the railway at Ngahere by means of an aerial tramway of about three miles in length. Drainage is effected by a water adit lately driven from the bed of Ford's Creek; this has rendered the use of pumps unnecessary. Ventilation is by fan. Last year's output was 64,713 tons.

The ports of Westport and Greymouth are, and must continue to be, the chief centres of shipment, as, in addition to the collieries at present working, new collieries on an extensive scale will shortly be opened up in the vicinities of both ports. At one of these, coal of a quality which corresponds with that of the celebrated South Wales coal will probably be won.

There are several small pits, worked purely for local requirements, in the neighbourhood of Reefton, at some of which a most excellent house-coal is obtained. A new colliery (which is included in the West Coast district) is situated at Puponga, near Cape Farewell, the most northern point of the Middle (or South) Island, and upwards of a hundred miles nearer than Westport to the City of Wellington and other northern ports. One seam of coal is at present being worked. This averages about 7 ft. in thickness, and in quality is pre-eminent as a domestic fuel, for which it is in extensive demand. Mechanical screening is practised, and the small coal washed and graded into "nuts" for house and steam purposes. Fan ventilation has been adopted, and the plant generally is being augmented to meet trade requirements. The coal is shipped at the company's own wharf, which connects with the colliery by a light railway of less than two miles in length. Harbour improvements of an extensive character are being prepared for, and these, when completed, will admit of the employment of much larger steamers than those at present engaged.

On the eastern side of the dividing-range of the Middle Island—known as the Southern Alps—brown coal, pitch-coal, and lignite are worked over a very large area, but the mines are, with few exceptions, on a limited scale. In Canterbury, the Homebush Colliery, at Glentunnel, is the principal mine now at work. A brown coal is obtained, the output last year being 15,415 tons. There are a few other small mines which produce coal for purely local requirements. At Mount Somers there is a very thick seam of brown coal which yielded 7,588 tons during 1905. At some future time this deposit may be more extensively operated upon.

In north Otago, the Shag Point Colliery was for many years the chief producer, the coal being a pitch-coal of excellent quality. In all, seven distinct seams have been discovered in this coalfield, most of which may be classed as thin. To some extent the workings of the Shag Point Colliery were submarine, and the large flow of water met with some six years ago led to the abandonment of the under-sea workings and subsequent dismantling of the colliery. The Allandale Colliery, a property which adjoins the Shag Point area, is now the scene of active mining operations, three seams, varying from 4 ft. to 6 ft. in thickness, being operated upon. In quality the coal is very similar to that which was mined at Shag Point. Mechanical ventilation is in vogue, and electrical transmission of power for underground haulage and pumping has been adopted. In the latter connection it is worthy of note that the first installation in this colony of high-lift centrifugal pumps for mining purposes was made at Allandale Colliery, the venture being reported eminently satisfactory. Last year's output was 19,533 tons.

South of Dunedin the first coalfield is that of Green Island. where colliery operations have been conducted for many years. Several mines formerly worked are exhausted or closed down for other reasons, but quite a number are now working, the principal properties with their respective productions for the year 1905 being enumerated as follows: Saddle Hill Colliery, Saddle Hill, 27,594 tons; Freeman's Colliery, Abbotsford, 21,285 tons; Jubilee Colliery, Walton Park, 16,928 tons.

The coal of this locality is an ordinary brown coal, and the deposits are, generally speaking, of considerable size, seams 20 ft. thick being operated upon at a few of the pits.

Some fairly extensive deposits of a similar class of coal occur in the Tokomairiro district, between the Town of Milton and the sea-coast. These are also of considerable thickness, and have been worked on a small scale for many years. A branch line of railway, privately owned, now connects the mines with the main line of Government railways at Milton, and it is expected that by this improved means of outlet the production of the mines will be increased.

The next coalfield is that of Tuakitoto and Kaitangata, where the Taratu–Kaitangata Railway and Coal Company (Limited) and the New Zealand Coal and Oil Company (Limited) have collieries. The former is a recent undertaking, and, at the present time, a seam of good brown coal some 20 ft. in thickness is being opened up, last year's output being 18,189 tons. The New Zealand Coal and Oil Company (Limited) own the collieries formerly operated by the Kaitangata Railway and Coal Company (Limited) and the Castle Hill Coal Company (Limited) at Kaitangata, as well as the shale-mine and oilworks at Orepuki, Southland. This company's collieries are the largest in this part of the colony, the output for 1905 being 119,744 tons. The seams generally are of considerable thickness, a maximum of something like 40 ft. having been attained in some places. Extensive plant of modern type has been installed, the endless-rope system of haulage and also for the transmission of power for pumping

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Kaitangata Colliery, from Mine Mouth

being adopted in addition to other methods of work. Compressed air is also largely used as a secondary power for operating winches used in the workings. A superior brown coal is produced which is in considerable demand for domestic purposes as well as steam-production, and the screening plant at the Castle Hill Colliery (a working model of which is to be seen at the Mines Department exhibit of colliery workings at the International Exhibition, Christchurch) is probably the most perfect plant of its class to be found in the colony. Mechanical ventilation is adopted at the Kaitangata Colliery, and furnace ventilation at Castle Hill. In February, 1879, Káitangata Colliery was the scene of a disastrous explosion, by which thirty-four persons lost their lives.

Central Otago contains numerous deposits of lignite and brown coal, some of which are being worked for the supply of purely local demands. In many instances the mines are merely open quarries operated on a very small scale; others are worked by the ordinary methods of underground mining. Some of the lignite-deposits are of great thickness, that at Coal Creek, near Roxburgh, being fully 80 ft. at two opencast mines, whilst at an adjoining mine (where the deposit is practically vertical) the horizontal distance across the seam is approximately 100 ft. Several instances occur where the seams are from 30 ft. to 40 ft. in thickness. The lignites of the interior of Otago provide a cheap, if low-grade, fuel in a district which would otherwise be destitute of firing-material, and are correspondingly valued. Of late years the gold-dredging industry in Central Otago has given an impetus to coal and lignite mining, and during the year 1905 the output (from underground workings) of the three principal proprietaries was as follows: Cromwell and Bannockburn Collieries Company, Bannockburn, 11,142 tons; Mathias Bros. and Hunter, Alexandra, 9,553 tons; Alexandra Coal Company, Alexandra, 8,959 tons.

In Southland there are also a large number of small lignite-pits for the supply of local requirements pure and simple. The mines having the largest output are in the vicinity of Gore and Mataura, the principal producers being Green's mine, at Gore, which had an output of 11,314 tons during last year, and Sleeman's mine, at Mataura, which produced 9,419 tons. Several other mines put out from 2,000 to nearly 6,000 tons during the same period, the gold-dredges in the Gore, Waikaka, and Waikaia localities being fairly large consumers. The principal colliery in Southland is that of the Nightcaps Coal Company (Limited), at Nightcaps, which had an output of 45,500 tons of good-quality brown coal during the year 1905. This property is freehold. The seam is divided into three sections, having an aggregate thickness of 36 ft., of which 24 ft. is ordinarily worked. The mine is worked level-free (drainage being effected by a low-level tunnel), and ventilation maintained by a fan of modern design.

Turning to the North Island, it may be remarked that some years ago fairly extensive operations were conducted at Kawakawa, Bay of Islands, but the area leased is now practically exhausted, and no prospecting of any moment appears to have been done to prove the continuation or otherwise of the coal-bearing measures. The Maoris have reported the existence of coal on Native lands between Kawakawa and Hokianga, but nothing has yet been done to prove or develop the field. The coal worked at Kawakawa was friable, but of excellent quality for steaming purposes.

The principal coal-producing centres in the North Island are those of Whangarei and Taupiri. The former district is approximately thirty miles south of Kawakawa, and ninety miles north of the City of Auckland. Excellent coal of semi-bituminous character is mined at Hikurangi and Kiripaka, townships situated some few miles from the Town of Whangarei. Two collieries are at work at Hikurangi, the oldest being that of the Hikurangi Coal Company (Limited), which last year had an output of 50,410 tons. The seam is from 7 ft. to 10 ft. in thickness, and is reached by a short incline having a very moderate grade, the workings being under rough moorlands of no particular value. This feature admits of the total extraction of the seam without any question of surface-damage arising. A colliery which has been more recently opened out is that of the Northern Collieries

Company (Limited). This is situated on hill country north of the Hikurangi Coal Company's mine, and last year produced 37,733 tons from a seam about 6½ ft. in thickness. It is worked level-free, and the coal conveyed from the mine to the railway by tramway, worked partly by locomotive-power and partly by gravitation.

At Kiripaka, two small mines (the Ngunguru and the Panipo) have been worked for some years; the former is now exhausted, and, as its owners held property in close proximity to the latter, an amalgamation of the two proprietaries (and also that of the Northern Collieries at Hikurangi) has been effected and operations commenced for the purpose of developing the Panipo Colliery on a much larger scale than that hitherto attained. The seam is variable in thickness, with an average of approximately 10 ft. A tramway connects the mine with the shipping staiths on the Ngunguru River. Last year's output at Kiripaka was 19,591 tons.

South of Auckland the Taupiri Coalfield at present holds first place. Three collieries belonging to the Taupiri Coalmines (Limited) are worked in the neighbourhood of Huntly, the combined output for last year being 118,612 tons. The coal is a superior class of brown coal of great thickness, a maximum of 70 ft. being attained in places. There are very few faults, and the inclination of the seam is very moderate. The method of working is by bord-and-pillar, but no pillars are extracted, as the coal underlies water-logged strata, and portions of the workings are under the Waikato River and adjacent lakes. A large thickness of roof-coal is also left for the protection of the mine-workings. At two of the pits the coal is raised through vertical shafts, and at the third an incline tunnel connects the workings with the surface. Mechanical screening is adopted in the preparation of the coal for market, and the mines are ventilated by fans.

Operations for the opening of a new colliery have recently been commenced near Lake Waahi. There are also large tracts of undeveloped brown-coal areas between Huntly, Raglan, and Kawhia.

The Mokau Coalfield has not as yet been developed to any extent. One small mine is at work several miles up the Mokau River, but the difficulties of transport due to the shallowness of the river are such that only boats of small tonnage can be employed for the conveyance of coal from the mine.

The coal-mining industry of New Zealand is steadily growing year by year, and has already become a very important factor in the progress and welfare of the colony.

NELSON AND WEST COAST DISTRICTS.

By Robert Tennent, Inspector of Mines.

Takaka and Collingwood.

Coal-mining may be regarded as an institution founded in the early history of Collingwood. In the first working, coal for local purposes was mined for several years on the elevated terraces behind the Township of Ferntown, but owing to local conditions operations were finally abandoned some years previous to 1897. To meet the requirements of Collingwood and suburban districts, Mr. Caldwell opened a new coalfield at Pakawau, the seam here maintaining an average thickness of 3 ft., parted with a middle band of stone 10 in. in thickness. Hampered, however, by the thinness of the seam, and the very primitive system of transit and shipping, mining here was suspended as being non-paying. In 1900, and under the ownership of young Mr. Caldwell, a new mine was opened, and fitted with screening and washing appliances, while transit and shipping facilities received more approved attention. Again, in 1905, Mr. Pilcher, of Wellington, having acquired the mining titles, reopened the mine, and continues to carry on operations on a small scale.

The Golden Bay Coal Company has reopened its property for the purpose of coal-mining and the manufacture of

Portland cement. In connection with the development of the property, a coal-seam 5 ft. in thickness has been opened by a dip heading, and lime-kilns constructed, the limestones in this region being abundant, and possessing superior qualities for building purposes.

The Puponga Coalfield, situated near the head of Golden Bay, was leased and registered in 1903, under the title of "The Puponga Coal and Gold Mining Company (Limited)," Mr. Sydney George Hayward, of Nelson, being resident attorney for the company. The coalfield is opened from the outcrop by a dip inclined heading, on an average gradient of 1 in 4, to a total distance of 20 chains, the seam maintaining an average quality and thickness, especially as operations proceed eastward. The underground haulage is actuated by steam-power, while the screening and washing installations consist of modern and approved appliances. Mine-ventilation is also controlled by a steam-driven fan of the colonial type. To connect the colliery with the shipping-basin a mile and a half of 2 ft. gauge tramway was constructed suitable for light locomotive traffic, while the jetty extension on same line of rail gives an additional 39 chains of haulage. Since the initiation of the company a gross tonnage of 37,979 tons of marketable coal has been produced for commercial purposes. The coal-seam is highly bituminous, and commands a ready market for household and steaming purposes. Shallowness of water in the loading-basin is a chief drawback.

West Wanganui.

In the West Wanganui mining district two seams of brown coal occur on the Patarau River, holding a thickness of 12 ft. and 6 ft. respectively. These seams are of average quality, but beyond exposing the outcrops nothing further has been done. At Pa Point, on the western entrance to the inlet, a coal-seam, 4 ft. in thickness, was worked by a Wellington syndicate about twenty years ago, but owing to shipping and other incidental difficulties the company surrendered its rights to the Taitapu Gold Estates (Limited). Extending south of the Patarau the coal becomes more or less patchy, especially on the low-hill country located between the Patarau flats and Lake Otuhie. In the locality of the Golden Ridge the miners use a 3 ft. seam as a household fuel, and on Malone's Creek the Golden Blocks Gold-mining Company mine a 4 ft. seam for steaming purposes at its crushing plant. Coming to the eastern bank of the inlet, coal of average quality has been examined and reported on on behalf of an Otago syndicate.

Westport District.

Denniston Mines.—The Westport Coal Company was registered in 1881, with a capital of 80,000 shares at £5 each, to acquire for a term of ninety-one years all mining rights, titles, and interests of two Crown leases, named Coalbrookdale and Granity Creek respectively. The Coalbrookdale lease, comprising 2,480 acres, extends from the head of the Whareatea Creek to some distance north of the Waimangaroa River, and is exploited by the Coalbrookdale and Ironbridge Mines, which produce an average output of 1,050 tons per day of eight hours, whilst the gross tonnage raised during the history of the mines is approximately 4,167,605 tons. In the matter of natural conditions, coal-mining on the Buller Coalfield is somewhat unique compared with many parts of the world, as the mining and general operations connected therewith are conducted at altitudes ranging between 1,800 ft. and 2,000 ft. above sea-level. Hence, as a natural sequence of the field, the continuity of these elevated seams is much broken and intersected by deep ravines, while uniformity of inclination is varied by the influences effected by Nature's potent agency in bygone ages. Consequently, to maintain production at a satisfactory commercial standard, the exploitation of these coal-seams demands development of an expensive and exceptional character, and, as a leading factor in the working economics, considerable engineering skill. But this enterprise and skill have had their reward, as shown by the fact that these highly bituminous seams of superior-quality coal easily command a steady and reliable market. Speaking generally, the coal-seams vary in thickness from a few feet to 40 ft., and are economically worked on the bord-and-pillar system, the working and natural conditions being favourable to win the coal either by hand-labour or coal-cutting machinery. Compressed aid being the power applied to actuate coal-cutting machines and all other underground mechanical appliances, each mine has a separate installation, suitably erected on the surface.

Drainage of the mines is effected by deep-level adits, specially determined, and driven from daylight points in the deep gorges to the lowest main levels in the mine-workings. Thus heavy and expensive pumping is set aside for the more favourable advantages of free drainage by adits. To effect free drainage in the Ironbridge Mine an adit was driven 36 chains in length, of which 28 chains are rock-driven; area, 6 ft. by 6 ft. This system of drainage is positively essential during the extraction of pillars, as the thin overlying strata, which is much intersected by deep gullies and creeks, freely admits considerable quantities of water through the broken ground during heavy rainfalls; but, as these water-drives have ample capacity to drain off immense volumes of water, the total exhaustion of large pillar areas is effected without obstruction or loss of coal, which would otherwise be impracticable to win.

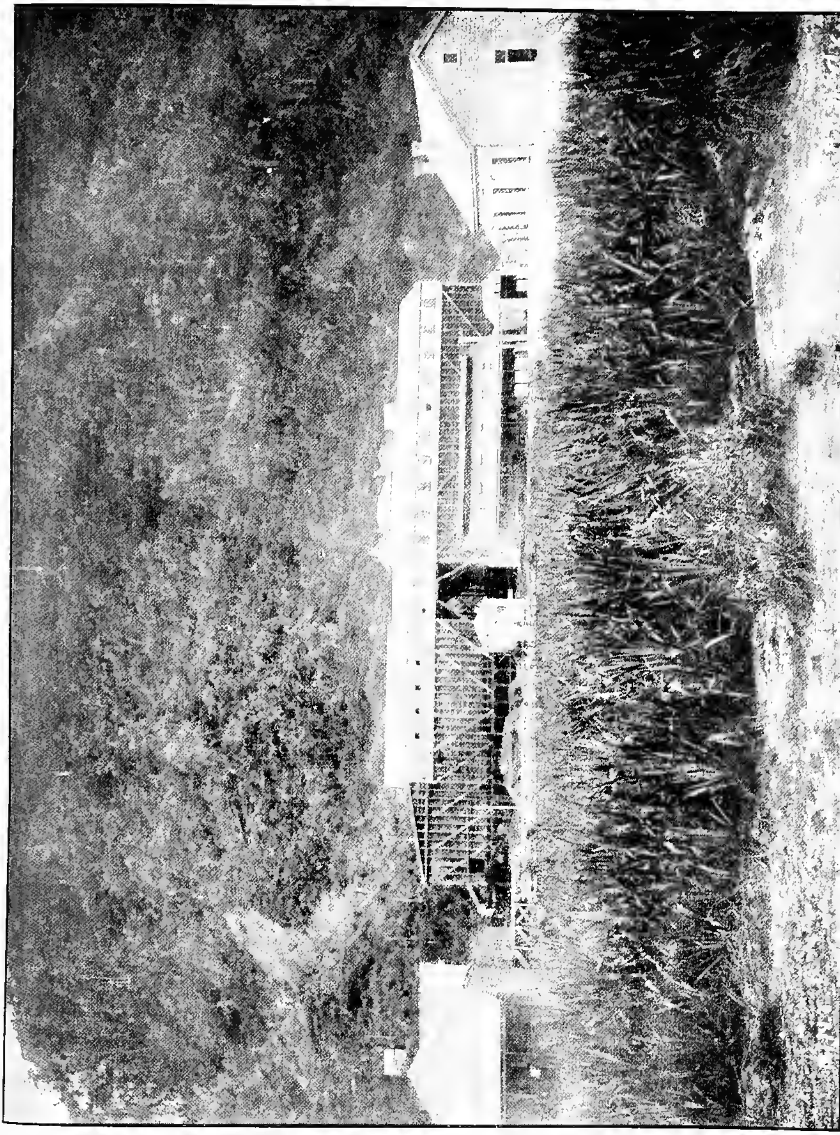
These mines are classed as non-gassy; but, the importance of ventilation having been duly considered, efficiency is amply maintained by three steam-driven exhaust-fans, capable of inducing continuous air-currents at an aggregate measurement of 200,000 cubic feet per minute.

Haulage and other machinery are largely and economically employed, while the steam-boiler equipment connected therewith has an aggregate total of 1,300-horse power. It may be worth noting that the total length of steel-wire rope in daily operation, including that used on jigs, direct and endless rope haulage, inclines, &c., is 12¾ miles, as follows: 70 chains of 4 in., 808 chains of 3½ in., and 142 chains of 2 in. rope.

To connect the mines with the screening and loading plant at Denniston, the main surface tram-line, equipped with endless-rope haulage, extends from the brake-head terminal to the junction known as "Wooden Bridge," a distance of a mile and a half. At this junction the subsidiary endless-rope haulage delivers the coal from the respective mines—that of Coalbrookdale Mine a mile and three-quarters in length, and that of Ironbridge 1 mile 14 chains. The roads are laid with steel rails, 30 lb. to the yard, to a gauge of 2 ft., and the mine-tubs, with a capacity of 12 cwt., are attached by chain clips to the rope running underneath the tubs. The main haulage-rope referred to can readily deliver loaded tubs at the screens at the rate of eighteen score per hour, on gradients varying in parts from 1 in 5·75, 1 in 8, and 1 in 10, with over half a mile practically level.

The coal is loaded at the screens into Government wagons, which are brought from the sidings at Conn's Creek Station, and thereto returned by an inclined railway laid down the mountain-spurs. This inclined mining railway is doubtless one of the steepest in the world, having a maximum grade of 1 in 1·34, and a ruling grade of 1 in 2·25, with a total length of 85 chains. The incline is operated on in two sections, known as the upper incline, 35 chains in length, and the lower or second section, 50 chains, each section having distinct controlling-power. The motive power is obtained by the weight of the full wagon against the empty one. These wagons have a carrying-capacity of 8 tons, with an approximate tare of 4½ tons. Patent plough-steel wire ropes of 4 in. are used on the upper and steeper incline, and 3½ in. ropes of a similar quality on the lower incline. The lowering and raising of the wagons is controlled by hydraulic-brake power, a separate plant being at the brow of each section. The cylinders of the hydraulic brakes are 12 in. diameter and 4 ft. stroke, with suitable by-pass valves, &c. The rope-drums are 9 ft. and 10 ft. diameter respectively. Both sections run concurrently; therefore, when an empty wagon is being delivered at Denniston a full wagon is arriving at Conn's Creek, at which terminal the requisite trains of coal are made up for haulage by Government locomotives to the port of shipment. This system works very effectively, as an average of 120 tons of coal per hour can be lowered to Conn's Creek terminal.

At Denniston bin storage-capacity is provided for some



2,800 tons of coal. These bins are fitted with shaker screens, which operate in connection with steel-plate travelling picking-belts that run longitudinally with the bin. These belts are fitted with automatic tippers, and can thereby be regulated to deliver the coal into any desired part. Steel-plate conveyers, running the whole length of the bin, underneath each row of openings, are operated to load the coal into the railway-wagons. The doors of these openings are opened and shut by hydraulic power. The necessary engineering, black-smithing, and carpentering workshops are established.

The whole of the works are lighted by electricity, as also the inclines, which are often in operation before and after daylight.

An up-to-date workmen's club-house at Denniston, erected and subsidised by the company, embodies a splendid library, lecture-room, billiard-room, games-room, &c. This building is well equipped to meet requirements.

The Millerton Collieries, owned by the Westport Coal Company (Limited), are situated on an elevated plateau, eighteen miles north from the town and port of Westport, and about seven miles north, as the crow flies, from the Denniston collieries. The area held under Crown lease for coal-mining purposes (known as Granity Creek) comprises 3,026 acres, whilst the gross tonnage raised to date is 1,878,000 tons. Referring to geological data of the Buller Coalfield, the coal-seam worked in the Granity Creek, or Millerton, lease is scientifically confirmed to be the continuation of the Coalbrookdale area, extending northward in one unbroken series from the southern boundary at the head of the Whareatea Creek. With respect to quality and heating properties of these highly bituminous coal-seams, comment shall not form part of this paper, as their calorific values for commercial and maritime purposes are facts in their economy too widely known over the Australasian Colonies. The following gives the average analytical test:—

	Per Cent.
Fixed carbon	74·83
Volatile matter	20·50
Ash	3·51
Moisture	1·16
	100·00

In comparing the altitudinal position of the coal-seam above sea-level, and the rugged and deeply intersected surface-characteristics of the Millerton lease with Coalbrookdale, it may be stated that development has entailed exceptional expenditure in the construction of heavily inclined tramways, efficiently equipped for endless-rope haulage. This system of haulage is universally installed over the field, with carrying-capacities capable of maintaining an average output of 1,000 tons per day of eight hours, on gradients which vary from 1 in 2·7 to 1 in 3 and 1 in 15. The tram-lines, covering an aggregate total length of two miles and a half, comprise 52 chains of rock-tunnelling, and employ five miles of patent plough-steel rope 4½ in. and 3½ in. circumference. Hydraulic brakes are separately installed to control the motion.

In connection with the haulage and mining operations, one of the chief economics of this property lies in the fact that the coal is filled by the miner at the working-face, is conveyed over the various systems of haulage to the screening plant, and loads direct into the Government railway-wagons on the siding at Granity Station, Granity being the acknowledged headquarters of the colliery offices and general workshops for fitting and effecting repairs to the mining plant.

The leasehold so far developed is divided into three main working districts, known as the "East Dip," "Mine Creek," and "New Tunnel" areas. The latter, or western, division of the coalfield was recently opened by an inclined tramway, equipped with endless-rope haulage, branching on a southerly course from the intersection of Nos. 1 and 2 inclines, construction of which comprised 18 chains of rock-tunnelling, 11 ft. by 7 ft., on a gradient of 1 in 5. Strike and thickness of coal-seam are somewhat variable—thickness 6 ft. to 35 ft., lying on a natural trend of 1 in 8 north-easterly, this ratio of inclination being considered a favourable working-condition both for coal-hewing by hand-labour and coal-cutting machinery. Computing the extent of seam operated on, both by solid and exhausted pillars, the total does not exceed 222 acres, of which the greater part is yet standing on pillars; therefore, the life of the mine is a consideration worth noting.

Bord-and-pillar is the system worked, but, in order to provide more effective and improved precautions against the possibilities of spontaneous combustion, the panel system was lately introduced into the Mine Creek area. The principle claimed for this system is that affected districts are more easily cut off with a minimum of danger. Holing and cutting machinery, actuated by compressed air, are largely and successfully employed in the solid work, round coal maintaining an average percentage equivalent to that produced by hand-labour. The holing-machines in use are of the percussive type (made by Leyner, of Denver, Colorado), and the shearing-machines, Siskol (late Champion). Free drainage is amply provided by rock adit, 1,260 ft. in length, and ventilation is efficiently maintained by two steam-driven exhaust-fans, which induce an aggregate air-current of 150,000 cubic feet per minute. The power-stations, fitted for generating steam, compressed air, and electricity, are separately and suitably installed on the surface, electricity being freely used in lighting the more important centres of underground haulage traffic.

The storage-bins, of 3,000 tons capacity, are fitted with the latest screening and sorting appliances, including jiggers and picking-belts; and the slide doors in use for freeing the coal into the railway-wagons are controlled by hydraulic rams, operated under a head pressure of 600 ft., hydraulic power being used to operate all screening-appliances, workshop tools, electrical plant, &c.

The Westport-Stockton Coal Company (*Limited*), (G. H. Broome, mining manager), was incorporated under "The Companies Act, 1903," on the 3rd August, 1905, with a capital of £150,000, in 300,000 shares of 10s. each, to acquire and work a Crown lease of 1,577 acres, situated in the Ngakawau Basin of the Buller Coalfields Reserve, Westport, and adjoining the Granity Creek lease, owned by the Westport Coal Company. The area is conveniently situated for connection with the Government railway (Westport–Mokihinui), with which the company proposes to connect the workings by a series of inclined tram-lines suitable for endless-rope and electrical-motor haulage. Development is now in active progress, and the manager is sanguine that, with the advantage gained by his previous knowledge of the coalfield, every effort necessary to command and maintain a commercial and economical system of working will be advanced. Meantime, drivings are being extended on several outcrops to develop and improve the field, and it is pleasing to note that thickness, quality of seam, and general working-conditions give decided promise of a successful venture. Ventilation is very efficiently maintained in the various drives by exhaust-fans, actuated by means of oil-engines.

Reefton Coal-mines.

Coal-mining in the Reefton district seems to attain no higher sphere in commercial circles than ordinary household consumption, while the small coal is utilised for steaming purposes at the Golden Fleece crushing-battery and the Keep-it-Dark winding-engine. The seams worked at the Murray Creek, Phœnix, and Lankey's Gully mines maintain a thickness of 10 ft. to 20 ft., and their highly bituminous qualities not only procure a ready sale for local use, but considerable consignments find their way by rail to Kumara and Hokitika. The total output raised from these mines to the 31st December, 1905, was 49,121 tons, and for the whole district 98,585 tons. The coal is sold in the town at £1 2s. per ton, and the same price is obtained for consignments on the railway-wagons at Reefton Station. A small mine was recently opened in the township reserve, but development so far is not important.

Boatman's and Bourke's Creek Mines, near Reefton.—Coal-mining at Boatman's is confined to two small mines owned and worked by Mr. F. W. Archer and Mr. John Coghlan on their freeholds. The seam, having a similar quality and thickness to the Murray Creek mines, is carted and sold in Reefton at local rates, the small coal being largely used for steaming on the Boatman's Creek dredges. Needless to say, these dredges have been a considerable boon to the district. Bourke's Creek Mine (owned by Messrs. Cairns and McLiver) has been worked at a very low ebb during the last two years, but on the opposite side of the terrace Mr. Lockington (sawmiller) has recently opened and fitted a very complete mining plant. On the north bank of the Waitahu River Mr. James Scarlett, of Reefton, has opened a mine, the coal being freely sold in town.

Progress Mines take their coal-supplies for steaming purposes at the Globe quartz-mine from their own leasehold on the Merrijigs Road. The coal is carted to a shoot, thence trucked to the main shaft, and hoisted to the surface. On the adjoining leasehold about 300 tons a year is mined by Mr. Stephen Loughnan, and delivered for household fuel in Reefton.

Buller Road Coal-mines.

During the dredging boom Mr. George Walker, of Rocklands House, reopened the old Coal Creek Mine, but suspended operations owing to the failure of dredging on the Buller River.

Mr. Job Lines, of White Cliffs, continues to take coal from his lease on the Buller Road for the supply of the Old Diggings and Buller Junction dredges.

Mr. Stefano de Filippi, Three-channel Flat, has been somewhat successful with his mine in the supply of steam-coal to the Mokoia and New Feddersen dredges. The coal is soft, but very useful for steaming.

Coal-mining in Paparoa Range.

The Paparoa Coal-mining Company (Limited) was filed with the Registrar of Joint-stock Companies, Wellington, on the 22nd December, 1905, with a capital of 100,000 shares of £1 each, to acquire for a term of sixty-six years a Crown leasehold of 1,000 acres, situated on Mount Davy, Paparoa Range, at an altitude of 1,500 ft. above sea-level, and about two miles and a half north from the Township of Blackball. The field comprises six seams, with average thicknesses of 5 ft., 10 ft., and 10 ft. 6 in., making a total of 63 ft. of coal. The quality of the coal is somewhat remarkable, and, according to the following analysis by the Government Analyst, Nos. 1 and 2 seams may be classed amongst the anthracite coals, whilst the other seams compare equally with the West Coast coalfields:—

	Seam No. 1.	Seam No. 2.	Seam No. 3.	Seam No. 5.	Seam No. 6.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Fixed carbon ...	80·05	79·10	77·20	75·55	70·00
Hydrocarbon ...	15·10	15·05	19·00	22·75	24·35
Water	0·65	1·85	0·60	0·70	0·85
Ash	4·20	4·00	3·20	1·00	4·80
	100·00	100·00	100·00	100·00	100·00
Total sulphur ...	0·37	0·23	0·26	0·29	0·19
Evaporative power by standard usually adopted in New Zealand ...	10·40	10·28	10·04	9·82	9·10
Ditto in New South Wales	17·61	17·40	16·98	16·62	15·40

The coals of the lower seams (Nos. 1, 2, and 3) are practically smokeless, and should be eminently suitable for use in ocean-going steamers generally. The area can be opened level-free, and the coal conveyed by means of a self-acting haulage-road, about two miles in length (at a fairly easy gradient), to the new branch of the Government railway now under construction from Ngahere to Blackball.

Brunnerton Coal-mines.

Although the history of coal-mining in the West Coast Mining District may reasonably be said to have taken its origin in the Brunner Coalfield about the year 1870, it is nevertheless a fact that, although the Tyneside Colliery is still in active and successful operation, Wallsend, Coalpit Heath, and Brunner Mines are now institutions which belong to the past. The approximate tonnage raised from the Brunnerton district gives an aggregate total of 3,070,516 tons.

The Brunner Mine, situated about eight miles north-easterly from the Port of Greymouth, was originally opened by Matthew Batty and party in 1870, on the outcrop first discovered by Mr. Brunner, on the north side of the Grey River.

This party having failed to develop and work the mine to profitable advantage, it was afterwards taken over by a Ballarat syndicate, who also failed to comply with the conditions of the lease, when, after a series of varied and unsuccessful operations under the Provincial Government, Messrs. Kennedy Bros., then of Greymouth, acquired possession of the property. On this change of ownership the commercial and productive capacities of the mine soon attained a more hopeful aspect, and on the appointment of Mr. James Bishop as general manager the output acquired a first place in the colony. Whilst this flow of prosperity continued the whole of the properties were amalgamated, under the title of the "Grey Valley Coal Company," in 1890, in which year Wallsend Mine was declared abandoned, and all movable plant was withdrawn during the maritime strike. On resuming operations after this ruinous strike free labour was largely employed, and it was a noticeable feature, as regards the welfare and prosperity of the district, that the former vitality was fast ebbing out. Ownership was again changed, the title of the new lessees being the "Greymouth – Point Elizabeth Railway and Coal Company," who purchased and acquired possession of the mining, coke, and brickmaking plants in the year previous to the memorable accident in March, 1896, this company still continuing in full possession of the property.

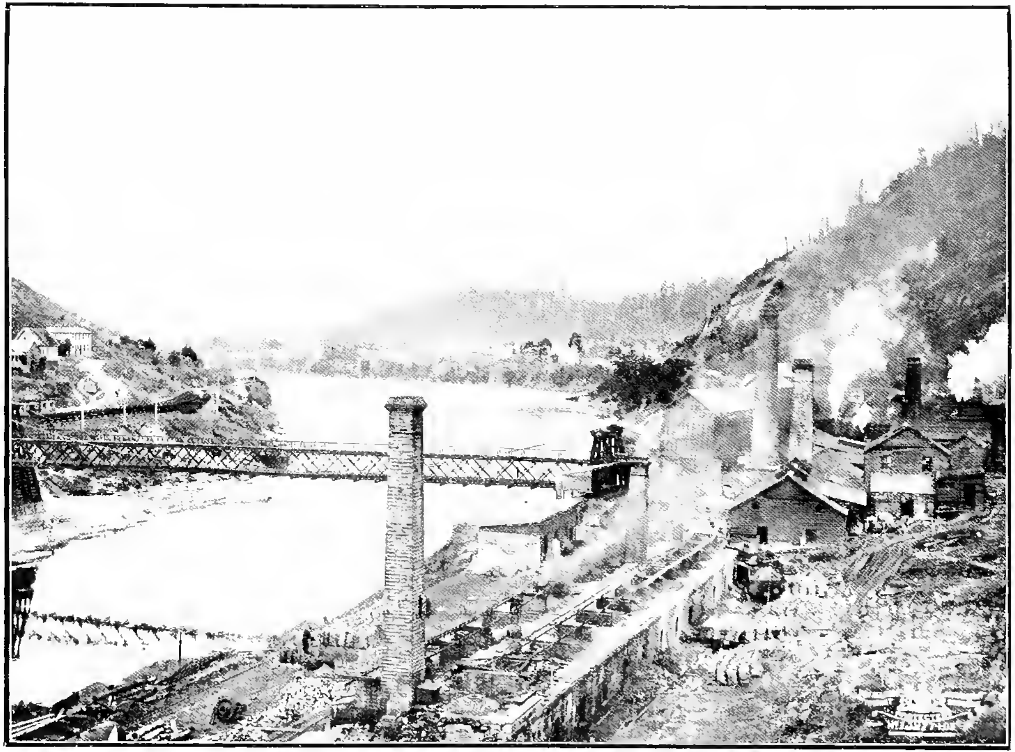
Tyneside Colliery, which now stands directly behind the Brunner Railway-station, was opened by a Greymouth syndicate in the year 1873 by a winding-shaft 98 ft. in depth, with a finished diameter of 10 ft., suitable for two single-decked winding-cages, whilst the adit on the south bank of the Grey River provides a suitable travelling-way for the workmen and an efficient intake for ventilation. During the early history of the mine it would appear that success had not favoured the efforts of the original promoters, as operations were finally abandoned. About 1888 Mr. Joseph Kilgour, of Greymouth, reopened the mine, but after a short season of favourable promise he entered into a purchase agreement with the Grey Valley Coal Company, who shortly afterwards abandoned the property and withdrew all movable plant. Nothing further was done on the property until the Tyneside Coal Company (a local concern) opened and unwatered the mine in June, 1902. This advent was followed by a short season of success, when the mine was again taken over by the Tyneside Proprietary in 1903. During the history of this proprietary mining operations have been very successful, and in 1905 the gross tonnage raised was 44,047 tons. The surface arrangements are well equipped with modern appliances for cleaning and sorting the coal. Ventilation is efficiently maintained by exhaust-fan, and the underground workings are safely and well regulated throughout, while the highly bituminous character of the seam, from 10 ft. to 12 ft. in thickness, commands a ready market for general commercial and steaming purposes.

Fleming's Lease, Stillwater.—In 1904 a coal lease was issued in favour of Mr. Malcolm Fleming over 232 acres 3 roods 15 perches in the Arnold Survey District for a term of sixty-six years, on the terms that the sum of £500 be lodged with the Public Trustee as a guarantee that the conditions of the lease be complied with. The lease is now opened by a rock tunnel, 6 ft. by 5 ft., which intersects the coal-seam at a driven distance of 600 ft. The seam is soft, thickness variable, and the dip has a steep angle of inclination.

CANTERBURY COAL-MINES.

By E. R. Green, Inspector of Mines.

The principal mine in the province is the Homebush Mine, in the estate of the late Mr. John Deans, at Glentunnel, South Malvern district. These mines were started in the year 1873, and have been worked continuously since that date, principally in winning coal to rise of main levels, which were extended 42 chains west, all in coal; headings and bords driven, and pillars brought back successfully. It is estimated



Brunner Colliery, Grey River: General View, looking towards Greymouth; Taylorville on right.

Mining Handbook.

that over 85 per cent. of coal available has been won from the pillared area. Extensive development to the dip of main levels has proved continuation of the seam in that direction. Steam plant for dip haulage has been erected, and, the lower workings being comparatively dry, pumping plant is not yet required. Main seam, 6 ft. to 7 ft. in thickness; furnace ventilation. A seam of fireclay occurs on the property, and is mined for manufacture into bricks, sanitary glazed pipes, and other ware at the extensive pottery-works in connection with the mine. Mr. Deans having sent a working-sample of the clay to a firm of manufacturers in Liverpool, received a report that "for taking salt glaze the clay was as good as any of its class they had seen, and they only wished that they had a similar clay on their own premises."

Other mines in the Malvern district are those at White Cliffs and Springfield, the latter being chiefly worked in conjunction with the fireclay-deposits underlying the coal-seams, the clay being sent by rail to Christchurch for manufacture there. At Springfield, and at Sheffield, too, the coal-seams are now practically exhausted in regard to coal to rise or outcrop, and the same may be said of other coal-bearing localities, as at White Cliffs, &c., and expenditure upon haulage and pumping plants will require to be undertaken if coal at depth is to be won. The mines at Woolshed Creek and Mount Somers work steadily with a limited number of men, but are heavily handicapped by lack of branch railway communication; the Selwyn County narrow-gauge horse-tramway, nine miles in length, as laid from Mount Somers Railway-station to the mines termini, provides slow traction, and an extra handling of coal by crane at the station adds to cost on railway-trucks.

At Waiho several small mines are conducted with more or less vigour, mainly in accordance with local requirements, the mine on Chamberlain Settlement, Albury, being somewhat similarly situated.

In addition to the mines mentioned, a number of other deposits are known to occur; some of them, being far back, are worked as required for local use.

Coal in Canterbury is principally found in the Tertiary deposits of the foothills lying between the plains and the eastern slopes of the Southern Alps, in area extending from Waimakariri River on the north to Waitaki River on the south, quality ranging from superior to medium brown coal. At Acheron, Rakaia Gorge, and at Brockley, South Malvern, are seams of anthracite coal, altered by proximity of dolerite-flows. These seams are not being worked on account of inaccessibility and distance from nearest point of railway—the terminus of the Christchurch – White Cliffs Branch, at White Cliffs. A considerable amount of prospecting for coal in convenient localities has from time to time been undertaken, notably at Springfield, by the Springfield Coal Company and others, also at Hartley and South Malvern, Makikihi, Stavely, Springburn, and at Mount Winterslow, where an Ashburton resident recently spent a considerable sum of money in searching for a seam of bituminous coal supposed to exist there.

Complete statistics and detailed reports on all the mines are published annually by the Mines Department in "Papers and Reports relating to Minerals and Mining," according to which 25,638 tons of coal were raised during the year 1905, making a total of 458,132 tons produced in the province.

The valuable deposits of fireclay at Homebush and Springfield Mines also occur in the coal-measures, and are being worked at Sheffield, whence the clay is being taken to Christchurch for use, and at White Cliffs, where it is being converted in the extensive local pottery-works. 617 tons of fireclay were raised for use in Canterbury during the year 1905.

A deposit of kaolin, at Kakahu, is said to have been favourably reported on by expert pottery-makers.

Lime-burning is carried on at Selwyn Gorge, Mount Somers, and at Springburn, Stavely, at which latter place coal is mined exclusively for this purpose.

OTAGO AND SOUTHLAND COAL-MINES.

By E. R. Green, Inspector of Mines.

These provincial districts are fortunate in the number of existing local coal-deposits, varying in extent or area, and ranging in value from lignite to brown-coal and pitch-coal of superior quality. From an economic point of view, in relation to the various centres of population, also outlying districts, the value of the proximity of these extensive beds cannot be overestimated. They may also be expected to become important factors in the event of their being found suitable for use in connection with producer-gas power plants.

Peat-beds occur occasionally, as in Waipahi Valley and other places, also on tops of high mountain-ranges, many of which carry large areas of peat-bog.

Lignite occurs plentifully as fluviatile or lacustrine deposits, mainly following the valleys and terrace formations of the Clutha and Mataura River systems and tributaries thereto. One of the most extensive deposits is that at Gore and surrounding districts, extending to Mataura and Wyndham, thence by way of Seaward Forest to Clifton, at South Invercargill, a distance of about fifty miles in length by one mile and over in breadth. Generally, the lignites occur near the surface, and are overlaid by gravels and clays 5 ft. to 10 ft. in depth. Seams vary from 6 ft. and upwards to 20 ft. and over in thickness. At Alexandra the seam is 28 ft.; at Clyde, two seams aggregate 80 ft.; and at Coal Creek, Roxburgh, one seam as exposed is 100 ft. or more in thickness. In or near river-courses and in low-lying situations the lignite-beds are usually found horizontal in deposition, and in terrace formations with a slight dip from the outcrop.

Large deposits of pitch and brown coals occur at Shag Point, Kaitangata, Nightcaps, Green Island, Tokomairiro, Taratu, and Orepuki, and in lesser degree at Lovell's Flat, Papakaio, Gibbston, Nevis, Cardrona, Bannockburn, and other places.

Shales of low specific gravity, found associated with lignite-deposits at Idaburn and Waikaia, are used as fuel. At Orepuki a seam of oil-shale, 4 ft. in thickness, immediately overlies the coal-seam there. Extensive works erected for reduction of this mineral have been closed down for some time.

Clutha Coalfield.

Kaitangata and Castle Hill Mines.—The principal mines in the southern district, not only by reason of the extent of this coalfield, but also on account of their being the largest in operation, are the Kaitangata and Castle Hill Mines, the property of the New Zealand Coal and Oil Company (Limited). About 120,000 tons of coal are raised annually; seams worked are main seam, 35 ft., and 18 ft., the latter occasionally "split" into 12 ft. and 6 ft. seams, having partings between of variable thickness. Main cross-measures drive east is at 3,300 ft. from surface to working-face; main lines of fault, having a general north and south strike, downthrow east, have been successfully encountered. The measures, which formerly had a heavy westerly dip, are found flattening gradually to the anticline of the seaward range of hills forming the central axis of the field. The mines are equipped with efficient haulage and pumping plants, air-compressors, loading-banks, and screens (electrically lighted), and suitable machinery for conducting the works. Kaitangata Mine is ventilated by an electrically driven fan and Castle Hill Mine by furnace, while main haulage-roads of latter mine are lighted electrically, and furnished with telephonic connection from the surface. Both mines are reticulated with systems of compressed-air and water pipes, the former for transmission of power to dip-haulage winches and pumps, while water is laid on for suppression of spontaneous fires, to which the coal is particularly liable under certain well-known conditions, as pillar-crush, accumulations of dross, falls of coal and stone with clay, &c. Recent improvements at Kaitangata Mine include a new upcast air-shaft, which is being sunk abreast of the main body of advancing workings. The collieries are connected by private branch lines with the Main Trunk Railway at Stirling Station.

Shag Point Coalfield.

Under-sea and foreshore workings having been abandoned, the Allandale Colliery has become the principal producer of coal from this field. Development-work to the dip of the measures having resulted favourably, the management installed an electric plant for dip haulage and pumping, also for main-level haulage underground, while the ventilating-fan is also electrically driven. A new motor, 100-horse power, is on order to provide for additional power as required for advancing workings. Coal is conveyed from the colliery on the company's private branch line, which connects with the main line of railway at Bushey Station.

Green Island Coalfield.

This coalfield includes Abbotsford, Saddle Hill, &c. About 70,000 tons per annum continue to be raised from this field for consumption in Dunedin City and surrounding districts, and from indications there should be no diminution of the rate of output for some years to come. The several collieries forming the group are being vigorously conducted. Coal-seams vary from 12 ft. to 20 ft. in thickness; method of working, bord and pillar, with subsequent robbing of pillars and head coal. Two branch lines of railway afford communication with the main line at Abbotsford and Burnside Railway-stations respectively.

Nightcaps Coalfield.

The Nightcaps Coal Company's mine is the principal one on this field, having an annual output of about 43,000 tons. Three seams are being worked, aggregating 36 ft. of good coal, separated by two partings of hard clay or "bat." On the outcrop of the seams coal is stripped and worked opencast. Underground, levels and dips driven to the boundaries are being brought back on pillars and head coal, with a high percentage of coal won in pillared areas. Efficient haulage plant and appliances, loading-bank, and screens are provided. An acetylene-gas plant has been installed for lighting the surface works, railway-station, and yard. Coal is conveyed on the company's private line, some two miles and a half, to Wairio Railway-station.

Other Coalfields.

Other mines in Otago having considerable outputs are the Taratu Coal Company, Lovell's Flat, Bruce Railway and Coal Company, and Real Mackay, Milton, each having private branch lines of railway from collieries to main lines.

In Central Otago the chief mining centres are Alexandra, Clyde, Bannockburn, and Roxburgh; while in Southland, in addition to Nightcaps, the principal workings are at Gore, Mataura, Waikaka, and Waikaia.

Output from Coal-mines, Southern Mining District.

The following table shows the output of coal from the principal mines in the southern district for the year 1905 and to the end of that year; also total output from all the mines in the district to end of year 1905:—

	Output for 1905. Tons.	Approximate Total Output to 31st Dec., 1904. Tons.	Approximate Total Output to 31st Dec., 1905. Tons.
Kaitangata collieries	119,896	1,903,603	2,023,499
Shag Point collieries	20,198	635,300	655,498
Green Island collieries	70,204	1,407,266	1,477,470
Nightcaps collieries	48,188	459,633	507,821
Totals ...	258,486	4,405,802	4,664,288

The following is the output from all mines, including the above:—

	Output for 1905. Tons.	Approximate Total Output to 31st Dec., 1904. Tons.	Approximate Total Output to 31st Dec., 1905. Tons.
Canterbury ...	25,638	432,494	458,132
Otago	317,731	5,096,779	5,414,510
Southland ...	126,284	1,021,159	1,147,443*
Totals ...	469,653	6,550,432	7,020,085

* Includes 14,422 tons of oil-shale raised at Orepuki.

Other Minerals—1905.

Fireclay.—At Benhar and Lovell's Flat, 1,800 tons of fire-clay was raised, and converted into sanitary pipes and other glazed ware during the year 1905.

Building-sand.—14,484 tons of sand was produced at Green Island Coalfield for use in Dunedin and district.

Marl (Burnside).—Eight hundred tons was utilised by the Milburn Lime and Cement Company at its cement-works, Dunedin.

Lime (Canterbury and Otago).—12,260 tons has been returned as having been disposed of during the year. (Output from one or two small kilns not included.)

Phosphate Rock.—Five thousand tons of rock was recovered from the field at Clarendon, and after being calcined on the ground was forwarded to the chemical works for treatment and conversion into artificial manures.

Hæmatite.—Fifty-six tons was raised at Mataura for use by the paper-mills at their works at Mataura Falls, Southland.

THE STATE COAL-MINES.

Point Elizabeth State Colliery.

By J. Bishop, M.I.M.E., Manager Point Elizabeth State Coal-mine.

Introductory.

The history of State mining within the colony dates from the passing of the State Coal-mines Act in the parliamentary session of 1901, whereby the Government was authorised to embark in coal-mining under the direct control of the Minister of Mines, who by the Act is empowered to open and work coal-mines, and generally to carry on the business of coal-mining in all its branches; and under the Act the Government has power to make reserves of such land as may be found necessary for State coal-mining purposes.

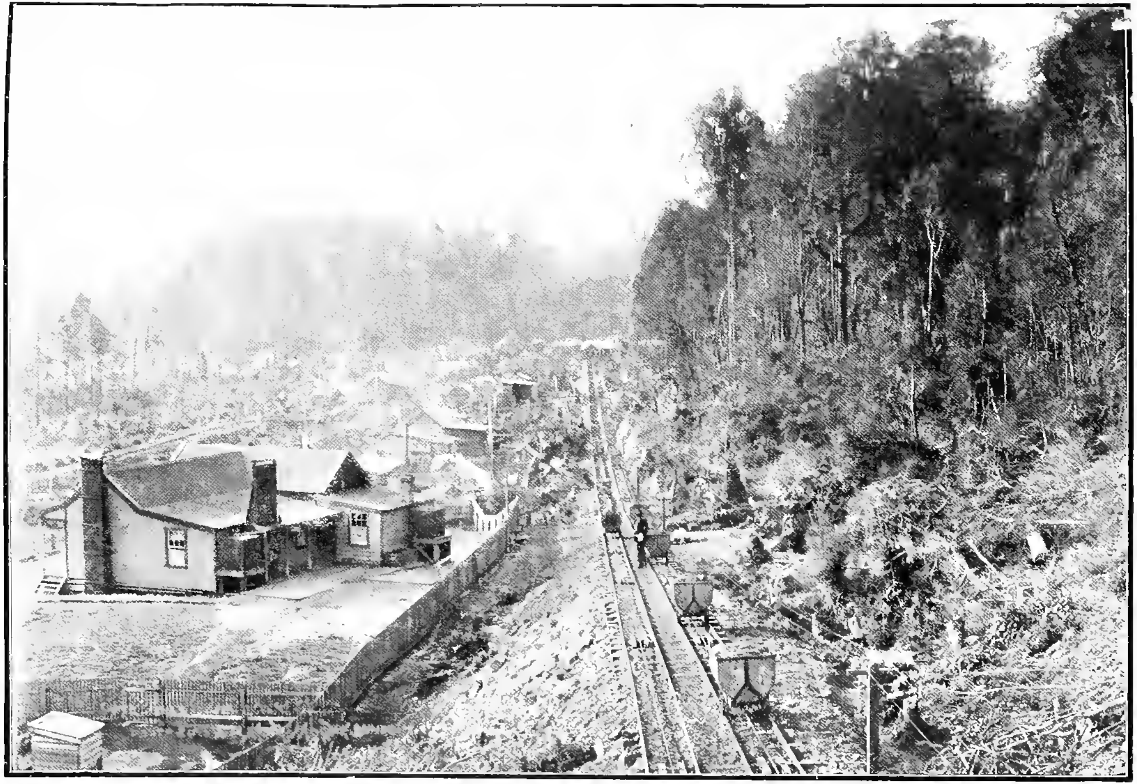
The west coast of the Middle Island being, so far as is known, the only part of the colony capable of producing coal of a quality suitable for the varying requirements of the colony's manufactures, the propulsion of steamships, and for use as locomotive-fuel, the first mines under the State ownership and control have been opened in that region.

The colliery, of which the following notes give a brief outline, is situated five miles north from the town and port of Greymouth, and approximately two miles east from that point of the sea-coast known as Point Elizabeth. Hence the name given to the colliery.

Area of Reserves.

The area of land at present reserved for the purposes of this or any other State mine which it may be found desirable to open in the same region is approximately 8,000 acres, being a portion of what is designated the Grey Coalfield. The area may be said to be divided into three blocks—viz., the North, Central, and South Blocks.

Geology and Topographical Features.—The coal-seams of the region are probably of Eocene age. The strata overlying and otherwise associated with the coal-seams are shelly limestones, marls, soft sandstones, coaly shales, and grit. The surface of the country is strikingly uneven, and varies in elevation from a few feet to as much as 2,000 ft. above sea-level. The lower elevations are covered by a dense forest of valuable timber, suitable for use in the construction of permanent surface works necessary in connection with coal-mines. There is also abundance of suitable timber for use in the underground workings of the colliery. The country is traversed by a number of important creeks, some of which—notably the Waimatuku or Seven-mile Creek—have, by erosion, cut their channels through practically the whole of the coal-measures, thus exposing the coal-seams in a splendid natural section, and enabling the position and character of most of them to be ascertained with comparative ease. The section just referred to shows the existence of at least twenty-one distinct layers or seams of coal, totalling a thickness of



44 ft. Of the twenty-one seams at least four are workable, these varying in thickness from 2 ft. 6 in. to 10 ft.

Lines of Faulting.—Denudation and erosion have not only exposed the coal-seams, but have enabled the lines of faults—of which there are several traversing the district—to be ascertained with a very close approximation to correctness prior to mining being started, thus preventing the disappointments which often arise from the laying-out of works that afterwards prove unsuitable in consequence of a fault or faults which could not be located by surface exploration.

Inclination of the Seams.—The coal-measures here are, like most of the other portions of the Grey Coalfield, found to have an angle of inclination varying from 1 in 3 to 1 in 5, or approximately $12\frac{1}{2}^{\circ}$, the dip being to the south-west.

Colliery-development.—The necessary works for the development of the colliery were commenced in September, 1902, and were so far completed as to enable coal to be shipped in June, 1904. In consequence of the existence and effect produced by faults, the lines of which had been traced on the surface, it was deemed advisable to open the colliery by driving two main tunnels for haulage. The site chosen was in the valley of the Camp Creek. The tunnels are numbered 1 and 2. No. 1 is on the rise side of the largest of the faults, and No. 2 is on the dip side of the same, but on the rise side of the second fault. The line chosen for the tunnels enabled them to be driven almost directly against the rise of the measures, and was in stone overlying the 10 ft. seam for a distance of $11\frac{1}{2}$ chains before striking the coal. Seeing that the main tunnels were driven to intersect coal separated by a fault or displacement of considerable magnitude, the working of the coal is being carried on as two distinct collieries in so far as the underground operations are concerned.

System of Work.—The system of work adopted is mainly by bord and pillar, a small portion only of this coal having been worked by the longwall method. In the bord-and-pillar system the bords are 18 ft. wide, and pillars 14 yards thick. The pillars are left intact until the boundary of a section is reached, when they are worked back. The roof has in the main proved good, enabling a large percentage of the pillar-coal to be won.

Colliery Equipment.—The plant already installed consists of two ventilating-fans; endless-rope haulage system, with engine and boiler, also six hundred coal-tubs; temporary engines for dip haulage; coal-storage bin and appliances, including picking-belts and screens; workshops, machine tools, and sawmill.

Ventilation.—Ventilation is produced by two exhaust-fans, one for each section of the colliery, for, as has been explained, the underground work is carried on as two distinct concerns.

Haulage.—The conveyance of the coal from the miners' working-place in the rise workings is done by self-acting or gravity inclines, by which the tubs are lowered to the main level to be attached to the endless rope. Coal from the dip is raised by an auxiliary haulage-engine to the main level, also for attachment to the endless rope, which is in all 160 chains long, and is actuated by a steam-engine located near the storage-bins on delivery end. The coal-tubs, of which there are six hundred in use, are attached to the rope by clip chains at irregular intervals apart—five, ten, or more yards may be found necessary. The rope is carried on rollers placed between the rails, and it runs under the tubs. The rope from the engine direct to No. 1 tunnel is passed round a terminal or return wheel, then back to No. 2 tunnel, having the loaded tubs from No. 1 attached. Arriving at the junction with No. 2, the tubs from No. 1 are unclipped from rope and passed over the junction. The rope is passed into No. 2 round the terminal wheel there, and returns with loaded tubs attached, passing the junction with the main line. The output of coal (750 tons daily) from both sections is conveyed to the storage-bins or to screens as may be necessary.

Tipping-platform.—Arrived at the tipping-platform, the tubs are detached from the rope by boys, who pass them over the weighbridge, when the weight is taken and booked to the credit of the miners whose number or tally is attached to the tubs. In charge of the weighbridge are two men, representing the State and the Miners' Union respectively. Leaving the weighbridge, the tubs are run forward to the men in charge at the tipping-cradle. Here the coal is tipped on to endless steel belts, 115 ft. long, 5 ft. wide, of which there are two in use. These belts extend over the whole length of the storage-bins, into which the coal is delivered, the removal from the belt being effected by means of a plough pushing the coal into sliding shoots placed on each side of the belt. If required for screening, the coal is transferred from the main steel belt to an auxiliary belt travelling in the reverse direction; this delivers the coal on to a vibrating screen. Passing the coal over belts as just described enables the stone or other impurity sent out with the coal to be removed before the coal is stored or screened. The work of picking is done by boys placed at intervals alongside the belt. The introduction of the belts and allied appliances not only enables the coal to be freed from impurity, but also enables the bin to be filled to its maximum holding-capacity (2,000 tons) with the minimum of manual labour.

It may be mentioned that the tubs, in going to the tipping-machines, never leave the rails; the full tub pushes the empty from the machine, and by releasing the brake the loaded tub causes the machine to revolve one-third revolution, empties the coal from the tub, bumping another empty into line. The empties leaving the machine run on a down grade to the point where they are again attached to the rope for return to the miner.

The advisability of using a storage-bin for coal may be questioned, as it has doubtless an injurious effect on the size of the coal, for however carefully it may be handled breakage must result. On the other hand, having such storage assists in the regulation of the work at the colliery when ships are prevented arriving in consequence of storms at sea or floods in the river. It is under such conditions that the benefit of storage is felt, for not only are the miners kept better employed, but having the stock enables vessels after a block in the harbour to be dispatched sooner than would otherwise be possible.

Railway Sidings.—The general arrangement of the railway sidings or station-yard provides for four lines of rails running under the bin, the floor of which is provided with fifty-two doors (sliding), all workable by steam-power, so that railway-trucks can be loaded from storage at the rate of from 300 to 350 tons per hour.

Workshops.—These comprise smithy and carpenter's shops. The former is commodious, and well equipped with the following new and useful machine tools: One 5 cwt. steam-hammer, one radial drill, screwing-machine and punching and shearing machine. All forges are fitted with fan-blast, actuated by a small steam-engine. The carpenter's shop (not so large as the smithy) has located in it a first-class lathe. The tools referred to have proved most useful, enabling much of the lighter class of plant and appliances for the colliery to be made on the works.

Sawmill.—The sawmill, established at the outset in connection with the opening of the colliery, is equipped with a steam-engine and boiler, planing-mill, and other accessories, and from it is obtained all sawn timber required for the erection of permanent structures on the surface, as well as sawn timber for underground use; and workmen are supplied with timber for building cottages at prices much less than are charged for timber obtainable from outside sources.

Railway.—The railway connecting the colliery with the port, although constructed from the vote for "Colliery-development," is now part of the railway system of the colony, having been taken over by the Department of Working Railways. The distance between the colliery and the wharf at Greymouth is, approximately, five miles. The traffic is handled under the railway tariff, and provided for a minimum distance of ten miles—viz., 1s. 10d. a ton—which includes shipping. The system of shipping coal is by hydraulic cranes stationed on the wharf. The coal-trucks—or, as they are called, "hoppers," from the fact that the body is hopper-shaped—carry mainly 8 tons. When run alongside a vessel the crane is attached, and the hoppers are lifted from the frames and swung over the vessel's hatch, when the bottom doors are opened and the coal is dropped into the hold. In vessels having large hatches the hoppers are lowered into the hold before the doors are opened, thus saving the coal from breakage.

Harbour Conditions.—The entrance to the harbour being an open roadstead, absolutely without shelter, there are frequent blocks of shipping, due to heavy seas on the bar; and floods in the river, in which the ships must remain until loaded, are also a cause of hindrance. The first-named cause cannot be remedied, but the hindrances from floods can be much minimised by improved portable cranes. These would also lessen the periods of detention often caused by inability to handle inward and outward cargo with despatch. It is understood that improvements are to be introduced in the direction of improved cranes and other facilities.

Classes of Labour employed, and System of Payment.—Persons having no practical acquaintance with coal-mining are apt to fall into the error that the cost of labour in producing coal is covered by the amount paid for its hewing, whereas there are a number of other items of cost, which may be realised by a glance at the complete list here following, which shows the various kinds of labour employed:—

Underground Labour: Hewing (contract work), timbering, trucking and hauling, brushing, baling water and pumping, overmen and deputies, maintenance-work, ventilation, lamp-trimming, mine-manager.

Overground Labour: Tipping, loading, and screening, weighing, blacksmith and fitter, carpenter, enginemen and stokers, general labour, tub-cleaning, engine-wright.

And to the above, to complete the cost at the mine, must be added stores of all kinds, including timber, rails, general ironwork, ropes, nails, oils, &c.

Referring to the above list of labour, the coal-hewer only is paid by contract; this explains the need for weighing the coal as it arrives from the mine. The hewing-rate in connection with this colliery is a standard of 2s. 4d. per ton for all coal 5 ft. in thickness and over. For coal under that thickness the rate is increased, and in some cases as much as 3s. 6d. per ton is paid for hewing, exclusive of payments for stone and yardage.

The workers are registered as an industrial union, and work is carried on under a mutual agreement entered into between the manager and the employees. By this agreement all rates of pay are fixed, and matters which might lead to dispute, if not provided for, are clearly set out, and in the event of any dispute arising during the term for which the agreement is made there is a proviso which practically prevents any friction between the two parties. In the drawing-up of an agreement, where there are so many items giving rise to discussion, much time and consideration has to be given to it, and it is found that the more thoroughly the various points are dealt with the more satisfactory the working will be. At present the greatest good feeling exists between the management and the employees, and so long as matters in dispute are approached in the same spirit as in the past there need be but little difficulty in arriving at mutually satisfactory agreements.

Future Development.—In order to keep abreast of the demand, and to efficiently develop the coal lying to the dip of the present workings, powerful new haulage-engines, also air-compressing engines, have been designed, and are now on order. The haulage plant will be capable of drawing 1,000 tons per shift from the dip field, the tubs to be conveyed by endless rope. The air-compressors are to be used for the driving of pumps, rock-drills, and auxiliary haulage-engines, all of which will be driven by compressed air. In no case will steam be taken underground.

As mentioned at the outset of these notes, in order to define the position of the lower seams, a bore is being put down near the site of the present colliery. In addition, steps are being taken to exploit the seams of bituminous and anthracitous coal exposed on the northern block. These seams range from 2 ft. to 20 ft. thick, and are existing under conditions favourable to economical exploitation; this being so, it is not unreasonable to anticipate that within a comparatively short period the production of coal from the State-owned colliery in this region will be from 8,000 to 12,000 tons weekly.

Township.—To facilitate the settlement of the workmen employed at the colliery, the Government has laid out a township called Runanga. The location is sheltered and attractive, being within easy distance of the colliery, about four miles from Greymouth, and two miles from the sea-shore at Point Elizabeth, which is the pleasure resort of the people in the district during the summer months. Extensive roading has already been done, and is still being carried on in the township. The railway passes through it, and the railway-station (where the post, telegraph, and money-order offices are to be housed) is conveniently situated. Many of the employees have already erected comfortable homes; others are in course of doing so, and it is pleasing to note that in most cases the style of architecture is neat. Outside of workmen's homes, the Medical Association has erected a very good residence for their medical officer. There are several general stores, and the Grey Education Board has built a commodious school, which was opened by the late Right Hon. R. J. Seddon in January last, and as indicating the progress of the settlement it may be mentioned that there are already a hundred children on the roll.

With the object of meeting the demand for homes, or assisting their erection more expeditiously than would otherwise be possible, it is proposed to set aside a portion of the township for the erection of cottages by the Government on such terms as will, no doubt, prove acceptable and beneficial to the workers, while adding to the general progress of the place. There is also to be erected a building suitable for a library, and in which games of a recreative character may be indulged in. Before leaving this subject, it may be mentioned that most of the timber required for the building of the workmen's homes is obtained from the clearing of the township. The logs are taken to the colliery sawmill, cut into scantlings, boards, &c., and supplied to the users at prices and under conditions favourable to them.

Seddonville State Coal-mine.

By Henry A. Gordon, F.G.S., Consulting Engineer.

The coal-mines that are at present being developed and worked by the State are situated in the districts of Mokihinui and Grey. In both of these districts coal-mining operations have been carried on for a number of years.

Coal was discovered in the Mokihinui district about thirty years ago. Prospecting operations were carried on by Mr. E. B. Gareen and others on the side of the Mokihinui River, about two miles up from its mouth. Coal was found of excellent quality as regards its calorific properties, but at that time, there being no roads or means of transit, the parties interested abandoned the enterprise. The coal from these prospecting operations lay on the surface for some years, and showed very little deterioration by atmospheric action.

Nothing further was done in prospecting for coal in this district for several years, until Mr. Eugene O'Connor and others discovered a large outcrop of coal on the western side of Coal Creek, a tributary of the Mokihinui River. This outcrop showed a thickness of about 30 ft., and from its outside appearance it led its discoverers to believe that a large field of excellent coal, whose calorific value was equal to any coal found in the Westport district, had been found. A lease of 640 acres was applied for and granted. Experts were employed to report on the potentialities of the field, with the view of making certain that if mining operations were commenced they would prove a success. But, as the poet Burns remarks, "The best laid schemes o' mice and men gang aft a-gley." The experts employed spoke highly of the probabilities of the field. A corporation of influential shareholders was formed, and capital was provided not only to open up the mine, but also to construct a railway from the mine to near the mouth of the Mokihinui River, where small vessels could come up to load. A bin was constructed at this place with a holding-capacity sufficient for loading small steamers. There is a large volume of water in the Mokihinui River, and at high water in ordinary tides there is from 10 ft. to 14 ft. on the bar at the entrance; after getting over the bar there is a considerable depth of water in the river up to the place where the bin was constructed. Large bins were also erected about 20 chains from the mouth of the mine, and every provision made for an output of from 40,000 to 60,000 tons of coal per annum. For some time the coal was taken away by small steamers. The company also had one of its own, but it got wrecked in crossing the bar, after, however, running for a considerable time. The company then made arrangements to send the coal to Westport for shipment, the railway at that time being completed up to the terminus of the company's railway After carrying on operations in a southward direction for some years, the company did not find a profitable market for the class of coal that was generally found in the mine. The quality of the coal was all that could be desired in regard to its calorific properties, but its soft, friable character, with handling and transit to ports where it was delivered, proved a great drawback, and there was not sufficient demand for it at a marketable rate to leave a profit to the shareholders for working the mine. The company therefore finally abandoned the workings.

A syndicate of co-operative miners took up the mine, and carried on operations for some time, but one portion of the workings was found to be on fire, and could not be extinguished. That fire has now spread over a large area, and is still burning. Several co-operative parties of miners have taken up a portion of the original lease, and developed the field on the northernmost side of Coal Creek, which is opposite to that of the burning seam, but a little lower down the stream. Success, however, did not attend their efforts. Indeed, it would only be by mere chance that any co-operative company of workmen, who have not a considerable amount of capital at their back, could convert an abandoned mine into a remunerative investment. Any company giving up a coal property would naturally work it so that very little available coal of a good description could be procured unless at a considerable expense. The best portion of the mine being on fire has rendered the possibility of reopening the southern portion of the field from Coal Creek almost hopeless.

The first output from this mine was in 1887, when 200 tons were taken out, and up to the time the last co-operative party carried on mining operations in 1905 the total output was 84,313 tons.

About the year 1892 a coal lease was granted to Mr. A. D. Bayfeild and others, adjoining the place where coal was first discovered in the Mokihinui district, and a company, termed the Westport-Cardiff Coal Company (Limited), was formed to work it. This company expended a considerable sum of money in opening out a portion of the coalfield in a southern direction to a large fault or dislocation which crosses the country from Coal Creek to the ocean. Railway sidings were constructed; bins were erected at the foot of the terrace on the Mokihinui Flat; an endless-rope haulage-road from the mine to the bins, a distance of about 40 chains, was constructed; and a valuable steam-haulage plant erected, with all appliances for providing for a considerable output. The bins had a holding-capacity of about 900 tons. All necessary buildings were erected for carrying on mining operations for a long period. The company had a capital of £10,000; this was expended in opening up the nearest section of the property, which, when first opened out, contained a good class of coal, but as the workings were extended the coal became more soft and friable, having only a block of hard coal here and there. As far as can be ascertained, about £40,000 was expended in developing this section, and what is known as the Bridge Section, the latter section being on the west side of Chasm Creek. Some £30,000 of this capital came from the profits of working the mine; the shareholders did not receive any of the money they originally subscribed. All the hard coal was taken out of the first section of the property; a bridge was constructed across Chasm Creek, and a considerable amount of development-work done in this section; but, with the exception of the face of the outcrops in the Bridge Section, no hard coal was met with, and the price obtained for the soft small coal did not cover the cost of putting it on board ship at Westport.

A considerable amount of prospecting-work was done on the adjoining section, known as the Cave area, which is separated from the first section opened out by a major fault that traverses the country for a considerable distance. Mr. G. H. Broome, the company's managing engineer, and Mr. Denniston examined this area, and had a number of bore-holes put down, when coal was found of an average thickness of about 13 ft. Only one of the bores showed a want of coal, and this bore was considered to be on the eastern side of the coal area. In addition to these boreholes there are various out-crops on the side of the terrace facing Chasm Creek; some of those outcrops show a face of excellent coal, especially the one known as Grant's face. Mr. Broome recommended his company to open up this area, which he estimated would contain about 1,400,000 tons of coal, and that the section on the west side of Chasm Creek, directly opposite the Cave area, would probably contain about 700,000 tons.

The whole of the marketable coal had been exhausted in the first section of the property, and the Bridge Section, so far as development had been extended, contained nothing but very small soft coal. The shareholders got so disheartened through not getting any of their original capital returned that they decided to abandon the enterprise. A few months after mining operations were suspended a fire broke out in the first section opened out. How this fire originated, whether by spontaneous combustion or through carelessness of some one with a light going through the old workings, was never known. From the analysis of the coal one would not expect it to be liable to spontaneous combustion; still, such might take place where the coal is soft and mushy, and especially if it is in close proximity to a fault. The fire got too much of a hold before any real attempt was made to put it out, and although strong efforts were made eventually to extinguish it they were unavailing. This portion of the field is still on fire, but it is circumscribed in every direction by faults or dislocations in the country and by the deep gorge of Chasm Creek, the bed of which is below the level of the burning seam. The fire cannot reach any other portion of the field, and will in time extinguish itself by a total collapse of the surface, which will eventually settle down and exclude the air.

The Westport-Cardiff Company commenced mining operations about 1893, and suspended working the property in 1899. During the six or seven years the mine was worked the output of coal was 227,441 tons. After a lapse of about two years it finally abandoned the property, and sold to the Government the whole of the plant and buildings, which consisted of a powerful steam-engine and hauling-gear, steam winches and pumps, a large assortment of steel rails, chains, tubs, mining tools, mining stores, bins, blacksmith's and carpenter's shops, office, and store.

After the abandonment of this mine there was very little traffic on that portion of the railway from Ngakawau to Mokihinui, and, as this railway was specially constructed to open up the coalfield, the Government employed experts to examine this field, and more especially the Cave area, which had been favourably reported on by the Westport-Cardiff Company's engineer two years previously. These experts carefully examined all the outcrops facing Chasm Creek, on which some prospecting-work had been done by the late company. Cuts had been put in the face of the terrace, and exposed the coal in various places along the side of Chasm Creek, the seam showing a thickness of from 8 ft. to fully 16 ft. In one of these cuts, at the place known as Grant's face, it showed excellent hard coal. Some blocks of this coal, which had been broken two years previously when the face was exposed, were lying on the ground, and showed no sign of deterioration. In making this examination, the Cave area appeared to be divided into two sections by a fault, the extent of which could not be determined until further prospecting-work had been done. The locality of the different boreholes, and formation of the country to the eastward of the Cave area, were also carefully examined. These experts recommended further prospecting operations to be carried on, with the view of determining the area of coal in the Grant's face section of the Cave area. Their recommendations were approved by Government, and a tunnel was driven in from Grant's face for a distance of 15 chains through coal. Those in charge of the prospecting operations gave a favourable report, and this induced the Government to open up the Cave area.

A line of tramway was surveyed from the top of the first terrace above the bins, which went in a straight line to Grant's face, and a tunnel was commenced in the face of a steep granite sideling, the mouth of which was 90 chains from the bin, and at an elevation of about 450 ft. above the flat where the bins were erected. This tunnel was driven through rock for a distance of 25 chains before it struck the coal in the Cave area. Levels were opened up to work the coal, but it was found that this portion of the Cave area contained a very large percentage of soft coal. The coal-seam continued to dip in the direction of Grant's face, and it was deemed desirable to extend the tunnel, which was constructed through 13½ chains of granitoid rock before the coal was cut in the Grant's section of the property. Afterwards the tunnel was carried through coal to Grant's face.

The Grant's face section of the Cave area contained a much better class of coal than in the northern section, but, as its area was circumscribed within narrow limits, prospecting operations were commenced on the western side of Chasm Creek. Two prospecting-tunnels were driven in this section from the terrace facing the creek, about 16 chains apart, which showed the character of the coal to be similar to that in the Grant's face section. A bridge was constructed across Chasm Creek, and an endless-rope haulage-road laid down from the western side of the creek to the bins, a distance of about 150 chains.

The haulage-road here is of a very permanent character, as it is laid with 40 lb. rails from the bins to the place where the coal was first cut in the tunnel, and with 25 lb. rails for the remaining distance. The area of the western portion of the property has not yet been determined; but as coal-outcrops are found in Patten's Creek, about 40 chains across the table-land, it is expected that a considerable area of coal will be opened up in the western section of the property.

No one at the present time can tell the limits of the Mokihinui Coalfield. There are several granitic intrusions and belts, but beyond these the coal is again found, and in all probability will form a connection with the Denniston field, also with the seams of coal found on the eastern side of Mount William, where large outcrops exist. There are extensive areas of coal in this district, but a great percentage of it is of a soft character; nevertheless, the analysis shows the softest portions to contain a high calorific value. There is a difficulty, however, in getting a fair remuneration for soft coal, as, in order to utilise it and get the greatest benefit as a fuel, it requires in using it somewhat different conditions from ordinary fuel. For marine purposes the fire-bars require to be set very close together, and the firing requires to be light and often. If a heavy fire of small soft coal is put on, the steam will go down; but if it is used properly in light firing, and frequently, no better fuel can be obtained.

Since the Government has opened up the Cave area it has found it difficult to dispose of the small coal at such a rate as would recoup the expense of making it a marketable commodity. Recently screens have been erected at the mine, whereby about 35 per cent. of the coal brought from the mine passes over the screens as suitable for household coal, while that portion which passes through the screens falls into a pit, from which it is lifted by elevators and again screened. The portion which cannot pass through this second screen is termed "nuts," and is distributed into the bins, while that portion which passes through the second screen is carried away by a stream of water in a sluice-box, and passed over a hopper, with ½ in. holes, and saved as "peas," while the residue which passes through the hopper is washed away as refuse. The washed peas have been tried for blacksmith work, and are said to be the best sample of coal which can be got for that purpose. As it is only recently that these appliances have been erected, no one outside the district has had an opportunity of testing the properties of the washed product, but when it becomes generally known there will no doubt be plenty of demand for it from foundry-owners and others.

To deal with the large percentage of soft coal there is in the Mokihinui district, the Government has imported a briquette-making plant to utilise the soft coal. This plant is represented by the manufacturers to have a capacity of 200 tons of briquettes in eight hours, or about 3,600 tons per week, if worked continuously. This plant is now in course of erection at Westport, on a site close to the wharf and shipping. The reason of having it at the shipping port is that the cost of erection is much less in the first instance, as no railway carriage is required, and the binding material, which forms from 5 to 6 per cent. of the manufactured briquettes, can be landed at the works, instead of being carried forward and back to Westport as would have been the case if the briquette plant had been erected at the mine.

In regard to the facilities for working the Mokihinui Coalfield—the situation of the bins and the railway sidings in close proximity to the railway—the arrangements made at Seddonville could scarcely be improved on. Seddonville is an ideal mining-camp. There is a considerable area of flat ground having splendid soil suitable for cultivation in any form; plenty of room to lay out a township, with large sections where the miners can build comfortable homes and have sufficient ground around their cottages for growing vegetables and fruit. The trouble in the past has been the difficulty in getting a market for the soft coal, and consequently the miners could not obtain constant employment; but with the present arrangements, and with the future prospects of the whole of the soft coal being utilised in making briquettes, which are said to have on the Continent of Europe 20 per cent. higher calorific value than the best screened coal, there is every prospect of steady employment for a limited number of miners in this locality for a number of years. Indeed, in very few mining localities could such an ideal site for a township be found. The climate cannot be surpassed; the land when cleared is exceedingly fruitful; the dense fogs and mist met with at Millerton and Denniston are unknown in the Mokihinui Valley. The Government, in opening up the mines in this locality, has conferred a great benefit not only on those who reside in the district, but also on those who wish to make comfortable homes for themselves. With constant employment men with good vegetable-gardens can live cheaply, and will be in a position to lay aside a little of their earn-

TRAMWAY, SEDDONVILLE STATE COAL-MINE.

ings to provide for old age. If the Government can make the mine pay all the expenses of working it, the enterprise will benefit a large community by providing remunerative employment for those who earn their livelihood by the sweat of their brow, and it will be the means of establishing many a happy home, and of maintaining a thriving township.

The success of this undertaking would be greatly enhanced if the Government would treat the carriage of produce from the mines on the railways according to its value, as, for instance: Seddonville is nearly thirty miles from Westport, where all the product of the mine has to be delivered; and, although the railway belongs to the State, the same as the coal-mine, the one Department insists on having full tariff rates from the other Department, even if the enterprise is not proving a remunerative investment. Concessions may be given by the Railway Department to private persons and corporations, but if one Department of the service requires a concession from the other, it is met with cast-iron regulations that cannot be changed. It reminds one of the history of the ancient Medes and Persians, whose laws were supposed to be unalterable. Here, at Seddonville, the coal being taken to a port of shipment, has to pay an increased rate of haulage compared with any other mine in the Westport district, not only on the best screened coal, but also on any waste product that comes from the mine, whose market value may be only one-sixth of the other. This gives no inducement to utilise the waste product from the mine; it is financially better to dump it on the waste-heap, while at the same time the wealth of the colony is being reduced daily. Seeing that there is so large a percentage of soft coal in the Mokihinui district, every inducement should be given to utilise it, and make such an enterprise self-supporting. The railway is constructed, and the cost of actual haulage is very little, so that concessions might be readily given at reduced rates for the haulage of highly inferior coal or waste products from a mine to be manufactured into a marketable commodity.

Since the Government took over the Seddonville Mine the output in two years has been 82,030 tons.

A FEW LEADING COAL-MINES.

THE WESTPORT COAL COMPANY.

For many years the coal resources of the Buller Coalfield were known only to a few, but amongst them were some enterprising men who clearly foresaw what a vast field of wealth these would be for the colony if they could be opened up. The efforts of the Hon. R. Oliver, M.L.C., Messrs. B. C. Haggitt, E. B. Cargill, R. Gillies, Fisher, Cable, Drummond, and many others were eventually successful in forming a company—the Westport Colliery Company, with a capital of £100,000—and operations were started; but this company's capital was exhausted before the coal was placed on the market, and in 1882 the present company—the Westport Coal Company—was formed, with a capital of £400,000. Three colliers were specially built for the trade, and the work was carried on vigorously. The company very soon found, however, that if any extent of trade was to be done the harbour must be improved, and after great effort they were successful in carrying through Parliament the Westport Harbour Board Act of 1884 By this Act all the profits of the local railway-line, the royalty on the coal from the Buller Coalfield, and the rents of certain sections in Westport were created an endowment for the Board. The harbour-works, as recommended by Sir John Coode, were carried out under the able supervision of the late Mr. Napier Bell, C.E., with the result that Westport is now by far the best harbour on the West Coast, with 24 ft. draught of water on the bar, and about 21 ft. in the river. The Westport Company's property comprises the Coalbrookdale lease of 2,480 acres, lying between the head-waters of the Wareatea Creek and the Waimangaroa River, and the Millerton lease of 2,950 acres, situated about ten miles north-east of that area. These leases, situated some 2,000 ft. above sea-level, are traversed throughout by the celebrated Coalbrookdale seam of coal, which varies in thickness from 8 ft. to

30 ft. The seam is worked at different sections of the leases, and the coal is conveyed from the underground workings to the tip or brake-heads by endless-rope haulage for many miles; thence it is lowered to the railway-lines by special inclines.

The company's works are situated amid the most wild and romantic scenery imaginable, and the coal is lowered over the inclines by powerful hydraulic brakes, the grading being so steep that in places it is like going over the roof of a house. It was a bold and enterprising company that would undertake such a great engineering work, and a bold engineer who ventured to recommend the carrying of it out, but their efforts have been crowned with success. The visitor to the works is simply amazed that any one should ever attempt to bring coal over such rugged spurs and across such seemingly impassable ravines, and when he rides up the bridle-path, surrounded by the most lovely ferns and overhanging forest-trees, he is no less startled to find such well-arranged works at the top. Here he will see, miles away over the plateau, endless trains of steel wagons, numbered by thousands, slowly travelling from the workings underground to the brake-head, and endless trains of empty ones returning to be refilled.

Power-stations, fitted with batteries of Babcock and Wilcox water-tube boilers and rows of Leyner air-compressors, convey the power underground throughout the mines to work the pick-machines, pumps, and haulage-engines, and one wonders how a company which had to face all these gigantic works and overcome such enormous difficulties could ever pay any dividend at all. It had, indeed, to struggle for many years before the shareholders got any return for their plucky enterprise; but by dint of patience, perseverance, and a large expenditure of money they were at last successful.

The company's mines are laid out on the most improved system; they have been supplied with the newest and most up-to-date plant and machinery, and they are now equipped for an output of 900,000 tons per annum. The first incline at Denniston was designed by Messrs. Young Bros., of Westport. The late Mr. Thomas Brown, to whose fertile brain, untiring energy, and thorough practical knowledge so much of the company's success is due, rose in its service from an ordinary miner to be district manager. He originated most of the mining appliances, opened out the Millerton Mine, and greatly improved the Denniston property. He was ably supported by Mr. Thomas J. Waters, C.E., and subsequently by Mr. Ashley Hunter, C.E., Mr. J. P. Maxwell, C.E., acting as consulting engineer for some time. The works are now under the management of Mr. J. Dixon at Denniston, Mr. George Fletcher at Millerton, with Mr. E. Gillow as engineer, who are ably maintaining the traditions of former managers and engineers, and under whom some most important works and improvements have been carried out with conspicuous ability.

It was satisfactory to find, when all these difficulties were overcome, that the company was able to place on the market a coal unrivalled in the world for its excellence. This has been proved by the high stand it has taken—(1) as a household coal, producing a clean bright fire, burning economically, and being largely consumed in the colony; (2) as a steam-coal it ranks equally with the best Welsh coal, as will be seen by the saving of H.M.S. "Calliope" at Samoa, and the successful tests which have been made by the Admiralty and the mercantile marine, whereby the coal is being used in H.M. warships on the China, Australian, and New Zealand Stations, and by most of the home and intercolonial lines of steamers; (3) the principal gas, freezing, and manufacturing works throughout the colony use it almost exclusively, and even in the antarctic regions it gave such satisfaction that the "Discovery" and the "Morning" were delighted to use it in preference to their Welsh coal, which they brought back to Lyttelton.

Some idea of the magnitude of the undertaking may be gathered from the following statistics. The company has spent from its commencement in 1882—

	£
In wages	1,603,285
In freights to local carriers	1,220,550
On plant and new works	428,325
On stores, &c.	184,942
It has paid to the Government for royalty, haulage rates, and taxes	913,638

And at the end of 1905 it had placed on the market 5,786,983 tons of coal.

Its present output exceeds half a million tons per annum, and it employs upwards of a thousand men and boys, besides indirectly giving great support to labour by freights and other expenditure for handling coal. Some idea of the importance of an industry like this may be formed by the estimate, which is accurately calculated, that every ton of coal pays in labour, before it reaches the consumer, at least 9s. Nor are the company only mindful of the shareholders and their dividends: every possible care is taken of their employees. They contribute largely to the medical associations, pay largely to the Accident Fund over and above what they are liable for under the Workers' Compensation Act; they subsidise liberally the libraries, reading-rooms, bands, and recreation-grounds; they have built a large club, with reading, lecture, and billiard rooms, furnished it well throughout, and pay for a caretaker; it is managed by a committee of the employees, without any interference from the company.

A laboratory and gas-testing house has recently been built at Westport, where daily tests and analyses are made of coal from all parts of the mines by Mr. Bradley, the company's analyst, in order to supply the required description of coal for each class of customers.

THE BLACKBALL COAL COMPANY.

The Blackball Coal Company's leases at Ngahere are distant eighteen miles from Greymouth by rail in a north-easterly direction.

These leases were orginally the property of the Midland Railway Company, but some five years ago were acquired by the late Sir Edwin Dawes, whose estate holds the freehold right at the present time. Royalty is paid by the company for the mineral rights.

The coal leases consist of three rectangular blocks of 650 acres each. The surface is rugged, and contains numerous high spurs with valleys between. Practically the whole surface is covered with timber, comprising rimu, rata, silver and white pines, and totara. A large portion of this timber is used for mining and building purposes. Four permanent streams are on the property—viz., Blackball, Ford's, Coal, and Soldiers' Creeks, all having their sources in the Paparoa Range.

Rising in a north-easterly direction, and dipping towards the south-west, the whole lease is in a hard sandstone country, and contains two seams of coal, lying regularly and uniformly, and which outcrop along the cliff overlooking the Blackball and Coal Creeks. The coal in these seams has generally been described as bituminous, although in reality it belongs to the cannel class. It is compact, with little or no lustre, and has a slaty appearance, without suggestion of a banded structure. It breaks with a conchoidal fracture and smooth surfaces, while the colour is dull or greyish-black. The coal is an excellent steam coal, and is valuable as a gas-producer and for household purposes, being easily ignited and giving off intense heat until entirely consumed. The bottom seam has an average thickness of 12 ft., the coal generally being bright and hard, and as a steam coal possessing high evaporative power. According to analysis it contains 49·15 per cent. fixed carbon, 46·75 per cent. hydrocarbon, 3·2 per cent. water, and 0·9 per cent. ash. Evaporative power by Thompson's calorimeter, 14·25 lb. The top seam averages 5 ft. in thickness, and is separated from the bottom seam by from 2 ft. to 8 ft. of stone, shale, and fireclay. This coal is bright and very hard, and, according to analysis, contains 47·35 per cent. fixed carbon, 44·95 per cent. hydrocarbon, 4·8 per cent. water, and 2·9 per cent. ash. Evaporative power, 12·47 lb. The seams are liable to spontaneous combustion.

Mine.

The mine is situated at the north-west end of the township, and is 312 ft. above sea-level. The surface buildings are built on a semicircular piece of ground between two high spurs, and consist of engine and boiler houses, offices, blacksmith and carpenter's shops, store-rooms, and aerial-tram sheds.

Some fifteen years ago a tunnel, 9 ft. by 6 ft., with a rising grade of 1 in 300, was driven into the hillside. The stratum driven through was a very hard sandstone. A distance of 1,260 ft. was covered before the coal was met with. From this point a heading was driven to the full rise of the seam, and continued until the outcrop was reached—a distance of 21 chains. At this part of the outcrop the No. 1 furnace was erected for ventilation purposes, while a larger, or No. 2 furnace, was erected later on half a mile to the westward. No. 1 furnace circulated 13,000 and No. 2 30,000 cubic feet of air per minute.

Levels were driven eastward and westward from this main outcrop heading for the purpose of developing the upper section, which contained an area of 80 acres. The east side contributed very little towards the output, which was principally derived from the west side. The coal was extracted by the bord-and-pillar method. Levels were first driven and headings turned off the levels to the full rise of the seam (1 in 6) at intervals of 100 yards. Bords, 6 yards wide, were turned off the headings with 22-yard centres, and driven parallel to the levels. The bords are driven from each side of the pillars until a meeting is effected, the result of these excavations being that a solid block or pillar, 100 yards long by 16 yards wide, is left to support the roof. Subsequently these pillars are also removed, and the roof allowed to fall at will.

On account of the tender nature of the roof throughout the mine, timber is an expensive item, and in the extraction of the pillars great care has to be taken to prevent serious accident. The danger is reduced to a minimum by a systematic method of timbering. Although the roof is of such a soft, friable nature, a very small percentage of accidents met with are due to falls.

Outbursts of fire were of frequent occurrence in the upper section. One outburst could not be controlled, and rendered

The upper, or main, level deals with the whole output Endless-rope haulage is installed in this level. Headings are driven to the full rise off the main level. Places are then turned away every 22 yards left and right of these headings, but, instead of the bord-and-pillar system of the upper section, it was deemed necessary to alter the method of working, and the panel system was adopted. In this method the mine is laid out in panels, 150 yards by 200 yards. When once work is commenced on a panel the coal is extracted as rapidly as possible, and the openings to the panel sealed off immediately all the coal is extracted. The advantage claimed for this method is readily seen. Should a fire break out in a panel it is confined to that panel, and does not delay the whole mine, as it did at times in the upper section.

After being filled at the working-face, the trucks are brought out and lowered by means of self-acting inclines to the bottom level, where they are attached to the endless rope and conveyed to the surface. A large Robey engine of 300 i.h.p. (suitable also for main and tail haulage) works the endless rope. After being detached from the endless rope at the mouth of the adit, the coal is passed over the weighbridge, and the trucks are then attached to the aerial tramway.

The aerial tramway is three miles long, and was erected at a cost of £29,000. It consists of two sets of ropes—bearing and haulage. The bearing-rope on the full, or loaded, side is 38 millimeters diameter and 28 millimeters diameter on the empty side, while the hauling-rope is $\frac{3}{4}$ in. diameter. The bearing-rope is stationary, and is supported by steel standards, varying in height from 8 ft. to 85 ft. To keep the bearing-rope taut the line is divided into four sections, straining stations being erected for each section, but this division does not affect the haulage, which is continuous. Travellers with trucks attached run along the bearing-rope. These travellers consist of a pair of grooved wheels, to which are attached two long arms, which grip the trucks by a knob on each end, and convey them bodily along the line. The travellers are attached to the hauling-rope by means of patent grippers. On the engine being set in motion the full or loaded trucks are drawn towards the storage-bins, and the empties towards the mine to be filled again. The full trucks on reaching the storage-bins are automatically detached from the hauling-rope, and at the point of detachment also leave the bearing-rope and run on to a steel rail which traverses the whole length of the storage-bins. Thus the full trucks are detached on one side, taken and emptied into wagons or the storage-bins, and attached to the hauling-rope on the opposite side of the line and returned to the mine. The travellers are thus working continuously in a circle. An engine of 30 i.h.p. supplies the necessary power to work the aerial tramway. Three hundred and fifty tons per day of eight hours is the maximum capacity of the tramway. In all, twelve miles of rope are in use on the tram.

Ventilation of the mine is produced by a Capell fan, worked by a Piercy engine. This fan is capable of circulating 100,000 cubic feet of air per minute. The air enters No. 2 tunnel, passes round the working-faces into No. 1 tunnel (which acts as main return), and along this tunnel to the fan.

A direct-connected engine and dynamo supplies the power for pumping and surface-lighting. The whole steam-power is generated by three large boilers—two Cornish and one Lancashire.

A branch railway-line is now being constructed to connect the mine with the main Reefton line. The traffic-bridge over the Grey River is completed, at a cost of £25,000, and has been open to vehicle traffic some time. On completion of the branch line the aerial tramway as a means of transit will be discarded.

Mr. James Leitch, the present mining manager, has been associated with the Blackball Coal Company for a period of twelve years, the past four and a half of which he has had full charge of mining operations.

Township.

The Blackball Township is distant from the mine about three-quarters of a mile in an easterly direction, and has a population of about eight hundred. The township is principally dependent upon the mine for its existence. The Blackball Company distributes £16,000 annually in the district for wages.

THE KAITANGATA COLLIERIES.

The Kaitangata Collieries are owned by the New Zealand Coal and Oil Company (Limited), and are situated near the Township of Kaitangata, about fifty-five miles south-west of Dunedin. There are two mines—viz., the Kaitangata Colliery, formerly owned by the Kaitangata Railway and Coal Company (Limited), and the Castle Hill, formerly owned by the Castle Hill Coal Company (Limited). Both collieries were acquired by the present owners in 1898. The coal worked is a lignite of a superior quality, and burns with a long clear flame. It is chiefly used for household purposes, although a small proportion of the output is sold to the Government Railway Department for use on their locomotives. The following is a general analysis of the coal:—

	Per Cent.
Fixed carbon	44·60
Hydrocarbons	28·93
Water	20·06
Ash	6·41
	100·00

The seams worked vary in thickness from 6 ft. up to 25 ft. They are generally highly inclined, the pitch varying from 1 in 4 to 1 in $1\frac{1}{2}$, or more. The measures rise to the east, the strike of the seams being nearly due north and south. Faults, rolls, and washouts are numerous, and prove very troublesome in the working of the mines. These disturbances add very greatly to the cost of getting the coal. The principal faults have a general direction north and south. They are all down-throws to the east, and usually have a displacement of 100 ft.

The total output from both mines for the year ending the 31st December, 1905, was 119,743 tons.

The total number of men and boys employed at the two collieries on the surface and underground in the winter-time is about five hundred.

The coal worked is very liable to spontaneous combustion, and great care has to be exercised to avoid accidents from this cause. The method adopted for working the coal is that known as bord-and-pillar. Generally, the seam is worked in small sections, each 300 ft. long, and a solid pillar about 50 ft. wide is left between each section to prevent the fire from spreading from one section to the one adjoining it.

Kaitangata Colliery.

The coal is won by means of a cross-measures inclined plane 1,000 ft. long, which dips into the hills to the eastward at a gradient of 1 in 5. At the foot of this drive the main seam was struck. This seam was about 30 ft. thick, and was a good hard coal, with a splendid conglomerate roof. The seam at this part has been exhausted, and the drive was continued to the eastward with a slight rise for a distance of 3,000 ft., cutting various seams during the course of its length. The workings are now situated about 5,000 ft. from the mine-mouth, and the main seam is at present worked exclusively. Of late, the company has acquired the lease of extensive properties owned by Messrs. Aitcheson and James. The main seam has been proved in each property, the coal being of a first-class quality.

The coal is hauled out of the mine by a steam-engine working two loose-end ropes. One train of ten boxes descends the incline, whilst another similar train is being hauled up. The coal is passed over a shaker screen, where it is divided into four sizes—viz., large coal, nuts, peas, and fine small. The large coal goes on to a travelling picking-belt, where all the dirt and stone is picked out. This belt is fitted with a lowering-arm, which enables the coal to be lowered gently down into the bottom of the wagons, and thus insures the coal being loaded with a minimum of breakage. The fine small, which is unsaleable, is blown away by means of a large Root's blower, and is deposited on top of a hill about 150 ft. high and 900 ft. from the screens.

The underground pumps and winches are driven by means of compressed air. The air-compressor, built by Messrs Walker Bros., of Wigan, has steam and air cylinders (two of each), 2 ft. 2 in. diameter by 4 ft. stroke.

The surface works, screens, workshops, engine-houses, lamp-room, &c., are lighted by electricity.

The colliery is ventilated by a Hayes fan, 9 ft. in diameter, which is capable of giving an average volume of air of 36,000 cubic feet per minute with 1·6 in. water-gauge. The fan can be driven either by a steam-engine or by an electric motor as circumstances may direct. The electric motor is generally used, and the steam-engine is kept in reserve as an alternative power. The electric generator is situated in the air-compressor house, and the power is conveyed from there to the motor at the upcast shaft, a distance of about 700 yards. Both the generator and the motor are of 30 brake-horse-power, and capable of working up to 1,250 volts.

Considerable quantities of firedamp are given off in the workings, and the mine is therefore worked entirely by safety-lamps, no naked lights being allowed inside the lamp-station, which is situated close to the bottom of the drive.

A new air-shaft, 7 ft. 6 in. by 5 ft., is being put down to connect with the present workings. This will considerably reduce the length of the airways, the maintenance of which is very expensive at present.

Castle Hill Colliery.

Here the coal is won by means of an inclined cross-measures drive 2,700 ft. long. The gradient of the drive is 1 in $4\frac{1}{2}$. At 2,100 ft. a seam of coal, about 20 ft. thick, was struck. This was worked for a time, and the drive was continued at the same gradient for another 600 ft., and intersecting the 11 ft. seam at about 200 ft., and the 25 ft. seam near to the bottom of the drive. The drive was continued with a slight rise in an easterly direction, and what is known as "Green's seam," which is 20 ft. thick, was struck at a distance of 2,900 ft. from the surface, and the 6 ft. seam at 3,210 ft. from the surface. All the seams vary in thickness, and are badly cut up with faults, rolls, washouts, &c. These are rather troublesome, and render it very difficult to lay out the workings in a systematic manner. On an average 100 men are employed underground, and 100 safety-lamps of the Marsant deflector type are in use.

The surface works, engine-houses, and the landings at the various seams underground are all lighted by electricity.

The endless-rope system of haulage is in use. An endless rope also drives the main pump at the bottom of the drive. The rope for hauling the coal travels at the rate of one mile per hour, and the pump rope runs at about five miles per hour. The tubs are attached to the hauling-rope in pairs by a clip-chain attached to the front tub. Each tub carries about 6½ cwt. of coal. The engine for working the endless ropes has a pair of cylinders, 20 in. diameter by 5 ft. stroke, geared 5 to 1 on to the hauling-rope-drum shaft.

The pump, which is fixed 2,000 ft. down the drive, has three rams, each 10 in. in diameter by 20 in. stroke, and is capable of delivering 35,000 gallons of water per hour a vertical height of 500 ft.

The coal is passed over a Lyell's patent shaker screen, where it is divided into four sizes—viz., large, nuts, peas, and fine small. The large coal afterwards passes over a picking-belt, where all stone and inferior coal is picked out, so that only the very best household coal is sent to market.

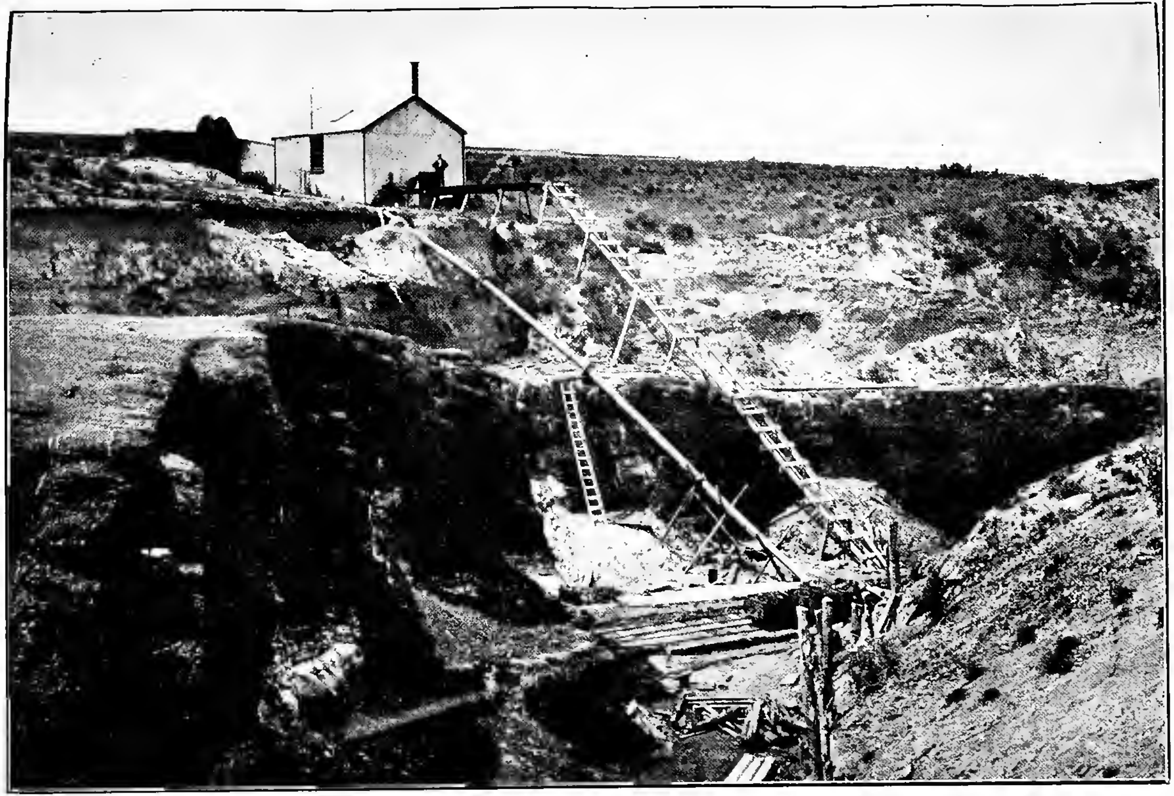
Compressed air is used underground for driving, haulage-engines, and pumps, which are used in connection with dip workings. The dip water is all pumped into a large lodgment, from which it is raised by the three-throw pump, which delivers it to the surface. A pair of two-stage Leyner air-compressors, fixed on the surface, are used for supplying air to the winches and pumps underground.

The colliery is ventilated by a good air-furnace, which is capable of producing a sufficient quantity of air for all present requirements.

There is ample siding accommodation at both collieries for the present output. A private line, about five miles in length, connects the collieries with the Government railway at Stirling.

THE NIGHTCAPS COLLIERY.

Somewhere between the years 1870 and 1880, if not earlier, coal was discovered in the vicinity of the Wairio and Morley Creeks, in the Wairio and Wairaki districts of Southland—some say by the late Mr. James Mackintosh, M.H.R. for Wallace, and others by the late Mr. William Johnston, of Wrey's Bush, or by their employees, when crossing these creeks in their wagons on what is now the main high road between the Winton and Waiau districts. There may be other claimants who deserve the honour as well. However, it was not until the winter of 1880 that these discoveries took a concrete form. Towards the end of 1879 Mr. William Handyside, the present managing director of the company, having been driven out of Ceylon by repeated attacks of fever in the course of several years' coffee-planting there, came to New Zealand on a visit to relatives engaged in sheep-farming, and the invigorating climate had such a beneficial effect that he decided to remain, and naturally began to look about for something to do. Hearing that coal was said to exist in what is now known as the Nightcaps district, and that something might be made of it, he determined to have a look round, first of all visiting the Shag Point Colliery, then in full swing, the Green Island pits, also the Kaitangata Mine, which was then recovering from the effects of the fearful explosion and loss of life that occurred shortly before. Coming to Invercargill later on, and being introduced to the late Mr. William Johnston, of Wrey's Bush, on whose land the coal was found, Mr. Handyside spent some time in prospecting, and also had a look at Orepuki, where a similar kind of coal was said to exist; but, preferring the open country and indications at Nightcaps as more likely, coupled with the prospects of the railway being shortly extended beyond Otautau in the direction of the new coal-find, he returned to Dunedin, and there making the acquaintance of Mr. Charles Edward Twining, mining engineer to the Kaitangata Colliery, and shortly previous to that manager of the Bold Colliery, in Lancashire, England, the two decided to make a trip to Nightcaps and test the field further, and also have analyses made of the coal, with the view of forming a small company to develop the same. This was carried out later on under the name of the "Nightcaps Coal Company," but not until the Government of the day decided to extend the railway to within three miles of the coal-outcrop, and also promised to use the coal on the railways, provided the quality and price was suitable. About September, 1880, the company was formed, with Mr. Handyside as managing director and Mr. Twining as mining engineer, and boring operations were begun near what is the present site of the post and telephone office, under the direction of Mr. Robert Sharp, a miner from the Kaitangata Colliery. These operations occupied some months, costing about £600, but with no very satisfactory results, as the diamond drill was not then in general use; however, the borehole (over 300 ft. deep) indications were good enough to warrant driving into the coal from the outcrop at the Wairio Creek, which was accordingly done with the usual winding-engine, drum, wire rope, &c., the coal dipping towards the east at an angle of about 1 ft. in 5 ft. or 6 ft. Being now assured that there was a considerable body of coal of fair quality for steam and house use, and after several practical tests on the railways and elsewhere, the company urged upon the Government the extension of the railway from Otautau, some thirteen miles, promising that if this was done efforts would be made to bring the coal to market. Whether they were not certain of the nearest outcrop of coal,



Nightcaps Colliery: View showing Part of Opencast Working and the Hayes Fan used for Ventilating the Underground Workings.

or whether they thought the railway could best be extended up the Aparima Valley at some future date by way of what is now Wairio, ten miles from Otautau (with then hardly a fence between or any roads or cultivation), the Government decided to take the railway no further than Wairio, leaving private enterprise to do the rest. To reach the coal the company resolved to continue the railway to Nightcaps (which takes its name from the hill above the township, with two tops, sometimes covered with snow, and resembling a nightcap), some two or three miles further; but the line had to be passed by the Government, with whom the company arranged to work the traffic, as at the present time. Meanwhile work was progressing at the mine, the services of the present mine-manager, Mr. John Lloyd, being procured through Mr. Twining, with whom he was working at the Kaitangata Coal-mine, the two having known each other in the coal districts of England and Wales, and having only then recently arrived in the colony. This was in May, 1881, and shortly after work was begun in earnest. There were many difficulties to contend with—no metalled roads to transport material, faults and breaks in the coal-seams, water to pump out, and other troubles incidental to making a settlement out of the wilderness, the miners and others having to live in tents and huts for a year or two; tramways to lay, coal-stage screens to erect, and the railway-station and yard, with its many coal and public sidings, to put down, &c. As it was necessary to lay out a township for the miners, storekeepers, and others, this was done by the company, and the township was sold at auction in Invercargill about Christmas, 1881, the proceeds from it coming in handy to meet the heavy outlay going on.

On the 3rd March, 1882, the railway was opened by a special train from Invercargill, bringing some four or five hundred people. From that day to this coal has rolled out of Nightcaps, day in and day out (Sundays as a rule excepted), with varying success. At the start three trains per week were supposed to suffice; now there are fifteen. The Government began using the coal on the railways, and the public for threshing and household purposes, not to mention other industries requiring fuel, and, finally, the Lake Wakatipu steamers. Shortly after opening, Mr. Lloyd, the mine-manager, in the course of further prospecting for the company, found another and much thicker seam of coal, and of better quality for steaming purposes; this has been worked ever since. From time to time he has found other seams in connection with it, and these are the seams that are being worked at the present time. About 1884 or 1885 the Orepuki Coalfield began to be opened out, and for a short time the Nightcaps Company experienced severe competition. In consequence the output increased but slowly, owing to the coal not being used for marine purposes when seaborne coal from Newcastle, as well as Greymouth and Westport coal, could be got at the Bluff—Southland's seaport. But during the great coal strike at these places in 1890 the Nightcaps Mine kept the Union Company's steamers running weekly between Port Chalmers and Melbourne, and *vice versa*, for about four months, until early in 1891, when the strike was declared off. Nightcaps coal was also supplied to the direct steamers for Home and to some of the local boats at that time, also to Dunedin for both gas and household use.

During the last eight or ten years, owing to the promotion of closer settlement and increased grain-growing, also flax-milling, the output has increased considerably; it is now about 47,000 tons per annum, and the total output has reached 505,000 tons. But it is not to be supposed that the present position has been attained without a considerable increase of the original capital to develop the mine and put down improved machinery and plant to keep pace with the demand, and the company has always to look ahead a year or two for this purpose. The paid-up capital is now £30,000.

On the 28th March, 1903, between 7 and 8 p.m., a sudden and terrible fire broke out in the main mine-working, evidently caused by sparks from the winding-engine lodging in the roof and timbers, and the smoke belching out of the principal entrance was so dense that it prevented the employees from getting in to quench the fire, so the only thing to be done was to pump water down the various shafts and then close them and every other crevice up, with the view of smothering the fire, which was done by Mr. Lloyd, the mine-manager, backed up by the company's employees, who with many of the public worked most heroically, and accomplished the feat within forty-eight hours without a moment's relaxation. It was at first thought that the mine would have to close down, as there was not a man in Nightcaps, except the mine-manager, that believed the fire would ever be extinguished; but Mr. Lloyd stood alone, confident that he could do it, and he did it most effectually in the course of eight months, the work never ceasing night or day, and the output of coal going on all the same as if nothing had happened.

Altogether, the company has been fortunate in its employees, many of whom, with the mine-manager, have been with it since the start, which is an evidence of fair treatment on both sides. It is worthy of remark that of the original shareholders in 1880 only two remain, Messrs. William Handyside and John Roberts, C.M.G., of Murray, Roberts, and Co., Dunedin.

ANALYSES OF NEW ZEALAND COALS.

The following table, compiled from the "Laboratory Reports of the Geological Survey of New Zealand," shows the analyses of samples of New Zealand coals freshly taken from the principal mines in the colony:—

No.	Description.	Locality.	Analysis by Skey.				
			Fixed Carbon.	Hydro-carbon.	Water.	Ash.	Evaporative Power.
1	Anthracite ..	Acheron, Canterbury	84·12	2·06	1·80	12·12	10·93
2	Bituminous ..	Coalbrookdale ..	74·83	20·50	1·16	3·51	10·72
3	" ..	" ..	70·00	22·15	2·52	5·33	9·10
4	" ..	Banbury ..	69·97	25·71	0·99	3·33	9·09
5	Altered brown coal	Malvern Hills ..	68·54	19·89	4·15	7·42	8·87
6	Bituminous ..	Tyneside ..	65·59	29·18	0·82	4·41	8·52
7	Glance-coal ..	Rakaia Gorge ..	64·51	21·27	6·76	7·46	8·30

Analyses of New Zealand Coals—*continued.*

No.	Description.	Locality.	Analysis by Skey. Fixed Carbon.	Hydro-carbon.	Water.	Ash.	Evaporative Power.
8	Bituminous ..	Wallsend ..	62·87	31·64	1·66	3·83	8·17
9	" ..	Grey River ..	62·37	29·44	1·99	6·20	8·01
10	Pitch-coal ..	Kawakawa ..	61·16	28·00	2·51	8·33	7·95
11	Bituminous ..	Preservation Inlet	60·88	20·69	4·33	6·19	7·91
12	Pitch-coal ..	Black Creek, Grey River	60·20	29·97	8·01	1·82	7·82
13	Bituminous ..	Mokihinui ..	59·75	32·14	3·27	4·14	7·76
14	" ..	Coalpit Heath ..	58·81	38·98	1·02	1·19	7·64
15	" ..	Mokihinui ..	57·92	34·94	3·96	3·18	7·50
16	" ..	Brunner Mine ..	56·62	35·68	1·59	6·11	7·36
17	" ..	" ..	56·21	37·83	1·50	4·56	7·30
18	" ..	Westport ..	56·01	37·17	2·60	4·22	7·28
19	" ..	Mokihinui ..	55·59	38·86	3·16	2·39	7·20
20	" ..	Brunner ..	54·16	35·85	2·50	7·49	7·04
21	Altered brown coal	Malvern Hills ..	53·29	32·04	12·65	2·02	6·92
22	Bituminous ..	Otamataura Creek	52·89	36·63	2·19	8·29	6·90
23	" ..	Wallsend ..	53·10	35·47	1·41	10·02	6·90
24	" ..	Near Cape Farewell	48·59	43·17	2·18	6·06	6·31
25	Pitch-coal ..	Shag Point ..	43·19	30·15	15·82	10·94	5·61
26	" ..	Kawakawa ..	50·15	42·63	4·18	3·04	6·50
27	Glance-coal .	Whangarei ..	50·11	38·68	8·01	3·20	6·50
28	Pitch-coal ..	Kamo	50·01	37·69	9·61	2·69	6·50
29	Brown coal ..	Malvern Hills ..	49·99	35·42	11·79	2·80	6·49
30	" ..	Fernhill ..	49·95	36·95	12·00	1·10	6·49
31	" ..	Allandale ..	47·31	36·26	12·41	6·02	6·15
32	" ..	Kaitangata ..	46·48	33·48	14·66	5·38	6·04
33	" ..	Shag Point ..	46·21	32·65	16·02	5·12	6·00
34	" ..	Homebush ..	44·92	36·00	15·83	3·25	5·83
35	" ..	Hokonui ..	44·28	38·22	16·50	1·00	5·75
36	" ..	Kaitangata ..	44·11	38·32	15·44	2·13	5·74
37	" ..	Nightcaps ..	43·62	33·68	18·33	4·37	5·67
38	" ..	Springfield ..	42·68	33·66	18·65	5·01	5·55
39	" ..	Orepuki ..	42·64	36·26	14·44	6·66	5·54
40	Pitch-coal ..	Walton's, Whangarei	38·80	41·20	7·20	12·80	4·96
41	Brown coal ..	Kaitangata ..	38·29	32·43	17·50	11·78	3·87
42	" ..	Shag Point ..	35·76	30·92	13·22	20·16	4·64
43	" ..	Allandale ..	34·72	40·26	18·99	4·86	4·51
44	Pitch-coal	Grey River ..	34·72	55·48	6·20	2·60	4·51

Name of Coal.	Approximate Total Output of Coal up to the 31st December, 1905.
	Tons.
Bituminous	12,330,315
Pitch	1,906,650
Brown	6,573,879
Lignite	876,153
Totals	21,686,997

TIMBER FOR MINING PURPOSES.

By Robert Tennent, Inspector of Mines for Marlborough, Nelson, and West Coast.

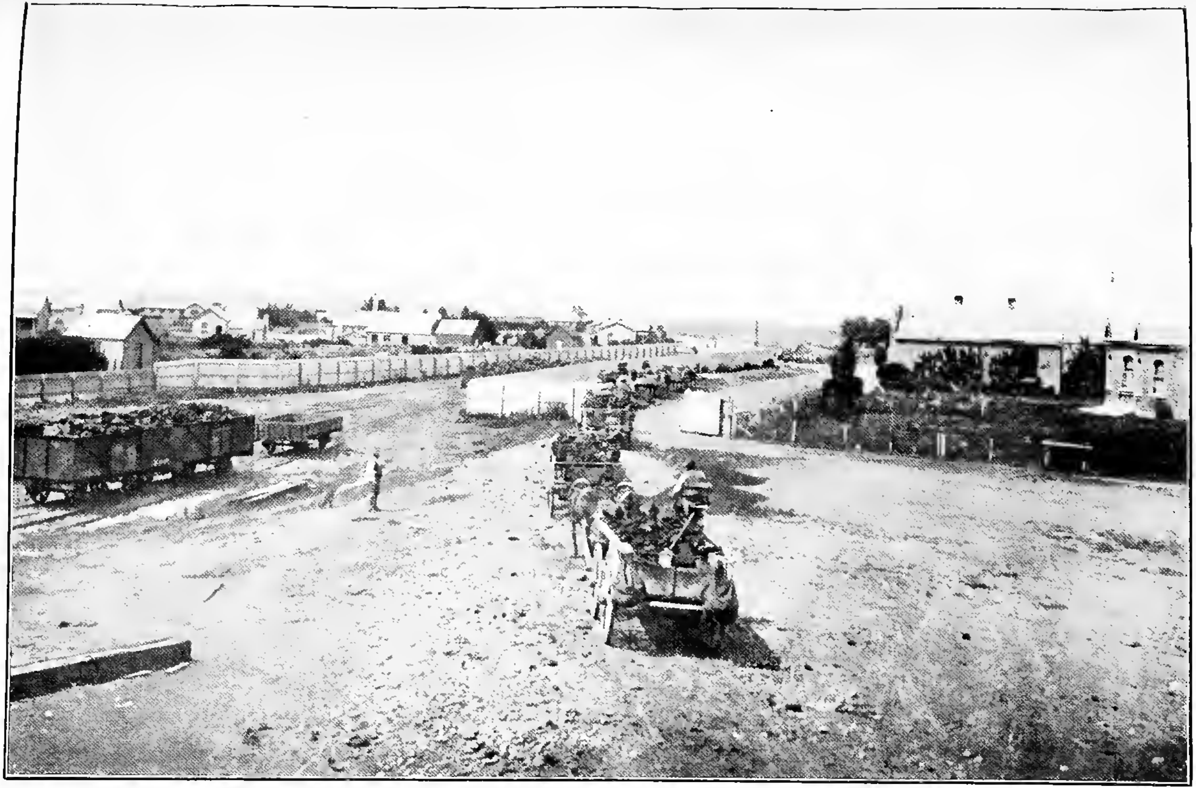
Timber suitable for mining purposes is generally classified as props, caps, and laths; but, in addition to these, there are large quantities of sawn timber which may be profitably used in underground working and be reasonably termed mining-timber. In fact, description is merely a mining phrase, applicable to timber where used under the circumstances. In timbering main levels, tunnels, &c., use black-birch, of which there are five useful qualities—namely, *Fagus fusca*, *Fagus solandri*, *Fagus colensoi*, *Fagus obsoleta*, and *Fagus ?dubia*. Rimu (*Dacrydium cupressinum*) is also a useful timber, but for blocking-out, where timber is not exposed to heavy strains or required for long standing, white-pine (*Podocarpus dacrydioides*) may be used. White or silver birch (*Fagus menziesii*) is equally good for general work. Again, where heavy strains are expected timber should either be split or sawn out of large trees bearing a straight grain; caps should be barked and free from knots, and, if possible, cut in the months of June and July; but for ordinary round props the time of falling is of no consequence, on account of the high percentage of sap-wood contained. In tunnels, where sound birch timbers are exposed to free intake air-currents, indications of a white flossy substance is rapidly exuded, and after exposure for about two years the sap-wood of birch shows marked signs of decomposition—more rapidly than rimu of the same dimensions. Kamai is a strong useful timber, but subject to dry-rot. Black-pine (Matai, *Podocarpus spicata*) is excellent timber for props if cut out of large trees, but brittle and unsuitable for caps subjected to heavy strains. The same remarks apply to totara and kawhaka. Miro (*Podocarpus ferruginea*)

The regulations issued under the Act provide that the Minister of Mines and the Public Trustee shall apply the moneys deposited, on receipt of a certificate from a duly qualified medical officer, and also on the certificate from an Inspector of Mines, for any of the objects hereinafter set forth, namely:—

(*a.*) When any workman has been off work through an accident for one week or more, he shall receive the sum of 12s. 6d. per week, or at the rate of 2s. 1d. for every working-day from the date of the accident, which shall continue so long as such medical officer and Inspector of Mines shall certify that such workman is unable to work; but when an accident occurs in any mine situate in a locality remote from settlement, where the services of a medical officer are not procurable, payment at the prescribed rate may be made for any period not exceeding thirty days from the date of the accident on the certificate of the Inspector of Mines alone. Or, in cases where any workman is permanently disabled, he may be granted a fixed sum, not exceeding £50, in satisfaction of all claims; but in the latter case the certificate of a duly qualified medical officer and an Inspector of Mines will be required. No workman shall be entitled to any payment unless he shall have been so disabled by accident as to prevent him working for a period of not less than one week.

(*b.*) If any workman meets with an accident which proves fatal, the nearest relative of such workman may be granted a sum not exceeding £10 towards defraying the funeral expenses of the deceased workman; and an additional sum, not exceeding £15, may be granted to the widow or other near relative of such deceased workman in full satisfaction of all claims.

(*c.*) Any workman who meets with an accident which disables him from work shall send, or cause to be sent, within seven days of such accident occurring, a notice in writing to the Inspector of Mines; and all



Mining Handbook. VIEW OF NIGHTCAPS TOWNSHIP FROM THE LOADING-BANK

applications for relief must be made within fourteen days from the date of the accident, or the claim cannot be entertained.

(*d.*) No workman shall be entitled to relief from the Coalminers' Relief Fund for any accident caused by drinking intoxicating liquors, fighting, or any kind of athletic sports or game of amusement, or for any accident caused by the misconduct of such workman.

All post-offices throughout the colony which are also money-order offices act for the Public Trustee in making payments and receiving lodgments in respect of business conducted by the Public Trust Office, which has proved a great convenience to the miners, as it enables them to receive payments from the fund without being required to travel long distances to obtain them.

Appended hereto is a tabulated statement showing the workings of the fund since it was first instituted in 1891 up to the 31st March, 1906:—

Year ending 31st March.	Amount paid into the Fund.	Interest added by Public Trust Office at Rate of 3½ and 4 per Cent.	Number of Persons relieved.	Accident, Funeral, and Compassionate Allowances paid.	Commission charged by Public Trust Office at Rate of 1 per Cent.	Balance at Credit of Fund on 1st April.
	£ s. d.	£ s. d.		£ s. d.	£ s. d.	£ s. d.
1891 ..	..	..	..	..	..	..
1892 ..	45 6 1	..	..	..	..	45 6 1
1893 ..	388 4 5	..	..	..	4 13 3	428 17 3
1894 ..	182 19 6	12 16 2	21	124 8 4	3 15 0	496 9 7
1895 ..	452 6 10	28 10 1	28	137 13 4	4 10 3	835 2 11
1896 ..	456 1 7	37 5 11	45	374 12 0	1 8 0	952 10 5
1897 ..	390 2 3	40 13 10	47	251 3 4	3 18 1	1,128 5 1
1898 ..	563 9 5	45 18 6	53	427 1 11	5 12 5	1,304 18 8
1899 ..	531 6 5	55 14 9	48	231 5 10	5 6 0	1,655 8 0
1900 ..	551 8 1	70 3 3	45	302 5 0	5 8 11	1,969 5 5
1901 ..	564 19 1	84 15 8	54	215 0 0	5 12 4	2,398 7 10
1902 ..	616 8 4	96 8 8	87	578 3 5	6 2 5	2,526 19 0
1903 ..	648 9 9	104 11 7	102	445 9 8	6 9 8	2,828 1 0
1904 ..	654 4 8	116 9 5	72	566 6 2	6 9 8	3,025 19 3
1905 ..	893 15 5	123 6 11	177	725 5 9	8 18 5	3,308 17 5
1906 ..	1,230 7 4	137 7 4	179	1,052 6 4	12 4 1	3,612 1 8
	8,169 9 2	954 2 1	..	5,431 1 1	80 8 6	..

COAL HARBOURS OF THE WEST COAST.

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Westport Harbour.

The Westport Harbour works were started under a scheme designed by the late Sir John Coode in 1885, and have proved eminently successful, as the following particulars will show. The works since that date have been under an administrative Harbour Board, composed of seven members, all nominated by Government, and appointed by the Governor in Council. The Engineer's return for the year 1905 of the depth of water on the bar averaged nearly the same as the previous year, although there had not been so many freshets in the river. The return shows that for 311 days during 1905 the depth of water on the bar averaged between 20 ft. and 24 ft., whilst it was only 8 ft. to 10 ft. in 1883.

The coal trade has expanded from 78,074 tons in the year 1885 to 570,266 tons for the year 1905, the total output since 1885 to end of 1905 being 6,149,563 tons. The gross tonnage of vessels which worked the port, in and out, during the year 1905 was 1,032,880 tons.

The revenue of the Board has increased from £8,108 in 1885 to £67,937 in 1905, being considerably over the rate of 800 per cent.

The expenditure for harbour-works and general harbour-maintenance amounted from the year 1885 to the year 1905 to the sum of £943,709, this sum also including extensions of the Westport–Mokihinui Railway and its equipment, amounting to about £150,000. The sum of £409,500 has also been expended as interest and sinking fund on the Board's loans for harbour-works, the sinking fund on present current loans of £650,000 amounting at end of year 1905 to £50,000.

The items above mentioned show the progressive nature of the port's business, and it should be mentioned that of the total output of coal from the Westport mines 248,261 tons has been sent to foreign ports for the use of the British Admiralty and commerce generally.

The port is most efficiently lighted, and fully equipped otherwise by an efficient harbour staff and a first-class up-to-date tug-boat.

An extension of the breakwater and the construction of a properly equipped floating basin are amongst the improvements proposed to be carried out at the port.

Greymouth Harbour.

Greymouth, a bar harbour, is situated on the west coast of the Middle Island. Prior to 1872 the place was worked by small schooners at great risk, but in that year Mr. C. Y. O'Connor was appointed Engineer for the district; the small existing wharves which had been built by the Borough Council were taken over by the Government and strengthened, and some protective work was done. In 1874 Mr. Moriarty, C.E., reported on the formation of a harbour, and drew up plans for an internal training-wall and a breakwater on the south side of the river. These plans were, a year or two later, modified by Mr. Carruthers, C.E., who proposed to add a training-wall on the north side. In 1878 the entrance was so bad that the shippers put on men in order to cut a channel to sea. Towards the end of that year Sir John Coode, at the request of the Government, visited Greymouth, and reported favourably on the formation of a harbour. The following year work was begun by the Public Works Department in accordance with his plans.

In 1884 the Greymouth Harbour Board was constituted by Act of Parliament, and given large powers and ample revenue from endowments. The work of harbour-construction was at once taken over and carried on by that body. The original plans of Sir John Coode have to some extent been modified by the advice of Mr. Napier Bell and the Board's own Engineers. The works as they now stand consist of two breakwaters, one on each side of the mouth of the river, the southern one being 3,542 ft. and the northern one 1,125 ft. in length.

The width of the entrance is 500 ft. There are also internal training-walls, which serve to utilise the scour of the river-current. Prior to the commencement of these works the depth on the bar was at the most 10 ft. As the breakwaters advanced this has increased, until now there is a depth of 22 ft. at high-water spring tides, and an average depth of 20 ft.

The berthage accommodation is placed on the south bank of the river, and consists of a wharf 2,355 ft. long, with another 313 ft. in course of construction. If this proves inadequate, plans are extant for dredging Karoro Lagoon and constructing a tidal dock capable of accommodating the largest steamers likely to visit the port.

The wharf is well equipped, there being three hydraulic cranes (two fixed and one movable) and several steam-cranes. It is directly connected with the railway-lines to Hokitika, Otira, and Reefton. The port is well lighted, and there is an efficient harbour staff.

The total revenue of the Greymouth Harbour Board since its inception in 1884 has been £357,900, of which sum £328,900 was derived from its endowments. The sum of £240,000 has also been borrowed on the security of these endowments. The expenditure by the Board on harbour-works has been £406,765. A further sum of £176,841 has been paid as interest and sinking fund on loans, making the total expenditure £583,606. The sinking fund, with accretions, now amounts to £32,914.

The net tonnage of vessels entering the port has increased from 103,913 tons in 1885 to 273,196 tons in 1905. The total tonnage since the constitution of the Board has been 3,310,903 tons.

The export of coal in 1885 was 98,407 tons; in 1905 it was 243,705 tons; and the total export for the period between and including those years was 3,257,862 tons.

Prior to 1892 there was no timber-export. During that year 415,820 superficial feet was shipped, and since then the export has increased until in 1905 it amounted to 29,636,617 ft. The total amount exported has been 193,887,126 ft.

MANUFACTURE OF PORTLAND CEMENT IN NEW ZEALAND.

Wilson's Star Brand Portland Cement and Hydraulic Lime Works, Mahurangi, Auckland.

MESSRS. John Wilson and Co.'s Portland cement and hydraulic lime works are situated on the Mahurangi River, two miles below Warkworth, and about forty miles north of Auckland.

Mahurangi hydraulic lime (now known as "Wilson's") was first burned where the works at present stand about the year 1849 or 1850, and became famous through being used in the Queen Street (Auckland) sewer in the early fifties. Later it was used in the Auckland dock and in the Domain tunnel with success; also in the first buildings erected in Auckland with ground mortar. In 1891–92 over 3,000 tons were supplied for the Potts Hill Reservoir, Sydney.

In 1885 the first Portland cement produced in the colony in marketable quantity was turned out at the Mahurangi works. Since then the cement branch has developed into a modern rotary plant, capable of turning out over 20,000 tons per annum, employing a large staff of men, and using local materials almost exclusively. The plant consists of two rotary furnaces and the most modern grinding plant. The raw materials and finished cement are tested every day. It is claimed that the cement is finer and stronger than the imported article. The Rangitoto Beacon, erected in 1886, was the first marine work in which Star brand Portland cement was used. Since then over 15,000 tons have been supplied by Messrs. Wilson and Co. for use by the following Harbour Boards: Auckland, Wellington, Napier, Gisborne, and Patea. Public works, local bodies, and general trade have absorbed the balance. The first ferro-concrete piles driven in New Zealand (on the 3rd September, 1904) were made with Star brand Portland cement, and the Ferro-concrete Company continues to use large quantities of it.

Portland Cement Works, near Picton.

Works have been established at the Elevation, near Picton, by the Wellington and Marlborough Cement, Lime, and Coal Company, with a capital of £25,000, which was floated some three years since. Large deposits of very fine-grained calcareous marl exist on the property alongside the works, and with the addition of white limestone, brought from the company's Tata Island property, a high-class Portland cement is now being manufactured. Operations have been carried on continuously since September last, and some 4,000 tons of cement have been produced up to date, employment being given by the company to 45 or 50 men in the works, quarries, and shipping. The most modern system of manufacture has been adopted—viz., the American rotary kiln, of which one 60 ft. long has been installed, the other plant being from the factories of Krupp (Germany) and Edgar Allen (Sheffield), local enterprise providing the engine and boilers. The plant, which is lighted by electricity, is now running to its fullest capacity, and it is expected to reach a monthly output of from 700 to 800 tons shortly.

Milburn Lime and Cement Company's Works, Dunedin.

Few industries connected with building-materials or engineering-construction have undergone such a rapid development during recent years as Portland cement. A generation ago it was almost unknown, and it was applied to very few of the uses which are now closely associated with the very name of the material. The immense utility of the product has led to a close study of the methods of manufacture, and enormous capital has been employed throughout the world in making improvements both as to process and plant. The net result is that Portland cement is now looked upon by engineers and architects as one of the most important articles in building-construction, more especially since the advent of reinforced concrete—*i.e.*, a combination of iron or steel with Portland-cement concrete. The quality of the product has been vastly improved. A few years ago a tensile strength of 200 lb. per square inch was looked upon as satisfactory. At the present day 600 lb. to 800 lb. is frequently imposed by engineers. It is interesting to review how this change has taken place, and there is an evidence of step-by-step advancement at the Dunedin cement-works.

A brief history of the company is worthy of note. In 1888 the valuable and well-known lime-deposit at Milburn, together with a small cement-works, was acquired by a Dunedin syndicate. The syndicate at once formed a company with a capital of £30,000, registered as the Milburn Lime and Cement Company (Limited). The quality of the lime was too widely known to cause the directors any anxiety, and from the start a satisfactory business was done; but with the other branch—*i.e.*, cement-making—difficulties cropped up. The works were then situated at Walton Park, about five miles from Dunedin—a site that seemed to possess every disadvantage, involving costly carriage of clay, lime, coke, general stores, and finished cement, combined with unsuitable machinery. After a few months' working the directors recognised the gravity of the position, and called a special meeting of shareholders to decide whether the company should retire from cement-making or acquire a new site and erect modern works. The "modern" works then erected were designed after the English practice—viz., Johnson kilns, with chambers, millstones for grinding both wet and dry, the process adopted being known as the semi-wet process. The materials—lime and clay—were mixed together in a wash-mill, thence ground in a wet state and pumped on to chamber-floors. The burning-off of the previously loaded kiln supplied the necessary heat to dry the mixture for the following kiln. At that time this was considered to be a most economical method of manufacture.

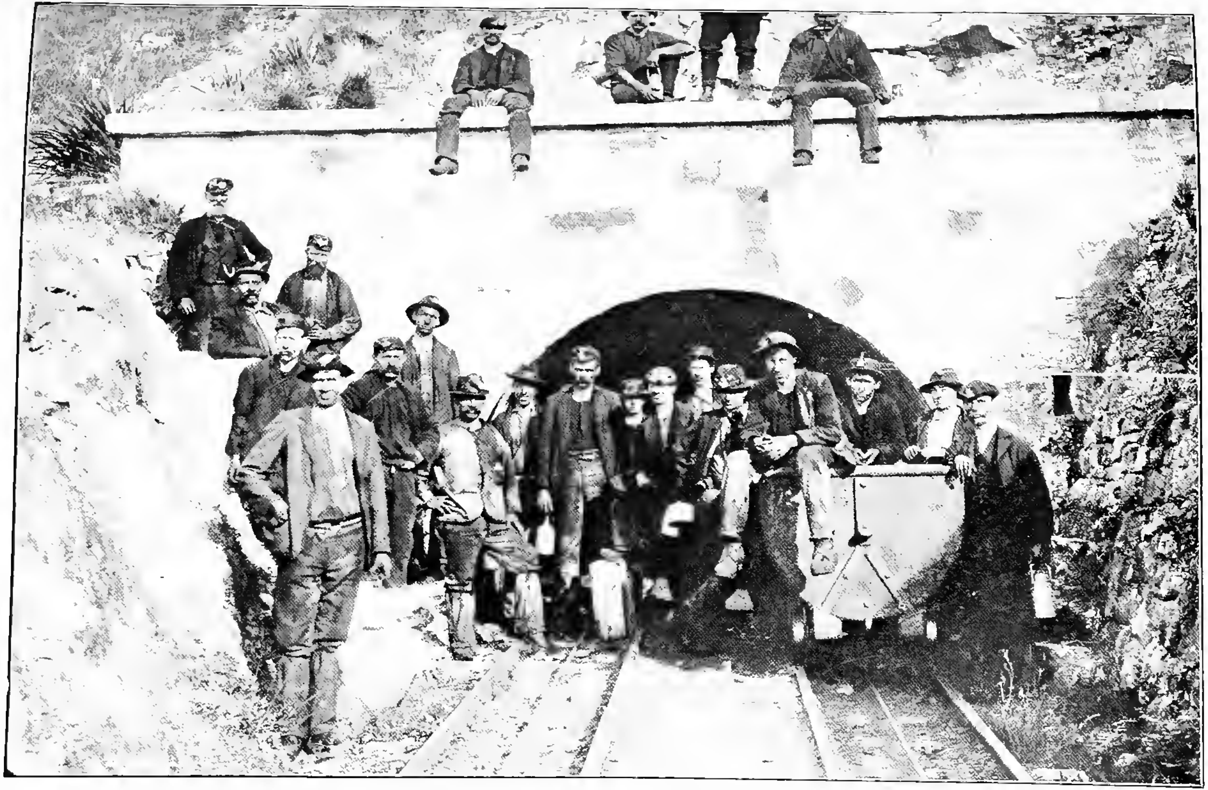
The next step was to produce a finer-ground cement to meet the requirements of better work demanded by engineers. The millstones were thrown out, and a complete plant, known as Askham's pulverising plant, was adopted. This was a distinct improvement on the old process, but costly in wear-and-tear. It was run with more or less success until 1897, when, after a visit to America, the Old Country, and the Continent, the manager elected to replace this grinding plant with a newer process of ball and tube mills, the great advantage of these machines being that the whole product is ground up and reduced to the necessary fineness without sifting. The Milburn Company claim to have been the first cement-makers south of the Line to adopt the tube mills, which are still in vogue, and looked upon by cement experts as the best method of grinding.

To meet the increasing demands for Milburn cement, further additions and improvements became necessary in the burning department. In 1900 the manager was sent to America to report on the American process of manufacture by the rotary kiln, with instructions that if he were satisfied he was to order a plant without delay. The advantages of the rotary process of burning were so apparent that a kiln was installed that year. The Milburn Company also claim to have been the first company south of the Line to adopt this modern process, and the experience of the past few years has demonstrated the wisdom and efficiency of the selection.

As there appears to be no finality in the process of the industry, the company was again compelled this year by the increasing demand to lay down more plant for dry grinding, and mills of the most powerful and successful type made are now installed.

A description of the processes at the works at the present time will be of interest. The raw materials consist of lime and clay. Careful analyses are made daily of the raw materials to estimate the proportions, and the mixture after fusion is again analysed as a check. It is of the utmost importance to limit the variation to within 1 per cent. In addition to chemical analyses, many physical tests are made daily, both of the newly ground cement and the matured stock. Careful record is kept of fineness of grinding; tensile tests are made at seven and twenty-eight days; also long-term tests, sand tests, and weekly records of accelerated tests.

The lime, which is obtained from Milburn, and clay, dredged from the harbour in close proximity to the works at Dunedin, are mixed together in a manner protected by letters



Westport Coal Company: Group of Miners at Mouth of Tunnel, Millerton.

patent. The usual method of supplying heat to evaporate the moisture from the clay is avoided. The raw materials are ground successively by pan and tube mills, thence elevated to a storage-bin (twenty-four-hour capacity), and conveyed, after being slightly damped, into the kiln. As this revolves the raw mix gravitates from the back to the front, getting hotter and hotter until it reaches the calcining stage. From there it is discharged in the form of small clinkers. It is picked up by an elevator and conveyed automatically to the clinker-store, where it is allowed to cool and cure. It is then ground practically to an impalpable powder in kominor and tube mills, the discharge of the tube mill being in the bulk store. Here it is cooled and bagged; thence it goes to the warehouse to mature.

The power is obtained from compound-jet condensing-engines of 250-horse power. In addition, there are auxiliary engines for electrically lighting the works and rotary-kiln drive.

The company owns a dredge and complete equipment for clay-dredging, and the works are well served with a railway-siding from the Main Trunk line directly into the warehouse. A supply of excellent water is obtained from an artesian bore 110 ft. in depth.

The coal used for rotary burning is Westport slack, which is dried and ground to a powder before being injected into the kilns. The site of the works comprises upwards of 4 acres, one-half of this being occupied by the various factory buildings.

The company has always made a point of storing its cement for some weeks before being sent out, which is considered prudent and in the interests of the consumer. The volume of business has steadily increased from 10,000 to 150,000 bags per annum. The works are fully employed, the company having large and important contracts with the Drainage Board, Dunedin Corporation, Tramways, Public Works and Railways, Otago Dock Trust, Water-supply, &c.

In addition to the cement-making business, the company has a large lime business, two pipe-factories (Monier and Kielberg), and phosphate-deposits.

NOTE.—There are also very extensive works near Whangarei, but particulars have not been furnished.

IRON ORES AND SANDS OF NEW ZEALAND.*

By Sir James Hector, K.C.M.G., M.D., F.R.S., late Director of the Geological Survey, New Zealand.

Iron-ores.

Almost every known variety of iron-ore has been discovered in New Zealand. There are also few soils or stream-gravels that will not yield a considerable quantity of black sand when washed. The chief deposits are, however, on the seashore of the west coast of both Islands, the best known being that at Taranaki.

Brown Hæmatite Ore.

At Parapara, Nelson, immense quantities of brown hæmatite ore occur on the surface of the ground. Some of this was converted into iron at Melbourne in 1873. This iron has the following characters: Colour uniform, approaching white; structure homogeneous, and finely granular, hard, brittle. It is therefore the variety called white iron.

A further valuable deposit of brown hæmatite has been discovered by an officer of the Geological Survey Department on the west side of Mount Peel, where the deposit is about 60 ft. thick. The ore contains 56 per cent. of metallic iron, and has been traced for a distance of three miles, beyond which point it is reported to swell out to as much as a mile in width.

The following are the chief localities in which iron-ore is found:—

Specular Iron-ore.—Dun Mountain, Nelson. Occurs in irregular veins in greenstone rocks; contains 63 per cent. of metallic iron.

Specular Iron-ore.—Maori Point, Shotover, Otago. A 6 ft. vein in mica-schist, equally rich with the above; extent unknown.

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* "Handbook of New Zealand, 1886" (Hector).

Compact Iron-ore. — D'Urville Island, Nelson. Vein, thickness unknown, in diorite slate, with serpentine and chrome; yields 63 per cent of iron.

Magnetic Iron-ore.—This valuable ore, though occurring chiefly as black sand, is found in several parts of the colony in the massive form.

Magnetic Iron-ore.—Dun Mountain, Nelson. In a vein 16 in. thick, in serpentinous slates.

Magnetic Iron-ore.—Wakatipu Lake, Otago. In a vein in mica-schists.

Magnetic Iron-ore.—Maramarua, Firth of Thames. From a vein of ferriferous slates; contains only oxides of titanium and manganese.

Black Ironsand.—From beach at Taranaki.

Ironband-ore.—Contains 70 per cent. of iron. Occurs at Wyndham River, Otago, and Manukau, Auckland; formed by black-sand layers becoming cemented with hæmatite. This would be a most valuable ore if obtained in large quantities.

Brown Hæmatite, or hydrous oxide, also occurs in Amuri in great quantity.

Reniform Iron-ore, Mongonui.

Bog Iron-ore.—Spring Swamp, Auckland. Forms thick layers at the bottom of swamps. Though rich in iron, the ore is inferior on account of the sulphur and phosphorus it usually contains.

Hæmatite.—An analysis of this ore from Raglan gave—

Sesquioxide of iron	72·69
Oxide of manganese	0·31
Alumina	2·02
Magnesia	0·69
Lime	0·58
Phosphoric acid	Not estimated.
Sulphide of iron	0·11
Hygroscopic water	4·61
Constitutional water	13·02
Silicates undecomposed by acids ...	5·97
	100·00

Ironsands.

The following tabular statement gives a particular account of ironsands:—

Ironsands of New Zealand.

Locality.	Matrix whence probably derived.	Magnetite.	Hæmatite.	Titanite.	Percentage of Iron.	Other Minerals present.
Upper Buller River, Nelson ..	Hornblende rocks	87·5	9·4	..	70·2	
Lower Buller River, Nelson ..	Tertiary gold-drift of diorite slate ..	54·0	..	42·3	59·0	Auriferous.
Upper Molyneux River, Otago	Mica-schist	82·7	..	9·7	65·9	Auriferous.
Lower Molyneux River, Otago	Mica-schist and Tertiary strata ..	74·4	..	2·5	58·7	Auriferous and with 12 per cent. of glauconite.
Mountain stream, Canterbury	Palæozoic slates	62·7	37·2	..	66·2	
Mountain stream, Otago ..	Palæozoic slates	86·1	10·5	..	58·5	Auriferous.
apeka, Otago	Old gold drift	2·2	92·8	..	63·8	Auriferous.
akatipu, Otago	Mica-schist	80·0	7·6	..	52·9	Auriferous.
ataura River (Upper) ..	Diorite slate	9·8	..	70·9	41·2	
ataura River	Old gold drift	63·5	16·1	8·0	60·6	
ewart Island	Granitic rocks with greenstone dykes	77·8	..	20·1	57·3	Auriferous.
ewart Island	Hornblende rocks	71·5	20·0	8·2	70·1	Auriferous.
atoki, Nelson	Granite and hornblende	79·8	7·7	3·4	60·2	Auriferous.
hinapua Lake (old channel of Hokitika)	River drift from diorite rocks ..	..	..	58·0	29·1	Aurif·rous, with garnets, topaz, disthene, &c.
a-beach, Hokitika	Sea-sand drift	75·0			54·0	Auriferous.
otueka River, Nelson ..	Tertiary strata and granite ..	33·0	32·5		42·0	Auriferous.
airau River, Marlborough ..	Tertiary strata and granite-schist ..	21·0	48·4		38·9	Auriferous.
anganui River, Nelson ..	Granite and Tertiary	54 0	13·0		43·2	Aurifsrous.
ddle Hill, Otago	Basaltic	58·3	..	25·6	52·9	
een Island, Otago	Basaltic or sea-beach	53·3	..	29·6	50·3	
oper Inlet	Basaltio or sea-beach	20·0	74·2		53·0	
sst Bluff, Southland, Foveaux Strait	Diorite or sea-beach	12·2	..	40·6	28·6	Auriferous and platinife-rous.
Urville Island, Nelson ..	Diabass and granite	78·6	..	..	57·4	Chrome iron.
ranaki beach	Trachyte	91·9	..	6·2	70·1	
Taranaki beach	Trachyte	71·0	..	8·0	56·1	Olivine and hornblende.
Tauranga beach	Trachyte	87·4	8·6	..	68·0	

The composition of the chief massive ores of iron may be illustrated by the following analyses:—

MASSIVE IRON ORES, OXIDES, AND TITANITES.

Variety.	Locality.	Centesimal Composition.					Percentage of Iron.
		Magnetite.	Hæmatite.	Titanic Iron.	Siliceous Matters.	Water.	
Impure magnetite	Manukau, Auckland	60·20	37·90	traces	1·90	..	70·06
Magnetite ..	Dunstan Gorge, Otago	86·32	..	traces	13·68	..	63·60
Hæmatite ..	Dunstan, Otago ..	..	96·11	..	3·89	..	68·30
Magnetite ..	Dun Mountain, Nelson	..	90·62	..	7·60	1·80	63·40
Mixed magnetite and hæmatite	Maramarua, Auckland	2·24	87·10	traces	10·66	..	62·30
Bog iron-ore ..	Spring Swamp, Auckland	..	73·17	..	13·83	13·00	51·22
Brown iron-ore	Raglan	..	72·69	..	9·68	17·60	50·88
Brown iron-ore*	Kawau	..	67·98	..	19·65	12·37	47·58
Hydrous hæmatite†	Parapara, Nelson ..	..	62·68	..	24·08	13·24	43·87
Hydrous hæmatite	Mount Peel, Nelson	..	..	..	..	..	56·00

* Manganese-oxide, 1·38. † Contains a little manganese.

Spathic Iron-ore.—This occurs in considerable quantity in the Collingwood district, in most cases more or less oxidized; one form of this ore, known as black-band, is one of the most valuable kinds found, and alternates with the coal-seams in Collingwood. A specimen of a siliceous and spathic iron-ore from Otamataura Gully is constituted approximately as follows:—

Carbonate of iron	56·9
Carbonate of lime and magnesia ...	2·8
Siliceous matters	40·3
	100·00

The iron amounts to about 27 per cent.

Other large deposits of spathic iron-ore have been found at Foote's Coal-mine at the Miranda Redoubt, and Jenkins's

Coal-mine, Nelson. They contain 40 per cent. and 41 per cent. of iron respectively.

Black-band or Spathic Iron-ores.

Variety.	Locality.	Protoxide of Iron.	Sesqui-oxide of Iron.	Carbonic Acid.	Silicates.	Per-centage of Iron.
Black-band ..	Collingwood, Nelson	35·23	25·77	21·12	3·93	46·06
Black-band ..	Collingwood, Nelson	40·38	5·26	21·97	16·69	35·12
Spathic ..	Miranda, Auckland	..	..	..	..	40·08
Spathic ..	Jackson's Mine, Nelson	..	..	..	..	41·00

Analyses of Two Specimens.

—	Spathic Iron-ores.	
	Malvern Hills.	Collingwood.
Protoxide of iron	51·2	35·23
Sesquioxide of iron	..	25·77
Oxide of magnesia	0·8	1·00
Alumina	1·8	2·11
Magnesia	0·4	1·94
Lime	0·3	0·71
Silica	13·6	0·90
Sulphuric acid	..	Traces.
Carbonic acid	32·2	21·12
Phosphoric acid		Not determined.
Sulphide of iron	..	0·41
Water	0·7	1·96
Organic matter	..	5·72
Silicates undecomposed by acids ..	..	3·03
	100·0	99·90

Hæmatite, containing about 40 per cent. of iron, occurs intermixed with quartz pebbles, in a stratum 100 ft. thick, exposed over several acres at Parapara, Nelson, and from it an excellent paint is manufactured, which, being a pure peroxide of iron, is the best preservative for that metal. Wood coated with this paint is comparatively non-inflammable, and it is therefore used in painting wooden buildings.

FURTHER NOTES ON THE IRON-ORES OF NEW ZEALAND.

By Alexander McKay, F.G.S., Government Geologist.

An extensive and valuable deposit of iron-ore (limonite and glauconite) occurs on the western slope of Mount Royal, in Waihemo County, Otago. The ore contains about 37 per cent. of the metal. The richest part of the deposit is exposed by the railway cuttings immediately south of the Township of Palmerston South. Both as regards quality and its position this deposit is of importance.

Malvern Hills.—Clay ironstone in rocks of Jurassic age is abundant in the Cairn Range, Malvern Hills, Canterbury, and ores of a like nature are found in connection with the coal rocks of the district.

Ashley District, Canterbury.—There is evidence of the presence of hæmatite iron deposits in Triassic rocks forming the southern slopes of Mount Thomas, and in the same range further to the north. No special ore-band of high quality is known, but a large percentage of iron occurs in the rock over a belt of considerable width, and deposits of manganese occur in connection therewith, while rich iron-ores occur in the same rocks further to the north-east.

Stonyhurst.—A band of hæmatite, 12 ft. wide, remarkably soft and pure, is found on the seaward slopes of the coastal range between the Waipara and the Hurunui Rivers. This ore occurs on the coast range on the Cheviot Estate, and also on the Lowry Peaks Range, on the western borders of that estate.

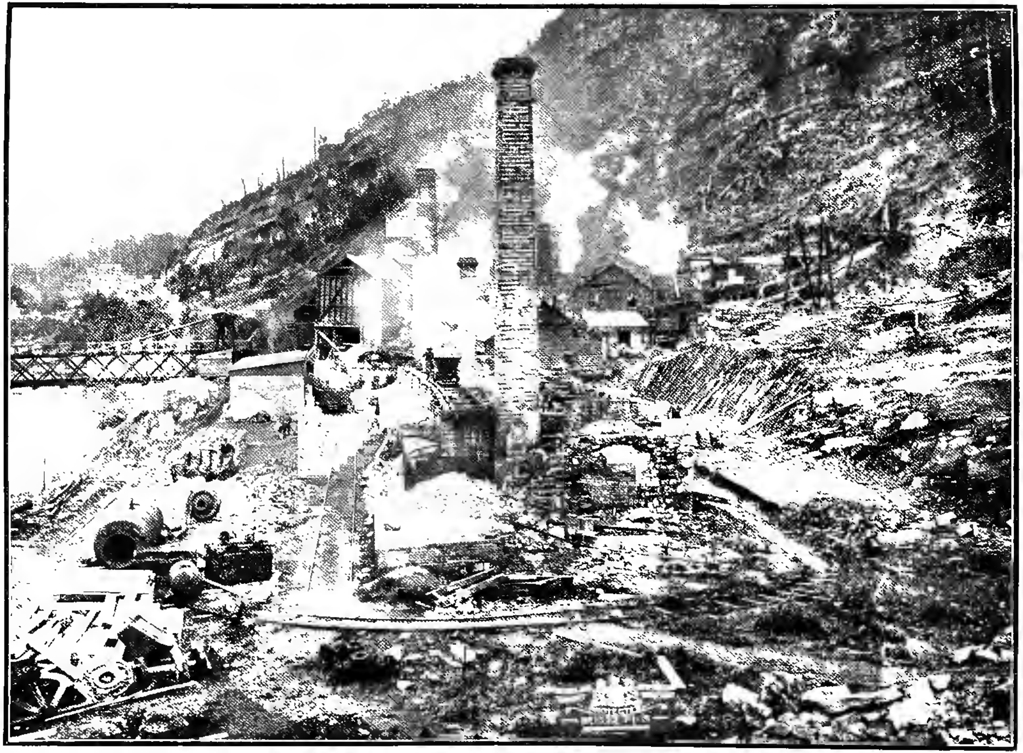
Nine-mile Creek, Greymouth.—Spathic iron occurs abundantly in connection with the gold-bearing rocks of the Brunner and Coal Creek coalfields. The bed of the Nine-mile Creek is filled with large boulders of this ore, but whether this has been derived from continuous beds or from boulders occurring in certain horizons of the coal-measures has yet to be ascertained. This ore yields 42 per cent.

Western Slopes of Mount Cook.—Very considerable deposits of pure magnetite occur in the schistose rocks of the western lower spurs of Mount Cook, Westland. Some bands attain the thickness of a foot. The following is the analysis of a sample collected by Cox and McKay in 1876: "Contains 50 per cent. protoxide of iron."

Charleston, West Coast of Nelson, Addison's Flat, &c.—Black sands of recent date are found widely from Cape Farewell to the Haast River, but could not be profitably collected except, perhaps, in the neighbourhood of Charleston and Addison's Flat; but here, where are specially large and thick deposits, the shipment of the ore is a possibility. These black sands are highly auriferous.

Okaihau, Bay of Islands.—North-west of Lake Omapere, on the high lands of Okaihau, there is a very extensive deposit of limonite covering a volcanic table-land to a depth of 4 ft. to 6 ft. The area of this deposit has not been exactly ascertained, but it certainly exceeds one and may be several square miles in extent. In the same district, and to the north-east as far as Taku Bay, there are lesser deposits of the same kind of iron-ore, and the plains of Kerikeri are overspread with a thin covering of the same material.

Range West of Kawakawa, Bay of Islands.—On the western slope of this range there is a heavy deposit of hæmatite, containing traces of gold.



Brunner Colliery, Grey River: General View of Works.

Mining Handbook.

THE PARAPARA HÆMATITE DEPOSITS.

THE following extracts from the Geological Survey Reports, having reference to the Parapara hæmatite deposits, will be of interest at the present time, when the attention of investors is being directed to these deposits:—

Report on Hæmatite at Parapara.*

By GEORGE J. BINNS, F.G.S.

In compliance with instructions received, I visited the hæmatite deposit at Parapara in the beginning of October, 1878, and have the honour to report as follows:—

The subject may be divided into three heads—

1. Extracts from what has already been published on the subject, with remarks.

2. Description of situation, mode of occurrence, &c.

3. Estimate of quantity.

1. EXTRACTS FROM WHAT HAS ALREADY BEEN PUBLISHED ON THE SUBJECT, WITH REMARKS.

In the seventh annual report on the Colonial Museum and Laboratory, published in 1872:—

1230.—Is a valuable hydrous hæmatite ore from Parapara, Collingwood, but it unfortunately occurs intermixed with quartz pebbles, being, in fact, the matrix of a bed of conglomerate at least 100 ft. thick, which extends for about 1,000 yards at the surface. If by hand-picking a large amount of

* "Geological Reports, 1878–79," pages 59–64. Plans prepared by Mr. Binns will be found in the "Geological Reports" for 1878–79.

iron-ore could be obtained equal to the sample analysed, the deposit would be a valuable one.

Sesquioxide of iron	62·68
Manganese	Traces.
Lime	0·61
Magnesia	Traces.
Siliceous matter	23·47
Water	13·24
	100·00

The amount of metallic iron in the sample received would be about 44 per cent. A very good pigment, especially adapted for ironwork, is manufactured from this ore.

Remarks.—I cannot quite agree with what is said about the occurrence of quartz pebbles, and the necessity for picking the ore. There are many places in which a quartz pebble is a rarity, and if the quarry were commenced in a judiciously chosen position it would, I think, be unnecessary to exercise any great care in selecting the ore. This would have to be in the upper portion of the deposit, as the stone there seems to be much more free from impurities. The length of the deposit within the boundary of the lease is 2,772 yards, and I think it runs right across the country to Onakaka Creek, a distance of more than a mile from the boundary. Its average thickness is, I think, over 200 ft.

From the ninth annual report on the Colonial Museum and Laboratory,—

Parapara Iron-ore.

As intimately connected with the value of the Parapara iron-ore, I give an analysis of some iron produced from it at Melbourne in the latter end of 1873. The composition of the iron alluded to was found to be as follows:—

Iron	97·668
Manganese	0·268
Carbon, combined	0·542
,, free (graphite)	0·208
Silicon, with titanium traces... ...	1·004
Phosphorus	0·041
Sulphur	0·269
	100·000

Physical Character.—Colour uniform, approaching white; structure homogeneous and finely granular, hard, brittle.

From the character and analytical results above cited it will be seen that this sample is of the variety technically known as white iron. It is comparatively free from phosphorus, but contains sulphur in some quantity, though not greater than is found in many pig-irons smelted from the same class of ore which has furnished the present specimen.

The following analysis of Parapara hæmatite is from the report on the Philadelphia Exhibition of 1876:—

Protoxide of iron...	35·23
Sesquioxide of iron	25·77
Oxide of manganese	1·00
Alumina	2·11
Magnesia	1·94
Lime	0·71
Silica	0·90
Sulphuric acid	Traces.
Carbonic acid	21·12
Phosphoric acid	Not det.
Sulphide of iron	0·41
Water	1·96
Organic matter	5·72
Silicates undecomposed by acids	3·03
	100·00

In a letter from Dr. Hector to the Colonial Secretary, dated Wellington, 2nd September, 1873:—

The ore occurs as large patches in a stratum of gravel. The greatest thickness of the stratum is 100 ft., and the area of the patches of ironstone showing at the surface is about 100 acres. The ironstone weathers to a dark colour, and covers the surface of the hills with blocks of all sizes up to many tons in weight. A rough estimate made on the spot gave the quantity of ore available by mere surface excavation as at least 15,000,000 tons.

The ironstone everywhere shows traces of its origin as a bog ore that was deposited as a cement among gravel, as it contains rolled pebbles of quartz; but much of it is free from such admixture, and by hand-picking and a simple modification of the smelting process much of the siliceous matter could be eliminated and the ore profitably smelted.

Remarks.—I have noticed the quartz pebbles elsewhere, and would merely suggest the alteration, "*most* of it is free from such admixture."

With reference to the above amount—viz., 15,000,000 tons —which is so very much under my estimate, the smaller amount includes only what is available by surface excavation, while the larger figure represents my estimate of the total quantity.

In a memorandum from Dr. Hector to the Colonial Industries Committee in 1873:—

No. 9 is from a deposit of hydrous hæmatite that occurs in the Upper Tertiary drifts at Parapara, in the Province of Nelson, but is also not infrequent in many other localities. The ore occurs as the matrix of a quartz conglomerate, but often containing large masses of nearly pure ore several hundred pounds in weight. On breaking these there is frequently a kernel of undecomposed sulphide of iron, showing the origin of the ore to be probably from the denudation of a mineral vein.

Mr. E. W. Mills, in evidence tendered to the same Committee, says:—

I produce to the Committee a piece of wrought iron made from the above ore. I consider it of first-rate quality. It was twisted and bent cold in my establishment this morning.

It may not be out of place to give a short extract from the publications of the Second Geological Survey of Pennsylvania, by Mr. F. Prime, jun., Assistant Geologist:—

Description of the Brown Hæmatite Ore Ranges of Lehigh County.

The great bulk of the iron-ore found in the dolomite or limestone is known under the names of "limonite" or "brown hæmatite." It is the hydrated ferric oxide, having the formula 2 Fe_2O_3, 3 H_2O, containing when pure 59·89 per cent. of iron. The ore occurs massive, earthy botryoidal, mammillary, concretionary, and occasionally stalactitic. It has a silky, often submetallic lustre; sometimes dull and earthy. Colour of surface of fracture, various shades of brown, commonly dark, and none bright; when earthy, brownish-yellow, ochre-yellow. The streak is yellowish-brown. When stalactitic it forms pipe ore, which is rather scarce. When concretionary it forms hollow spherical masses, commonly known under the name of "pot" or "bombshell" ore. These hollow masses commonly contain water or masses of unctuous clay. Their interior surface often presents a glazed appearance, due to a very thin coating or incrustation of oxide of manganese, which imparts a nearly black varnish-like surface. Sometimes the bombshell is solid; its interior then presents a honeycombed appearance, as if from the percolation of chalybeate waters into the mass after the exterior shell had been formed.

This is an admirable description of the Parapara hæmatite; but I did not find it stalactitic. The percentage of metallic iron in various samples of the Lehigh stone is about the same as that of the Parapara. To continue Mr. Prime's remarks:—

Many persons have supposed that the limonite was formed by the oxidation of iron-pyrites. It is to be noted as a fact rather opposed to this view that, with one exception, it has been found impossible thus far to find iron-pyrites in any of the mines examined. That exception is at Thomas Breinig's mine; and there the pyrites is evidently of later age than the limonite, and has a stalactitic appearance. Some persons, on the other hand, have supposed that the ore was formed by the alteration of carbonate of iron, which has been found in some cases present in the limestones. Still others have supposed the ores to be the result of reactions between the limestone and ferrous sulphate. As yet all these theories are mere hypotheses, and before the correctness of all or none of them can be proved it will require a long series of chemical investigations.

2. Description of Situation, Mode of Occurrence, etc.

The deposit forming the subject of this report occurs about a mile south-east of the mouth of the Parapara River, in the Province of Nelson. About five miles north of this is the Town of Collingwood, close to which is the Collingwood Coal Company's Wallsend Mine, which yields some of the best coal in New Zealand. At present this mine is unable to progress as rapidly as it might owing to the thinness of the seam, and to the fact that bands of shale exist in the coal, but the demand that would spring up in the event of the hæmatite being worked—presuming that this coal were used in smelting the stone, for which purpose it is admirably suited—would doubtless give such an impetus to the mine as to enable the works to be carried on at a profit.

The hæmatite is close to the Parapara Inlet, and a short tramway would enable the ore to be shipped in barges and taken to Collingwood, where there is every facility for the construction of a wharf at which vessels of any size could lie.

There is a large deposit of nearly pure crystalline limestone on the banks of the Parapara. The numerous streams on the neighbouring hills would give ample water-power should such be needed. It is unnecessary to describe the character of the ore itself, as Mr. Prime's description applies equally well to this stone.

The main mass extends in a longitudinal direction bearing about north-west and south-east, except at the end near the shore, where it turns round to the north. There are also several outlying portions. The parts in which the ore was found to be pyritous are all near the Parapara River. In some cases the ore seems to form part only of the hill, so in this and similar cases I have assumed its existence under that ground which is covered with it. To determine its position accurately, or to form any idea as to what its depth really is, would require boring or sinking. The ground is much broken up by gullies, &c., and for this an allowance is made in the estimate.

In a gully which has been excavated, partly by gold-diggers and partly by the action of water, to a depth of 30 ft. or 40 ft. I found what appeared to be the junction between the slates and the hæmatite. The line is much faulted and disturbed, and in places the ore appears to run up through the rock in veins. At the junction the hæmatite is of a very inferior and argillaceous character.

In Onakaka Creek the ore occurs in immense masses, of excellent quality, both in the bed of the stream and on the sides of the hills. This point is more than a mile distant from the south corner of the Parapara Company's lease.

In the bed of the Parapara River the hæmatite occurs on the east side of the stream, and has very much the appearance of a reef; but I failed to trace it on the other bank. Here it is very pyritous. On the inland track there is a small leader of ironstone, having a bearing of N. 58 E., a hade of

30° to the north, and a width of about 3 ft. This portion was so mixed with iron-pyrites as to appear to be almost entirely composed of it.

3. Estimate of Quantity.

The ironstone being in many places of so open a structure that it would be useless to take the specific gravity of a number of samples with a view to finding that of the whole, I have assumed this to be 2·8, thus making a cubic foot weigh 175 lb. I was unable to do more than take a number of aneroid readings, and so estimate the height of the main hill. This appears to be about 200 ft. Acting on these assumptions, I have made the following calculations:—

	Tons of Hæmatite.
A. Average height, 200 ft.; average width, 950 ft.; average section, 119,700 square feet, but, deducting one-third for gullies, this becomes 79,800 square feet; length, 8,316 ft.	51,835,600
B. Average height, 34 ft.; average section, 5,100 square feet; length, 2,100 ft.	836,719
C. Average height, 14 ft.; diameter, 310 ft. ...	82,553
D. Average height, 10 ft.; diameter, 75 ft. ...	3,450
E. Average height, 10 ft.; diameter, 75 ft. ...	3,450
F. Average height, 20 ft.; diameter, 240 ft. ...	70,686
G. Average height, 20 ft.; diameter, 90 ft. ...	9,927
H. Average height, 20 ft.; diameter, 120 ft. ...	13,254
I. Average height, 50 ft.; diameter, 132 ft. ...	37,419
Total	52,893,058

In this estimate no ore lying outside the boundary-line is included.

Between the small hills and the main hill is a small knob, which is to all outward appearance solid hæmatite. In this, however, is an excavation, about 8 ft. in depth, exhibiting the following section:—

	Ft.	in.
Ironstone, with many quartz pebbles ...	1	6
Clay	6	6

This shows that the mass of the hill is clay, with merely a shell of hæmatite. From this fact I am doubtful as to whether this may not occur in a good many cases, but it could be proved only by boring.

Without this aid no accurate estimate of the quantity of hæmatite can be made.

Extracts from Report by S. Herbert Cox, F.C.S., Assistant Geologist, on the District between the Aorere and Takaka Valleys, Collingwood.*

LOWER SILURIAN (?).

These beds consist of a crystalline limestone, bituminous and hornblende schists, with pyritous veins and heavy deposits of ironstone, as at Parapara. Besides these, the gneissic rocks of the Parapara River just mentioned must be considered as belonging to this series, and also the steatites and talcose rocks, which occur as irregular masses in them, evidently due to special conditions under which their metamorphism was locally effected. This formation covers a considerable area in the district which I have examined. It stretches down the Parapara River from above McGregor's Creek and Golden Gully to its mouth, being on its western side overlaid unconformably by the schistose rocks in which the Perseverance and other mines have been excavated. It appears to rise the hills across Glengyle Creek, and probably the rocks around Appo's Flat and below Ross's mine at Red Hill belong to this formation; but here they consist of quartzites and a much-decomposed felspathic-looking rock, in which quartz leaders are by no means rare. They extend through the coast range, which occupies the right-hand side of the Parapara near its source; and from a point a little to the north of the trigonometrical station recently erected at the head of the Puruwhakaho Creek their boundary may be approximately mapped by a line running from there to the lower slope of Gentle Annie, the hill opposite Beardmore's, on the Waitui River, over which the track to the Mount Arthur table-land goes. All the

* "Geological Reports, 1881," pages 44–47.

View of Granity from Millerton Track

rocks lying to the eastward of this line belong to the Lower Silurian formation until they are overlaid by the Cretaceo-tertiary limestones or the gravels of the plains, and they rise again on the opposite ranges. Generally speaking, these rocks are very regular in strike and dip, and the coastal range from the Parapara eastward consists of a very sharp syncline, which runs out to the northward about the locality of the mouth of the Parapara, and spreads slightly to the southward, thus spreading the formations and allowing higher beds to come in. The limestone offers a striking illustration of this at the mouth of the Parapara River, one main outcrop following that river down its course, while another runs from its mouth in a south-east direction. As far as can be seen from the observations one is able to take in river-beds in the bush, the strike and dip of these beds are moderately constant, the strike seldom varying much from north and south, while the dip is to the east on the west side of the syncline, and to the west on the east side. That certain contortions do, however, occur in these beds is, I think, made evident by the irregular exposure of some of their beds, and, as the limestone is the most marked, and perhaps the most readily recognised, I will instance this. The limestone occurs as a narrow belt from the mouth of the Parapara up to Richmond Hill, after passing which point it expands rapidly, running into the head of Golden Gully on one side and Happy Valley, a branch of the Parapara, on the other, and in this locality is about as broad as it is long. This sudden expansion of a bed could hardly, I think, be brought about in any other way than by a contortion of highly tilted strata, unless, indeed, they assumed a flatter dip at that point, which I can see no sign of their doing. A further proof that these contortions do occur is seen in One-spec Gully, a creek which falls into the Anatoki near its mouth, where the strike of the rocks varies at places to east and west, while on the hills they are striking north and south. The sharp contortions at right angles to one another are thereby proved in the vicinity of the granites against which they have been crushed. These contortions, I conceive, explain the belts of limestone which occur in the Riwaka Range on the opposite side of the Takaka Valley, and the crush by which they are formed appears also to account for the partial metamorphism of the Te Anau series. On the western side of the Takaka Valley these limestone rocks occupy the comparatively low ranges which flank the main ones, and through which the Anatoki and Waingaro Rivers have cut. The limestones generally occur farthest out towards the valley, with, at places, as at Mr. Sparrow's, the younger Cretaceo-tertiary fossiliferous limestone resting unconformably upon them; and as we reach the Waitui these younger fossiliferous beds completely cut out the older limestones on the western side of the valley.

It is associated with these rocks that the well-known Parapara hæmatite occurs, which, as pointed out by Mr. Binns,* is found as immense boulders in the Onakaka Creek. I followed this creek up carefully as far as the waterfall, which is over limestone, without seeing any sign of the hæmatite *in situ;* but there are, as Mr. Binns mentions, enormous boulders of many tons weight in the creek. Mr. Arthur Washbourn informs me that he has seen the limestone above the waterfall, so I concluded that it was following the line of the limestone. It does not appear again in the Puruwhakaho Creek, being possibly represented there by pyritous veins, of which there are several; but further south again, on the summits of the spurs above Waingaromumu, I again traced it as boulders having a vesicular form, and looking very much as if they had come from the back of the reef. I mentioned† the occurrence of a solid pyritous lode in the Parapara, above McGregor's Creek, where it crops out in the limestone, and I have very little doubt that the Parapara hæmatite is in reality the gossan of a large pyritous lode occurring under similar conditions. The great extent of the ironstone deposit at Parapara is not, I apprehend, due to the existence of such a very large reef as might be supposed, as, if a reef of only moderate size and decomposed to the state in which the Para-

* "Geological Reports, 1878–79," page 63.
† "Geological Reports, 1874–76," page 60.

para ore occurs were exposed at the surface, it would soon, by its waste, cover the three sides of the spur on which it was found. It is, moreover, apparent that in the greater part of the area over which this ore is found it is not *in situ*, and the number of pyrites crystals and cores of pyrites which occur in many of the boulders show that this ore was originally a sulphide, and it has only assumed its present form from oxidation at the surface.

Bituminous schists have also been found associated with this formation elsewhere, and the beds give an equally good account of themselves in this locality. Pieces of graphite, generally of an impure character, may be picked up in most of the creeks which cut across the strike of these beds, but it was only in the ranges at the head of the Puruwhakaho that I observed them *in situ*. At this point they occur overlying the limestones, and containing specimens of a very fair class of plumbago. They, however, require special examination before it could be decided whether any well-defined veins of the pure mineral occur, and, even should they, the locality is not one which could be got at without some considerable expense. The strike of the rocks would carry these beds through to the Onakaka, above the waterfall; and I have no doubt that they could be traced for the whole distance should it be found desirable to do so.

Extracts from Report on the Geology of the Aorere Valley, Collingwood.

By Alexander McKay, F.G.S., Government Geologist.

Parapara Hæmatite.

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

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

To the eastward of the main mass of limonite there runs for some distance an exceedingly massive lode of iron-pyrites, which to the westward has not a clearly defined wall, but on this side passes into pyritous slate. From the decomposition of the sulphides in this pyritous slate, and the removal by water of the products of oxidation and their subsequent precipitation, have arisen the mass of the Parapara hæmatite (or, rather, limonite) deposit. It has been said that the limonite deposit contains many masses having pyritous cores, thus implying that the deposit to a considerable extent resulted mechanically from the breaking-up of a large pyritous reef and subsequent oxidation from the surface affecting the masses more or less deeply.

Pyrites are often met with at places in the deposit, but usually as thin veins in joints and lining cavities, but never, so far as I have observed, in such amount as would lessen the general usefulness and value of the ore.

TARANAKI IRONSAND, MOKAU COAL, CLAY, ETC.

FROM time to time experiments have been made at the Colonial Laboratory, Wellington, by the late Mr. William Skey, F.C.S., and by his successor, Dr. J. S. Maclaurin, F.C.S., and the analyses have been very satisfactory. In 1896 Mr. G. J. Snelus, F.R.S., Vice-President of the Iron and Steel Institute, made analyses of the ironsand, coal, and clays taken to London by Mr. E. Metcalf Smith, M.H.R. for Taranaki.

Report by Mr. G. J. Snelus, F.R.S., Vice-President Iron and Steel Institute.

Laboratory, Victoria Mansions,
28 Victoria St., London, 11th July, 1896.

DEAR SIRS,—With the object of reporting on the practicability of manufacturing iron and steel from the Taranaki ironsands and the Mokau coal, using the clays of the locality as binding materials for the sand, and partially as fluxes, I personally selected from the exhibit by Mr. E. M. Smith the following samples, which I have submitted to careful analyses and other tests:—

No. 1. Sample of ironsand.
No. 2. ,, Mokau coal.
No. 3. ,, yellow clay.
No. 4. ,, blue clay.
No. 5. ,, compound ore-and-clay brick.
No. 6. ,, pig-iron produced by Mr. Smith.

The ironsand contained—

Metallic iron	58·700
Silica	4·600
Titanic acid	7·500
Sulphur	0·015
Phosphorus	0·015
Moisture	0·034

This corresponds fairly well with the analysis reported by Sir J. Hector, as under:—

Peroxide of iron, Protoxide of iron	82·00
Oxide of titanium	8·00
Silica	8·00
Water and loss	2·00

and also with the more complete analysis made by the late Mr. Richard Smith, of the Royal School of Mines, in 1888, as under:—

Peroxide of iron	52·88
Protoxide of iron	29·60
Alumina	0·90
Protoxide of manganese	0·48
Magnesia	4·00
Silica	3·80
Titanic acid	8·41
Oxide of cobalt	Trace
Phosphoric acid	None
Sulphur	None
	100·07
Metallic iron	60·3 %

The sands are therefore rich in iron, and free from sulphur and phosphorus, the difficulty of smelting being due to the mechanical condition and to the presence of titanic acid. The titanic acid is, however, lower than in titaniferous ores, which have been successfully smelted in Sweden, and at Norton, near Stockton, England.

Mokau Coal.

This is a bright, clean, strong bituminous coal, and gave the following results:—

Water at 100°	8·330
Hydrocarbons	51·550
Fixed carbon	33·110
Ash	7·010
Sulphur	1·630
Phosphorus	0·019

The ash is white, there is no visible pyrites, and the sulphur most likely exists as organic sulphur, which would possibly be largely volatilised in the furnace, and may exist very irregularly in the coal. It is not a coking coal.

Mr. R. Smith, of the Royal School of Mines, gives the following analysis of coal from the New Plymouth district:—

Carbonaceous residue	48·50
Hydrocarbons	37·87
Water	13·63

This coal could probably be used raw in the blast furnace, and is most likely to be rich in ammoniacal compounds and tar, which are now yielding such large profits (as much as 3s. 9d. per ton of iron made) to Scotch ironmasters. It would, however, be desirable to have it further tested in these respects. It is very rich in volatile hydrocarbons, yielding a highly luminous gas, and for this reason it would be very valuable for producing illuminating-gas, and for making producer gas for steelworks. The ash is white, and does not clinker—a matter of considerable importance for producer purposes.

Yellow Clay.

This yielded—

Moisture	10·580
Sulphur	0·018
Phosphorus	0·016
Iron	9·610

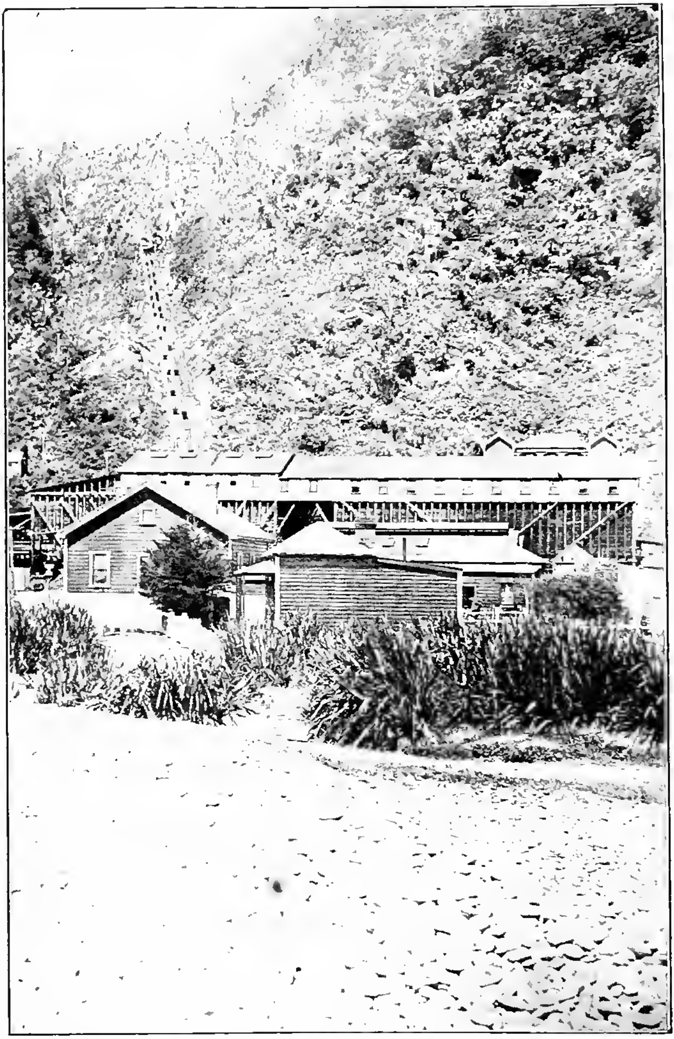
This clay is very plastic, and does not contain any quantity of deleterious matter, and is therefore eminently suitable for binding the ironsand together. It has the further advantage of containing nearly 10 per cent. of iron.

Blue Clay.

This yielded—

Moisture	5·440
Sulphur	1·879
Phosphorus	0·049
Iron	1·870

It will be seen that this clay contains a considerable quantity of sulphur, due, no doubt, to iron-pyrites occurring irregularly through the mass in crystals. No doubt different samples will vary much in this respect, and some samples may



Westport Coal Company: Bins and Screens, Granity.
Mining Handbook.

be free from sulphur; but as this has been found in it I should strongly advise using only the yellow clay, and more especially as the blue clay is also rather high in phosphorus. I should not be at all surprised if the phosphorus and sulphur discovered in the pig-iron, as shown later on, arose from this blue clay.

Compound Ore-and-clay Brick.

This is a hard compact material, quite capable of being smelted in the blast furnace. It does not decrepitate on being heated, and is sufficiently porous to allow of easy reduction. As its composition can be varied within wide limits, I do not think it necessary to submit it to analysis, the composition of its components being known.

Pig-iron produced by Mr. Metcalf Smith.

This yielded the following analysis:—

Iron	92·877
Combined carbon	0·850
Graphite	2·200
Silicon	3·270
Sulphur	0·136
Phosphorus	0·227
Manganese	0·200
Titanium	0·245
	100·005

The sample of pig-iron was extremely tough, good grey foundry-iron, chilling with a clean surface. I have no doubt it would produce good strong bar iron by puddling. As will be seen from the analysis, this sample contained too much sulphur and phosphorus to be safely used in the acid, Bessemer, or Siemens processes, although it could be made into good castings. But I do not attach any importance to these small quantities of sulphur and phosphorus in this sample of pig-iron, for, as already pointed out, they may come from sources that can be avoided in future.

I am quite of opinion that the materials at hand are pure enough to make iron suitable for steel-making processes. I also believe that, with proper metallurgical skill and a thoroughly modern blast furnace, it should be possible to deal with this rich ironsand, and convert it into pig-iron, at a very moderate cost—low enough to leave a very handsome profit, even if it had to compete at ports, say, in China, Japan, or India. Of course, if the iron can be produced so cheaply, the proximity of the Mokau coal would enable it to be converted into equally cheap steel on the spot.

I should strongly advise erecting a modern blast furnace capable of turning out about 500 to 600 tons of pig-iron per week, with modern hot-blast stoves and high-pressure blast engines.

It may not be necessary to burn the bricks, as stove-drying would probably render them hard enough to stand handling and charging into the blast furnace, when they would become partially burnt in the upper part of the furnace before reduction set in. A thoroughly efficient mechanical brick-making plant should be provided, the proper proportions of clay and sand being fed into the pug-mill continuously. By using three parts of ironsand to one of clay a mixture would be obtained containing nearly 50 per cent. iron, which should not cost more than 5s. per ton.

With coal at 13s. 4d. per ton, as given by Mr. Smith, pig-iron should not cost more than £2 10s. per ton—the approximate price of hæmatite pig-iron f.o.b. in this country at present. I do not think that the Mokau coal should cost more than half this price, and pig-iron ought to be produced at a little more than £2 per ton. The enormous deposit of these ironsands certainly guarantees a supply of material for fifty years to come, while the deposit of Mokau coal seems to be equally large. The profit should therefore be large and lasting.

Yours truly,

(Signed.) Geo. J. Snelus, F.R.S.

Report by Mr. R. Price Williams, M.I.C.E., on New Zealand Iron and Steel Company's Ironsand at New Plymouth.

Victoria Mansions, 32 Victoria Street,
London, S.W., 29th June, 1896.

Dear Sirs,—In accordance with your request, I send you in this report my views in regard to this company's magnetic-ironsand deposits at Taranaki, and the quality of the samples of pig-iron, wrought iron, and steel produced therefrom, which I have recently had the opportunity of examining at your offices.

It is now some years since my attention was first directed to these large deposits of magnetic ironsand, which for miles along the Taranaki Beach form so conspicuous an object when approaching New Plymouth by sea. According to an analysis furnished me at the time by Dr. (now Sir James) Hector, it contained about 82 per cent. of peroxide and protoxide of iron and 8 per cent. of titanium, and as much as 60 per cent. of metallic iron.

The exhibits I have recently examined at your offices of some fine samples of pig-iron, wrought and cast iron, and samples of steel made from it by Mr. Metcalf Smith's process, incontestably prove the resultant materials to be of very high quality, and the greatest credit is certainly due to Mr. Metcalf Smith for his untiring efforts, and the great skill and ability he has shown in so successfully accomplishing what has hitherto been regarded as impracticable. Nothing, however, succeeds like success, and, from what I have already seen of the material, I consider there is everything to indicate that the judicious expenditure of the further capital required to fully develop the company's undertaking will result in the establishment in New Zealand of a large and profitable iron and steel industry.

In my opinion, the quality of the material produced from this ironsand is of such excellence as to render it of especial value where great tensile strength combined with hardness and toughness are the chief requisites, as in the case of steel rails, boiler-plates, crank-axles, tires, &c. I also think that an admixture of some of it with the pig-iron produced from the hæmatite and chrome-iron ores, obtainable in large quantities from different parts of New Zealand, would undoubtedly have the effect of improving the character and qualities of the steel or iron.

The sample of Mokau coal appears to be a good coal of semi-bituminous character, and from the proximity of these coal-mines to New Plymouth it will undoubtedly prove of great value in connection with the company's iron and steel works there.

I should also state that the results of tests I have made with some of the coal obtained from mines I have visited and reported upon in the colony, situated within easy distance of New Plymouth by sea, prove that it produces a very good coke, as the tests carried out for me, and certified by the manager at the South London Gasworks, show.

It is scarcely necessary for me to say that, in view of the fact that there is an almost unlimited supply of this rich and pure ironsand at Taranaki, and of the relatively small cost at which, by Mr. Metcalf Smith's process, it can be made in the form of brick into an artificial compact ore, there is every reason to indicate that a first-class pig-iron can be produced from it at an exceptionally low figure, regard being had to the enhanced cost of labour in the colony; and I consider the estimated cost—viz., £2 10s. per ton—a very reasonable figure for an output of 500 tons a week.

The central position of New Plymouth (with its good harbour and breakwater, the latter designed by the late Sir John Coode), in direct connection as it is with the railway system of the North Island, renders it in every way most suitable for the construction of blast furnaces, rolling-mills, Bessemer or Martins-Siemens plant, &c.; and, as regards the cost of the plant, I may state that for an output of 50,000 tons it would, roundly, amount to about £50,000, so that altogether the total amount of capital outlay required for such an output would be about £130,000, and, I may add, about £200,000 for double that output.

The cost of the manufactured iron and steel at the company's works, according to the rough but reliable estimates I have made, ought not to exceed the present selling-price, f.o.b., of the same manufactured in England—viz., steel rails, £4 10s.; boiler-plate, £6 2s. 6d. The estimates of the cost you have furnished me, which I understand were prepared in the colony, appear to me, notwithstanding the high price of labour out there, to be rather too high. This is, however, an error on the safe side. Having regard to this, and to the saving in the cost of freight and the other charges incidental to the conveyance of the manufactures from this country, and the high prices charged in New Zealand, there is evidently a large margin of profit to be made by the company at well-appointed and properly managed works in New Zealand. It only remains for me to add that, in my opinion, a good market will be found for high-class pig-iron of this description, more especially in the neighbouring colonies of New South Wales and Victoria; and, as regards the estimates I have given relating to the cost of blast furnaces, I may state that they are based on the data given in Sir Bernard Samuelson's paper on the "Construction and Cost of Blast Furnaces" (Iron and Steel Institute Proceedings, 1887), and those relating to the cost of the plant and cost of working to data I have acquired from my own experience when manager of Bessemer Steelworks at Sheffield, and subsequently with Sir Henry Bessemer at the works at Greenwich, due allowance being made for the increased cost of labour and materials in the colony.

Yours faithfully,
(Signed.) R. PRICE WILLIAMS.

Letter from Mr. F. Siemens.

10 Queen Ann's Gate, Westminster,
London, 8th June, 1896.

DEAR SIRS,—I have for a long time had the opinion that the most rational and feasible method of smelting the black ironsand of New Zealand is to convert it into a sufficiently hard and tough artificial iron-ore (in such manner as Mr. E. Metcalf Smith has proposed) before treatment in the ordinary manner in a blast furnace of modern design.

I have had an opportunity of examining the specimen of pig-iron so produced by Mr. E. M. Smith, and it seems of very good quality, judging from the samples. I was pleased to see that wrought iron in bars, sheets, wire, &c., as well as steel and castings, all of excellent quality, can be made from the pig-iron produced from the artificial iron-ore, and I think a company has the best chance of success in New Zealand which intends working on these lines.

I am, &c.,

Pro FREDERICK SIEMENS.

(Signed.) ED. W. HARVEY.

Report by Mr. Horace Allen on Samples of Taranaki Ironsand, Fuel, &c.

Ironsand.—The ironsand consists of nearly pure magnetic oxide of iron in a very fine state of division, but in its natural state it is unfit for smelting in the ordinary blast furnace.

Iron-ore Compound.—This is in the form of bricks, raw and baked, consisting of a mixture of ironsand and clay material which, when dried, is so dense and hard as to prevent (during the period of the descent of the materials through the furnace) the separation of the ironsand; at the same time, it is so porous as to allow the reducing gases to penetrate to the interior of the bricks. An experiment to determine the porosity of a piece of baked brick showed that it was capable of absorbing as much as 9 per cent. of water, which is equivalent to nearly one-third of its volume. With a mixture of ironsand containing 60 per cent. of metallic iron the compound would contain about 46 per cent. of metallic iron, requiring 2 tons 2 cwt. of compound per ton of pig-iron produced. In this form the ironsand can be smelted in a modern blast furnace.

Fuel.—A sample of the patent fuel, in the form of a briquette, did not decrepitate when suddenly subjected to a high temperature, as in the top of a blast furnace, but in a short time became transformed into a hard coke. The ash in this sample was 17·5 per cent.

Slag.—The specimen of slag was of a blue-grey colour, and resinous fracture. The colour indicates that there is only a small proportion of oxide of iron present.

Pig-iron.—Six pieces of pig-iron broken to show fracture, which is of a grey colour, and is a close fine-grain foundry quality, suitable for puddling and for open-hearth steel-making. One piece of pig was turned in the form of a cylinder, having a very fine surface, quite sound, and showing that the iron was of so soft a quality as to be turned in a lathe.

Castings.—Samples marked "Direct castings."—The three specimens were sound, and had a good surface, the angles being sharp and well defined. 1. Cast barrow-wheel. 2. Cast mill-guide. Good, sharp, clean castings.

Samples marked "Second-run castings."—Two small bevel-wheels, one ratchet bevel-wheel, one cog-wheel, one small wagon-wheel, one small bevel-wheel, two other specimens: All very good, sound castings. Two 18 in. diameter wagon-wheels, brand "Taranaki ironsand, N.Z.R.," one ornamental casting, two other samples of cast-iron.

Samples of malleable castings.—Four small spanners; one of these was twisted half-round, and another two-thirds round, without showing any fracture. Manufactured iron and steel: One piece of puddle bar; seven specimens of rolled sheet, including a baking-dish made up (one sheet was only about $\frac{7}{1000}$ of 1 in. thick, which shows the ductility of the metal); seven specimen horse-shoes; two wedges; one clamp, screwed and finished, polished; one piece of bar $\frac{3}{4}$ in. by $\frac{3}{16}$ in. twisted several turns; one hat-and-coat hook, showing capability of forging, very good specimens; two bars, 1 in. by $\frac{1}{2}$ in., bent close without fracture, one also drawn out to a long point and made into a knot; one piece of galvanised sheet; one step for dog-cart, showing capability of forging, very good specimen; one hay-fork, finished and polished; three sheet-iron buckets, finished; bars about 5 ft. long, one bar 3 in. by ¾ in., one bar 1¾ in. square, two bars 1 in. square (one taken for testing), two bars 2¼ in. by ¾ in., one bar 1 in. square, short piece turned and flattened; one bar ⅜ in. square, short piece polished on one side taken for testing.

(Signed.) HORACE ALLEN,
Late Chemist, Barrow Hæmatite Steel
Company (Limited), &c.

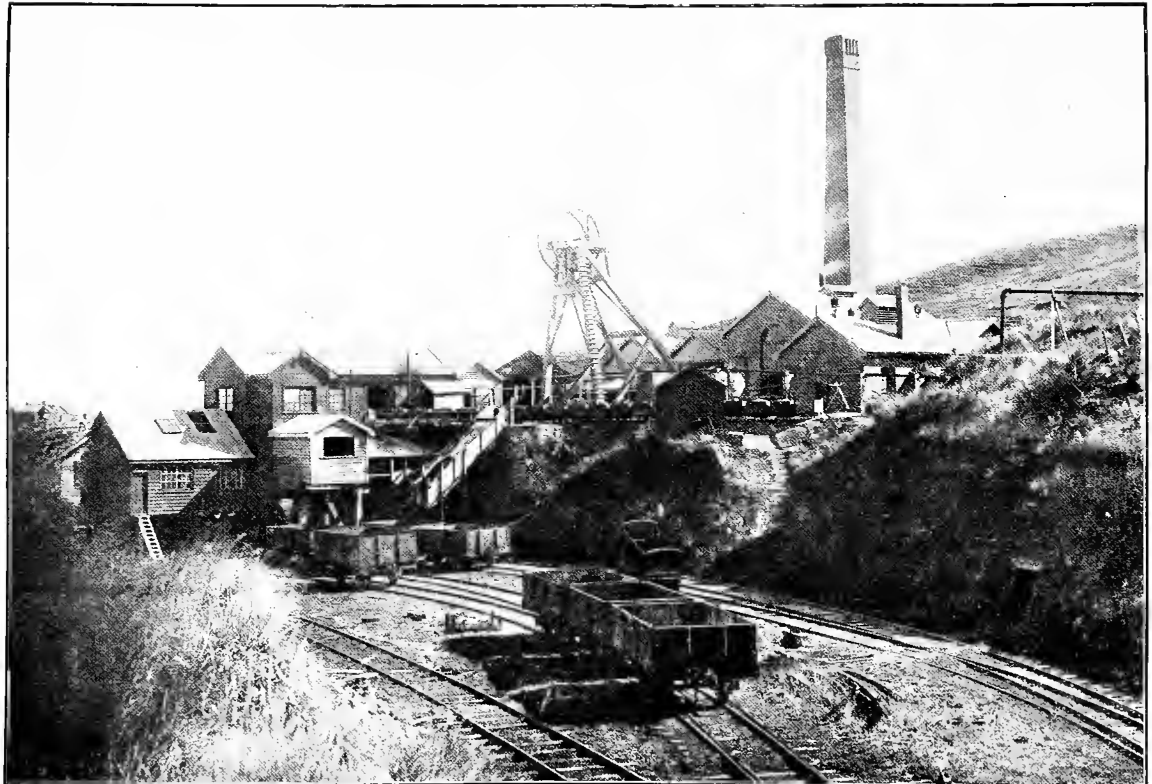
6th July, 1896.

Analysis by J. S. Maclaurin, D.Sc., F.C.S., Government Analyst, Mines Department, New Zealand, in the Year 1902.

Iron-monoxide*	40·68
Iron-sesquioxide*	36·05
Manganese-oxide	0·35
Titanium-oxide	9·20
Alumina	4·00
Lime	1·80
Magnesia	2·77
Silica	3·90
Phosphoric anhydride (P_2O_5)†	0·09
Sulphuric anhydride (SO_3)‡	0·01
Water	0·25
Alkalies and undetermined	0·90
	100·00

This ironsand contains only small percentages of phosphorus and sulphur, and should therefore prove suitable for the acid Bessemer process.

* Equivalent to metallic iron, 56·87 per cent.
† Equivalent to phosphorus, 0·039 per cent.
‡ Equivalent to sulphur, 0·004 per cent.



Castle Hill Mine, Kaitangata.

THE COPPER-DEPOSITS OF NEW ZEALAND.

By Alexander McKay, F.G.S., Government Geologist.

The following is a list of the copper-mines and of the localities where copper-ores have been discovered in New Zealand:—

1. *Waitahuna, Tuapeka County, Otago.*—Lode in schist rock. Ore, copper-pyrites. Prospected, but not worked. Ore, 4 ft. thick.

2. *Moke Creek, Shotover Valley, Lake County.*—Lode in schist rock. Ore, copper-pyrites. Prospected, but not worked. Ore, 10 in. thick.

3. *Route Burn, Lake County, Otago.* — Copper-pyrites widely dispersed through sub-schist rock. Not worked.

4. *Bradshaw's Reef, Ismuth Sound, Preservation Inlet, Fiord County, Otago.*—Lode in granite. Ore, a mixture of iron-pyrites, copper-pyrites, galena, and zinc-blende, gold, and silver. Prospected.

5. *George Sound.*—(See Mineral Map of New Zealand by Sir James Hector, M.D., F.R.S., Geological Reports, 1885.)

6. *Milford Sound.*—(See Mineral Map of New Zealand by Sir James Hector, M.D., F.R.S., Geological Reports, 1885.)

7. *Arawata River, Jackson's Bay, Westland County.*—(See Mineral Map of New Zealand by Sir James Hector, M.D., F.R.S., Geological Reports, 1885.)

8. *Mount Solitary, Dusky Sound, Fiord County.*—Lode in granite; large. Ore, copper-pyrites. Prospected, but not worked.

9. *Paringa River, Westland County.*—Lode in schist. Ore, copper-pyrites. Lode prospected, but not worked.

10. *Arahura Gorge, Westland County.*—A massive development of copper-bearing olivine and schist; analysis up to 10 per cent. of copper. Not worked.

11. *Flag-pole Hill, Malvern Hills, Selwyn County.*—Thick band of serpentinous or diabasic rock, charged with minute crystals of copper-pyrites producing silicate stains. Prospected, but not worked.

12. *Johnston's United Mine, Aniseed Valley, Nelson: Waimea County.*—Lode irregular; in serpentine rock. Ores, various.

13. *Hackett's Stratum, Serpentine River, Aniseed Valley, Nelson: Waimea County.*—A stratum of serpentine containing 5 per cent. of native copper. The copper is evenly dispersed as minute grains and scales of the metal.

14. *Champion Mine and adjacent leases, Roding River, Nelson: Waimea County.*—On these properties there is a heavy lode of copper-pyrites, but native copper chiefly has been worked. Reduction-works were erected some years ago, and work has lately been resumed. The different lodes occur in serpentine rock.

15. *Dun Mountain Copper-mine, Nelson: Waimea County.*—Ores, various; rock, serpentine.

16. *Wind-trap Gully, Maitai Valley, Nelson.*—Lode in serpentine. Ores, various. Prospected, but not now being worked.

17. *Croixelles Harbour.*—(See Mineral Map of New Zealand, by Sir James Hector, Geological Reports, 1885.)

18. *D'Urville Island, Nelson.*—Lode in serpentine. Prospected. Ores, various.

19. *Perseverance Mine, Bedstead Gully, Aorere Valley, Collingwood County.*—Lode in Silurian slate. Ore, copper-pyrites. Not now worked.

20. *Maharahara, Woodville, Hawke's Bay.*—A variable but generally massive lode in strata of Carboniferous age. Ore, sulphide and sub-sulphide of copper, with some gold and silver. Prospecting has been carried on with a view to the permanent working of the mine.

21. *Patua Range, Taranaki.*—Lode, thermal-spring quartz in connection with Tertiary volcanic tuffs. Some prospecting has been done, but is now discontinued.

22. *Te Aroha, Piako County, Auckland.*—Various mines worked for gold yield a mixed ore, consisting of copper-pyrites, galena, and zinc-blende.

23. *Sylvia Mine, Tararu Creek, Thames County, Auckland.*—Contains copper-ores, &c., as at Te Aroha.

24. *Kawau Island, Hauraki Gulf, Auckland.* — Lode worked in the past to a considerable extent. Ore, copper-pyrites. Private property.

25. *Great Barrier Island.*—Lode, a fissure lode in Palæozoic slates. Ore, copper-pyrites. Mine worked to the extent of an output of between 2,000 and 3,000 tons of ore. Work now discontinued.

26. *Manukau, North Head, and Kaipara Harbour.*—Copper occurs, but no regular deposits have been found.

27. *The Hen-and-Chickens, off Whangarei Harbour, Northern Auckland.*—Copper-pyrites dispersed through diorite rock. The copper-bearing formation is said to be of great thickness; the percentage of copper is low, seldom above 3 per cent. No official examination has been made.

28. *The Sunrise Copper-mine, Whangaroa County.*—Lode, a heavy deposit of marcasite, in which float kernels and masses of pure copper-pyrites; copper-pyrites about one-sixth of the whole. Prospected.

29. *North Head of Doubtless Bay, Mongonui County.*—Copper-pyrites in connection with diorites. Prospected, but not worked.

30. *Coast between Hokianga and Whangape, North Auckland.*—Frequent reports are current of the presence of copper-ores in this part of the Auckland District. No ores from this part have as yet reached the Mines Department.

31. *Mohaka River, Hawke's Bay.*—A quartz lode in green diabasic rock. Iron and copper pyrites; the latter in but small amount.

MINERALS OF NEW ZEALAND.*

By Sir JAMES HECTOR, K.C.M.G., M.D., F.R.S., late Director, Geological Survey.

[! Rare. !! Common. !!! In workable quantity.]

ACTINOLITE !—Milford Sound (Hector); Parapara (Cox), as radiating fan-shaped crystals in metamorphic schists

ALBITE, or SODA FELDSPAR ! !—Maori Point, West Coast, Wilkin River, Makarora, Dun Mountain, George Sound, in diorites (Hector, Haast, Davis).

ALUM ! !—Pomahaka, as a product of pyritous shale (Hector, 1862); Puai Island, Waikouaiti (Hochstetter, 1860); Tokomairiro, as potash alum (Hector, 1862); D'Urville Island, as manganese alum (Hacket, 1886). Analysis per cent. (Skey):—

Alumina	10·40
Ferric oxide	1·11
Lime	0·50
Magnesia	5·46
Soda	0·41
Sulphuric acid	37·40
Hydrochloric acid	Traces.
Water	42·72
Insoluble in water	2·00
	100·00

ALUNITE !—Rotorua, deposited by geysers (Ulrich).

ALUNOGENE ! !—Tuapeka, Manawatu, occurring in some of the brown coals, is colourless, crystalline, and completely soluble in water. Analysis per cent. (Skey):—

Sulphate of alumina	55·60
Sulphate of lime	1·01
Sulphate of magnesia	2·99
Alkaline sulphates	3·00
Water	37·40
	100·00

* Revised from "Trans. Aust. Assoc. Sci.," Vol. ii, p. 269. Published as an appendix to "Reports of Geological Explorations," 1890-91.

ANDESINE !—Colville Peninsula, Taupo district, Ruapehu, in andesites (Hutton).

ANORTHITE !—Kakapo Lake, West Coast, in diorite dykes (Hector, 1863).

ANTHOPHYLLITE !—Dun Mountain, Nelson, in a massive laminated form (Davis).

ANTIGORITE !—Dun Mountain, in serpentine schists (Cox).

ANTIMONIAL OCHRE !—Endeavour Inlet, as a coating on antimonite (Cox).

APATITE !—Wangapeka (Lab. and Geol. Reports).

APOPHYLLITE ! !—Turnagain Point, in amygdaloids; Rangitata, as ichthyophthalmite in felsite porphyries (Haast).

ARAGONITE ! !—Collingwood, in caves; Dunedin and Thames, in cavities in basaltic rocks; and from hot springs, East Cape (Hector), and several other places; lining fissures and cavities in volcanic rocks of Banks Peninsula (Haast).

ARSENIC (NATIVE) ! — Kapanga Mine, Coromandel, in auriferous quartz lode with calcite (Hector, 1864).

ASBESTOS ! ! !—Milford Sound, Collingwood, Takaka (Hector); also at Mount Arthur, Nelson, and Mount Pisa, Otago.

AUGITE ! !—Hororata district, Dunedin, Nelson, Auckland, Collingwood, Banks Peninsula, Acheron, Chathams; enters into the composition of all basalts, dolerites, augite-andesites, trachydolerites, diabases, and melaphyres; sometimes in crystals ½ in. long, Nelson (Hector).

AWARUITE ! — George River, S.W. coast, in serpentine. Analysis (Skey):—

Nickel	67·63
Cobalt	0·70
Iron	31·02
Sulphur	0·22
Silica	0·43
	100·00

AZURITE !—Nelson, Great Barrier Island, in gossan of copper lodes in serpentine.

BARYTES ! — Waikouaiti (Mantell, 1852); Akiteo (Hector, 1867); Thames (Skey, 1870); East Cape (McKay, 1874).

BERYL !—Dusky Sound, in hornblendic schists (Cox); Stewart Island, with tinstone in large crystals (McKay), determined by Skey.

BISMUTH !—Owen River, Nelson, alloyed with gold (Hector), determined by Skey.

BITUMEN—Cast up on the south and east coasts of New Zealand in considerable quantity (Lab. Geol. Reports III).

BOLE ! !—Lyttelton Tunnel, in dolerite rocks (Haast). Analysis (Skey):—

Silica	44·78
Alumina	15·66
Iron	16·87
Manganese	0·60
Lime	2·02
Magnesia	5·02
Potash	2·69
Water (constitutional)	12·36
	100·00

BORNITE !—Kawarau, Dunstan, in micaceous quartz (Hector).

BOURNONITE !—Wangapeka, occurs in quartz with galena (Hector).

BRAUNITE ! !—Malvern Hills, vicinity of Wellington, massive (Geol. Survey, 1873).

BRONZITE !—Dun Mountain, in diorite rocks (Hector, Davis).

BROOKITE !—Otepopo, in crystalline dolerite (Hector, 1862).

CALAMINE !—Tararu Creek, as lustrous transparent crystals attached to diallogite, but always external (Skey).

CALCSPAR (CALCITE) ! !—Tokatea Range, Otago, in Tertiary rocks of Otago as Dogtooth spar; Nelson, in limestone caves; Canterbury, as Iceland spar (Haast, 1864); Dunedin, Seacliff, near Waikouaiti, Cape Rodney, Tararu Creek, Thames, as smoke-coloured calcite, Cape Rodney (Cox, 1882); also at Waitekauri.

Marble ! !—Collingwood district (Hochstetter, 1860); West Coast Sounds (Hector, 1863); Kakahu, Canterbury (Monro, 1866).

Stalactite and *Stalagmite* ! !—Whangarei, Waipu, Collingwood, Mount Somers; occur in many limestone caves.

Travertine ! !—Oamaru, Mauriceville, Takaka, and many other places, deposited from calcareous waters (Hector).

CERVANTITE !—Widely distributed; occurs incrusting stibnite.

CHABASITE !—Dunedin, in vesicular basalts (Hector); Helenburn and Banks Peninsula, in trachytic rocks (Haast).

CHALCOPYRITE ! ! !—Kawau, Great Barrier Island, Moke Creek, Paringa River, Canterbury, Collingwood (Geol. Surv.).

CHIASTOLITE !—Collingwood, in clay-slate (Hector).

CHLORITE ! !—Fox Glacier, Westland, in chlorite-schists (Cox); Tararu Creek, Thames (Skey); West Coast of Otago and Otago Heads, in an amorphous form in vesicular basalts (Hector); Kakapo Lake (Liversidge).

CHLOROPHYLLITE !—Mount Somers, fine earthy mineral filling cavities in rocks (Haast).

CHROME OCHRE ! !—Nelson, occurs in combination with chromite in small quantities (Hacket, 1861).

CHROMITE ! ! — D'Urville Island, Dun Mountain, Aniseed Valley (Hochstetter); Red Mount, Otago, in a band of serpentine and olivine, also occurs as massive crystals, massive amorphous crystalline, disseminated, and granular Hector, 1865): Nelson, associated with nephrite (Hector, 1865). Sp. gr. 3·328. Analysis (Skey):—

Silica	12·66
Chromic oxide	47·69
Ferrous oxide	24·08
Alumina	6·29
Lime	3·16
Magnesia	6·12
	100·00

CHRYSOBERYL !—Stewart Island (determined by Skey, 1889).

CHRYSOCOLLA !—Nelson, incrusting gossans of copper-ores in the serpentine belt.

CHRYSOTILE, or PERIDOTE. — Dun Mountain, traversing the dark-green serpentine (Cox).

COALS ! ! !—Special schedule, abstract of report by Sir J. Hector. (See pages 451 and 452, Mining Handbook.)

COBALT BLOOM !—Otago, occurs in schists and gneiss (Hector).

COPPER (NATIVE)—Great Barrier Island, Nelson, Lake Wakatipu, Dun Mountain, Perseverance Mountain, &c., in plates associated with copper-deposits in serpentine (Skey); as grains disseminated through a granular serpentine, Aniseed Valley (Hacket), and as fine grains in basaltic dykes which cut through trachydolerite breccias, Thames (Geol. Survey), (Cox).

Black Copper, or *Tenorite*—D'Urville Island.

Copper Glance !—Nelson, in various parts of the serpentine belts, in a massive form.

Peacock Copper—Maharahara, Champion Mine, occurs associated with native copper (Hector).

Red Copper !—D'Urville Island, Lake Te Anau; 35·60 per cent. copper.

COPPER-PYRITES ! ! !—Waipori, Moke Creek, Coromandel, in a compact amorphous form (Hector). Analysis (Skey):—

Copper	15·03
Iron	28·00
Quartz	21·00
Sulphur	35·97
	100·00

COPPERAS !—Kawau, Barrier Island, crystallized.

COVELLINE !—D'Urville Island (Hector, Cox).

DERMATIN !—Dun Mountain, West Coast Sounds, occurs in faces with smooth polished surfaces (Davis).

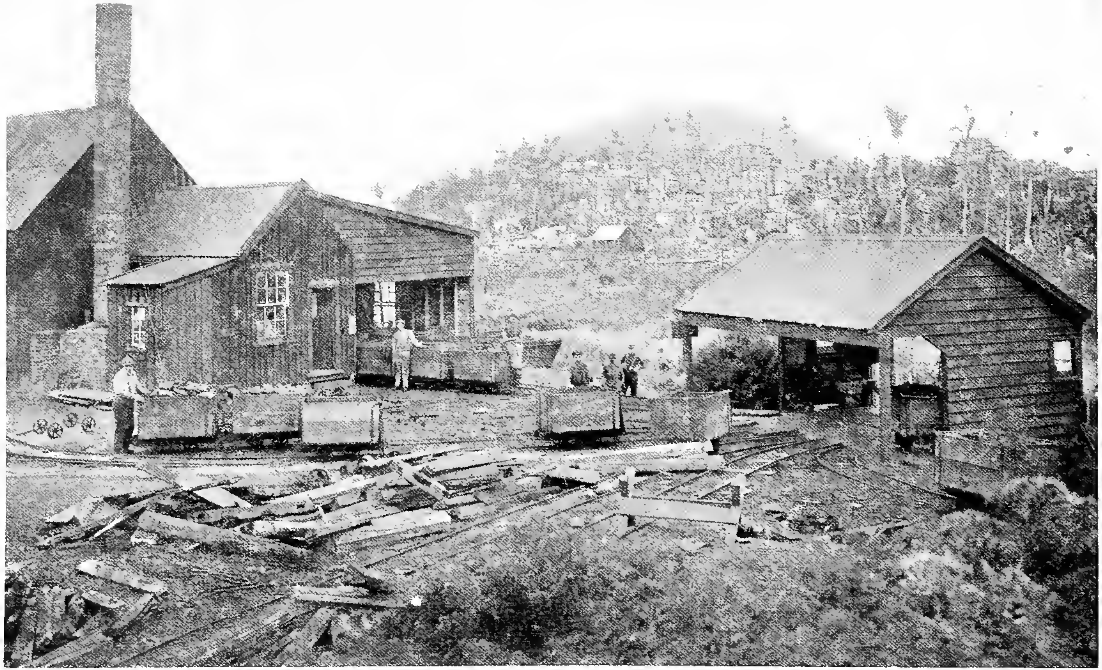
DIALLAGE, or ALUMINOUS AUGITE ! !—Kakapo Lake, in diorites and gabbros (Hector).

Green Diallage ! !—Mount Arthur, in serpentine schists (McKay).

DIALLOGITE ! !—Thames (Hector, 1881), associated with calamine; Makara (Skey, 1870); Paraparaumu, 1888, in a strong lode.

DILESSITE !—Mount Somers, fine earthy mineral filling up cavities in melaphyres (Haast).

DIOPTASE !—Thames, Nelson, occurs as an incrustation on the copper-ores (Skey).



SURFACE WORKS AT HIKULANGI COAL COMPANY'S MINE, SHOWING LIMESTONE ROCKS AND HIKURANGI MOUNTAIN IN BACKGROUND.

Dolomite !—Malvern Hills, interstratified with augitic sandstone (Haast, 1865); Collingwood (Hector, 1872).

Dopplerite !—Waiapu, formed as a surface deposit by oxidation of exuded petroleum (Hector, 1874). Analysis (Skey):—

Oils	3·1
Paraffin	9·3
Earthy matters	26·9
Water	11·3
Oxygenated hydrocarbons	49·4
	100·0

Dufrenoysite !—Great Barrier Island, as a fine crystalline vein associated with galena in large crystals (Hutton).

Dunite ! !—Dun Mountain, found massive, named by Hochstetter, 1860. Analysis (Reuter):—

Silica	42·80
Magnesia	47·38
Protoxide of iron	9·40
Water	0·57
	100·15

Elaterite !—Kawau (Hector, 1865), hardness, 2; sp. gr., 1·034; Poverty Bay (Liversidge, 1877).

Electrum ! ! !—Thames, usually found in places where gold occurs.

Emerald !—Dusky Sound, in quartz with pyrrhotine (collected by Docherty, determined by Cox and Skey).

Epidote !—West coast of Otago, in granites (Hector); Mount Torlesse, in diorites (Haast); Wairarapa, in massive form (Hector). Analysis (Skey:—

Silica	44·71
Iron	14·66
Alumina	11·47
Lime	22·93
Magnesia	2·13
Water of constitution	4·10
	100·00

Epsomite, or Epsom Salts !—Otago, as an efflorescence (Hector, 1865).

FAYALITE !—Nelson, in schist, contains 2·6 per cent. copper (Skey).

FELDSPAR (GLASSY) ! — Taupo district, in rhyolites, &c. (Hector).

FLUOR SPAR ! ! !—Stewart Island and West Otago (McKay, 1889); Batton River, associated with sulphate of baryta (Park, 1889); determined by Skey.

FULLER'S EARTH !—Great Barrier Island Hot Springs, in trachyte tuffs (Hutton); also at Tararu, Thames.

GAHNITE !—Stewart Island, with tinstone (McKay); determined by Skey, 1888.

GALENA !—Kaituna and Kaimanawa Range, associated with quartz, generally argentiferous; Wangapeka, containing an average yield of about 91 oz. of silver per ton; Great Barrier Island (Skey).

GARNET (*Iron Lime*)—West Otago, in gneiss (Hector).

Black Garnet—Dunedin, in vesicular basalts (Hector).

GLAUBER SALTS !—Brancepeth, Whareama, Wellington, sample forwarded by Mr. W. H. Beetham in 1874 (determined by Skey).

GLAUCONITE !—Otago, occurs in schist and greensands as rounded grains in several of the younger Secondary beds (Hector).

GOLD (NATIVE) ! ! ! — Auckland, Taranaki, Hawke's Bay, Wellington, Nelson, Marlborough, Canterbury, Otago, Southland, Westland; occurs plentifully in reefs, alluvial deposits, sea-sand, &c., as crystals in the Ben Nevis Range and Mahakipawa.

GRAPHITE ! ! !—Pakawau, occurs chiefly as thin flat veins interstratified with metamorphic schist, was largely worked prior to 1866; at Mount Potts, and in the Glossopteris beds (Permian), (collected by McKay); a boulder of very pure graphite in a stream from Waiokoura Creek, Mount Egmont. Analysis of Pakawau sample (Skey):—

Carbon	58·10
Water	5·68
Ash	36·22
	100·00

Green Earth !—Malvern Hills, filling cavities in melaphyres (Haast).

Halloysite ! !—Dunedin (Hector), in decomposing basalts; Water of Leith (Liversidge); Scinde Island (McKay). Analysis (Skey):—

Silica	58·22
Sesquioxide of iron	5·82
Alumina	24·34
Lime	2·02
Magnesia	2·53
Water	4·81
Alkalies and loss	2·26
	100·00

Hauerite ! — Wakatipu district, Collingwood, in crystals (McKay).

Hausmannite !—Selwyn River, in rolled pieces and coating joints in rocks (Haast, 1865).

Hectorite !—Dun Mountain, named by Cox, occurs with serpentine rocks (Cox, Trans. N.Z.I., 1882, p. 409). Analysis (Skey):—

Silica	57·89
Ferrous oxide	18·46
Alumina	4·74
Ferric oxide	Traces.
Manganese	Traces.
Lime	1·99
Magnesia	13·94
Water	2·98
	100·00

Hæmatite !—Mount Gilbert, Nelson, Dunstan, as lenticular masses. Analysis (Skey):—

Silica	4·60
Alumina	3·00
Sesquioxide of iron	90·60
Water of constitution	1·80
	100·00

Hessite !—Te Aroha, in auriferous quartz (Hector); analysed by Skey.

HEULANDITE !—Canterbury, in amygdaloidal traps associated with felsite porphyries (Haast).

HORNBLENDE ! !—Widely distributed (Hochstetter, 1859).

HYPERSTHENE ! !—Warp Point, Kotuku River, in diorite rocks and in hypersthenite (Hector).

IDOCRASE, or VESUVIANITE !—Dusky Sound, as dirty-green fluted prismatic crystals in quartz associated with crystalline rocks (Docherty), (identified by Skey).

IDRIALITE, or INFLAMMABLE CINNABAR !—Dunstan, Serpentine Valley, Waipori, Ohaeawai Springs, occurs as rounded grains in alluvium (Hector). Analysis (Skey):—

Water	6·89
Hydrocarbon	21·50
Cinnabar	34·10
Sand	37·51
	100·00

ILMENITE !—Taranaki ! ! !, and in ironsands in all parts of New Zealand.

IRIDOSMINE !—Takaka, Orepuki, occurs in gold-wash as small flat grains (Hochstetter).

IRON-PYRITES ! !—Collingwood, Wakatipu district, &c., sometimes occurs in octahedral crystals (Lab. and Geol. Reports).

ISERINE ! !—Common on the West Coast, South Island (Lab. and Geol. Reports).

JADE, NEPHRITE, or AXE-STONE ! !—Milford Sound, Teremakau River, known as "Maori greenstone." It occurs as rolled pieces on the beach and as white nephrite (Hector). Analysis (Skey):—

Silica	51·03
Ferric oxide, with traces of manganese and chromium	12·43
Alumina	1·42
Lime	9·00
Magnesia	21·35
Soda	Traces.
Water (constitutional)	0·97
	96·20

KAOLIN ! ! !—Manuherikia, Arrow River, Mount Somers, Collingwood, Stewart Island, formed by the decomposition of felsite porphyries (Hector, Cox).

KERMES !—Endeavour Inlet, occurs with stibnite.

KYANITE, or DISTHENE !—Westland, associated with quartz.

LABRADORITE ! !—Purakanui Range, Mount Charles, Banks Peninsula, in trachydolerites (Hector, Haast).

LEAD (NATIVE) !—Collingwood, in the wash of a creek in the form of round grains, like shot. It is alloyed with gold (Skey, Trans. N.Z.I., XII, p. 367).

LEPIDOLITE !—Thompson Sound, in marble (Hector).

LEPIDOMELANE !—Milford Sound, in schists and gneiss rock (Hector).

LEUCITE !—Castlepoint, in leucite basalt (McKay). Analysis of the basalt (Skey):—

Silica	48·63	48·29	43·06
Lime	25·39	26·59	24·34
Alumina	20·70	20·47	11·47
Iron and manganese	Traces	Traces	7·24
Magnesia	2·93	0·85	9·06
Water	2·35	2·53	3·42
Loss	...	1·27	1·41
	100·00	100·00	100·00

LEUCOPYRITE !—Thames, Reefton, Collingwood, with mispickel (Cox).

LIMONITE ! ! !—Whangarei, Parapara River, Shotover River, Collingwood, in massive earthy botryoidal, mammillary, and concretionary forms (Geol. Surv.).

MAGNESITE !—Rotorua, crystalline (Cox, 1878); Chatham Islands, massive (Smith).

MAGNETITE ! !—Lake Wakatipu, Mount Cook, disseminated through various rocks in minute crystals and grains (Haast), 72 per cent. iron (Skey).

MALACHITE—Moke Creek, D'Urville Island, occurs as thin encrusting films on some copper-ores (Hector, Cox). Analysis (Skey):—

Copper	58·20
Iron	1·10
Silica	3·33
Sulphur	Traces.
Carbonic acid and water	37·37
	100·00

Manganite ! !—Tory Channel, Kawarau, Clutha, Otago, Waiheke, Waimarama, Wellington, Waipu, "in veins in schists," "as rolled fragments in alluvial drift." Analysis (Skey):—

Sesquioxide of mauganese	63·42
Sesquioxide of iron	6·66
Alumina	Traces.
Silica	7·25
Sulphur	Traces.
Water (hygroscopic)	10·22
Water (constitutional)	12·45
	100·00

Margarite !—Milford Sound, in schists and gneiss (Hector).

Meerschaum !—Dun Mountain, in contact with massive white quartz (Davis). Analysis (Skey):—

Silica	53·76
Lime	2·36
Alumina	4·35
Iron-oxides	Traces.
Magnesia	20·36
Water of constitution	19·17
	100·00

Mellite !—Bligh Sound, from a cave (Hector, 1863); Thames, described as a resinous substance with a splintery fracture (Hutton, 1870).

Menaccanite !—Brancepeth, Wairarapa, occurs associated with feldspar (Skey).

Mercury !—Waipori, Bay of Islands, Westport, occurs in alluvial wash in the form of small thin globules (Hector); contains 99·54 per cent. of mercury.

METEORITE, or METEORIC IRON !—Wairarapa. Hardness 5–6, specific gravity 3·254, weight 9¼ lb., contents 49 cubic inches; containing 24 per cent. iron, with silica, sulphur, nickel, &c.

MICA ! ! !—West Coast, in all schists; Charleston and Stewart Island, in granite as large plates.

(Biaxial or *Potash)* !—West Otago, in schists (Hector).

(Uniaxial or *Biotite)* !—Dusky Inlet, Milford Sound, a black-green mica rock with numerous minute crystals of zircon (Hector).

Chrome Mica !—Dead-horse Gully and Dusky Sound, in flat tabular plates (McKay, Skey). Analysis (Skey 2):—

Specimens from	(I.) Schwartzenstein.	(II.) Dead-horse Gully.
Silica	47·68	39·25
Alumina	15·15	22·12
Chromic oxide	5·90	1·56
Ferric oxide	5·72	18·69
Manganous oxide	1·05	0·41
Magnesic oxide	11·58	10·60
Sodic oxide	1·17	1·13
Potassic oxide	7·27	
Water	2·86	4·06
Lime	..	2·18
	98·38	100·00

MISPICKEL !—Milford Sound, Waipori, Malvern Hills, Collingwood, Thames, associated with gold (Hector, Hutton, Cox). Analysed by Skey.

MOLYBDENITE !—Dusky Sound, as flakes in a gneiss rock (Docherty, 1880); also at the Thames (Allen).

MUSCOVITE, or MICA ! !—Snowy Peak Range, Milford Sound, Charleston, Dusky Bay, Great Barrier Island, as a common constituent of mica-schist, gneiss, and granite.

NATROLITE !—Dunedin, in vesicular basalts (Hector); Banks Peninsula, in volcanic rocks (Haast); also in cavities of basalts from Dunedin (Hector); Mount Livingstone, Lookout Point, Whakahara.

OBSIDIAN, or VOLCANIC GLASS ! !—Mayor Island, Banks Peninsula, Mount Eden, Taupo Island, associated with rhyolites and on the sides of trachyte dykes (Hochstetter, Hector).

OLIGOCLASE !—Mount Misery, Malvern Hills, Snowy Peak Range, in quartz-porphyries (Haast, Daintree).

OLIVINE, or CHRYSOLITE ! !—Mandamus district, Hurunui district, in dolerites (Liversidge, Hutton); Banks Peninsula, Chatham Islands, as grains in basaltic rocks (Haast); Saddle Hill, Milford Sound, in basaltic rocks (Hector, 1862).

OPAL ! !—Mount Somers, Malvern Hills, inferior qualities only.

Common Opal and Semi-opal ! !—Malvern Hills, filling small cavities in quartz-porphyries (Cox, Haast).

Fire Opal ! — Otago Peninsula, in tuffs, collected by Captain Fraser, determined by Skey; also in Tairua Valley, Thames.

Opal Jasper ! !—Portobello, Otago, in trachytic tufa (Liversidge).

Pitch Opal ! !—Dunstan, Rakaia Gorge, Harper's Hill (Liversidge).

Wood Opal, or *Silicified Wood* ! !—Mount Somers, Canterbury, Coromandel, occurs in tuffs and conglomerates and where siliceous rocks are decomposing (Haast, Hochstetter).

Geyserite ! !—Rotorua (Hochstetter).

Hyalite ! — Banks Peninsula, Malvern Hills, found lining cavities in volcanic rocks (Haast): Dunedin, in vesicular grey trachyte (Liversidge).

Menilite ! !—Bay of Islands.

ORTHOCLASE, or POTASH FELDSPAR ! !—Mount Misery, Banks Peninsula, West Coast, Auckland Islands, Ruapuke, Great Barrier Island, Sugar Loaves, Boulder Bank, Nelson, Hororata district, Dusky Sound, as a constituent of granites, syenites, gneiss, trachytes, and rhyolites.

OZOCERITE ! — Dunstan, Otago, occurring in brown coals (Hacket, 1865).

Spherulite and Obsidian, Road to Wires, Hikutaia Valley, Thames County.

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PALAGONITE ! !—Harper's Hill, Two Brothers, Taipo Hill, as angular fragments in palagonite tufas (Haast). Analysis (Skey):—

Silica	38·82
Alumina	23·12
Iron-oxide	6·30
Lime	3·65
Magnesia	3·27
Alkalies	2·08
Water	22·76
Carbonaceous matter	Traces.
	100·00

PEARL SPAR !—Thames (Hector, 1878).

PETROLEUM ! !—Sugar Loaves, Taranaki, from deep-seated coals, altered by volcanic dykes. A specific gravity, 0·960 to 0·964, rich in lubricants (Hector, Geol. Rep., 1866); Poverty Bay and Waiapu, deep wells and surface springs from Middle Jurassic strata (Hector, Geol. Rep., 1873). Paraffin-oil, sp. gr. 0·843 to 0·872, yielded 64 per cent. to 84 per cent. kerosene (Skey); also at Kotuku, Lake Brunner.

PICROLITE !—Dun Mountain, coarsely fibrous, of a dark-green colour (Cox).

PICROSMINE !—Dun Mountain, associated with chromite, and is also found as a network of veins in which crystals of bronzite occur (Cox).

PIMELITE !—Malvern Hills, Clent Hills, filling cavities in amygdaloidal rocks (Haast).

PISTACITE !—West Coast, Mount Torlesse, Mount Somers, Wairarapa, in gneiss, granite, and granulite, and in melaphyres (Hector, Haast).

PITCHSTONE !—Mount Somers, Snowy Peak, associated with quartz porphyries (Haast).

PLANTINIRIDIUM !—Takaka, Orepuki, as grains in gold-wash (Hochstetter).

PLATINUM (NATIVE) !—Collingwood and Takaka, Nelson (Hochstetter); Orepuki, Stewart Island, in the form of small flat grains of a steel-grey or white colour, associated with gold and zircons in southern goldfields, but it has never been found in reef (Hector); also at Round Hill, Southland.

PREHNITE !—Moeraki, Otepopo, Canterbury, in trap rocks (Hector, Daintree).

PROUSITE !—Thames (Hutton).

PSILOMELANE ! !—Waiheke, Waimakariri, Bay of Islands, Kawau, Wellington, massive, and is associated with manganite, forming a valuable ore. Analysis (Skey)—sample from Bay of Islands:—

Manganese oxides	75·46
Ferric oxide	11·76
Siliceous matters	2·74
Water	10·04
	100·00

PUMICE ! ! !—Tongariro, Tokaanu, Lake Taupo, Kereru, Ruapehu, &c., along the coast and on the banks of rivers, and on the plateau round Lake Taupo, 2,000 ft. above the sea-level; occurs also as pumice sand (McKay) at Kereru.

PYRITES (AURIFEROUS) ! !—Thames, Otago, as octahedral crystals in quartz reefs.

QUARTZ—*Amethyst* ! ! !—Rakaia Gorge, in an amygdaloidal trap; Canterbury, in the melaphyres (Haast).

Cellular Quartz ! !—Thames.

Ferruginous Quartz ! !—Abundant (Lab. and Geol. Reports, 1865).

Milk Quartz ! !—Everywhere, in the granites, schists, and slates.

Rose Quartz ! !—Rakaia Gorge, in trachyte and pitchstone (Haast).

Bloodstone !—Clent Hills, Snowy Peak, Malvern Hills, in small fragments (Haast).

Carnelian ! !—Malvern Hills, Mount Charles, Otago, in volcanic rock (Hector).

Chalcedony ! !—Canterbury, Clent Hills, Gawler Downs, Tokatoka, Moeraki, Otepopo, &c., in "geodes" in the "melaphyres" and quartz-porphyries (Hector, Haast, Hochstetter).

Chrysoprase !—Moeraki, Otepopo, Dunedin, Canterbury, Coromandel, filling cavities in amygdaloidal rocks (Haast).

Flint ! !—Kaipara and Clarence Valley, in chalk-marls (Hector); Campbell Island, in chalk (Hector); Amuri Bluff, in limestone (Haast); Bay of Islands, Tapanui (Liversidge), (see Trans. N.Z. Inst.); Whangarei, in diatom. earth (Hector).

Jasper ! !—Coromandel, abundant in volcanic and porphyritic rocks (Hector); Snowy Range, as porcelain jasper (Haast); Auckland, in tuffs and conglomerates (Hochstetter).

Agate Jasper ! !—Coromandel, in trachytic tuffs (Hector).

Plasma ! !—Mount Somers and Gawler Downs, filling fissures in Tertiary quartzose trachyte (Haast); Moeraki and Otepopo, in volcanic rocks (Hector).

Potato Stone or *Geode* !—Snowy Ranges (Haast).

Pearl Sinter !—Rotorua.

Prase !—Gawler Downs, as small deposits in quartzose porphyritic trachytes (Haast, 1865).

Rock Crystal ! ! !—Tamata, Kereru, Napier, Taupo, Canterbury, Milford Sound, in metamorphic schists, and derived from rhyolitic rocks (Lab. and Geol. Reports).

Siliceous Sinter ! !—Orakeikorako, surrounding thermal springs (Hochstetter); Te Tarata, in terraces.

Siderite ! !—Mongonui, in cover of brown-coal beds (Hector, 1866).

Tridymite ! !—Lyttelton Harbour, in trachytic rocks (Ulrich).

RETINITE, or AMBRITE ! !—Hyde, Caversham, Tuapeka, Waitahuna, Dunstan, Bay of Islands, occurs as masses of altered kauri-gum in brown coals. First mentioned by Hochstetter, also Hector (Geol. and Lab. Reports). Mean of three analyses by Richard-Maly:—

Carbon	76·65
Hydrogen	10·38
Oxygen	12·78
Ash	0·19
	100·00

RHODONITE, or MANGANESE SPAR !—Canterbury, Kawarau, Clutha, Dunstan, Waiheke, as veins in schists and as rolled fragments in alluvial drifts (Haast, 1865). Analysis (Skey):—

Silica	25·20
Sesquioxide of iron	40·10
Protoxide of iron	1·20
Protoxide of manganese	18·85
Alumina	7·20
Copper	Traces.
Lime	3·02
Magnesic oxide	3·00
Water (constitutional)	1·43
	100·00

RUBELLANE !—Banks Peninsula (Haast).

SAPPHIRE !—Southern Alps and Collingwood, in alluvial-gold beds (Haast, Hutton); determined by Skey.

Emery—Stewart Island.

SAUSSURITE !—Mount Torlesse, in gabbro (Haast).

SCHEELITE ! ! !—Lake Wakatipu, Buckler Burn, Rees River, Waipori, Richardson Mountains, Havelock, solid lodes and large rolled fragments, and in arsenical pyrites in the form of small grains (Hector 1863, McKay 1880); also at Macrae's Flat, Otago, and Top Valley, Marlborough.

SCHILLER SPAR !—West Coast, with iron-pyrites (Hector).

SCHORL !—Bedstead Gully, Mosquito Hill, Resolution Island, in gneiss and in micaceous and hornblendic schists (Hector).

SCHRÖTTERITE !—Malvern Hills, filling the cavities in amygdaloidal trachytes, having a mammillated crust on its surface (Liversidge).

SELENITE, or GYPSUM ! !—Widely distributed throughout Canterbury, Auckland, Nelson, New Plymouth, &c., as groups of crystals associated with sulphur, or as nests of crystals in clay or marls. It is very plentiful, and is mentioned several times in the Geol. Surv. and Lab. Reports.

"SELEN - SULPHUR" ! — White Island, massive dark - yellow varieties of sulphur (Liversidge, Trans. N.Z. Inst., Vol. X).

SERPENTINE, or MARMOLITE—Mineral Belt, Nelson, and Dun Mountain, as common serpentine forming rock masses (Hochstetter); Milford Sound, noble serpentine occurring with nephrite in thin veins (Hector). Analyses (Skey):—

Silica	40·20	41·20	45·91
Protoxide of iron ...	12·10	12·10	1·67
Alumina	Traces	Traces	5·63
Manganese ...	Traces	Traces	Traces.
Chromium ...	Traces	Traces	Traces.
Magnesia ...	33·20	34·02	35·07
Water (constitutional)	12·70	12·94	12·67
	98·20	100·26	100·95

SILVER ! !—Kawau Island, Lake Wakatipu, Waipori, also commonly alloyed with gold and as a component of tetrahedrite; Golden Crown Mine, as rolled fragments.

SMARAGDITE !—Red Hill, Collingwood, in diorite (Hector).

SPHÆROSIDERITE !—Mount Somers, Banks Peninsula, in volcanic and dyke rocks (Haast).

SPINEL—Manawatu and Waipori, Otago, Mount Somers, Canterbury, as rhombic dodecahedrons, nearly opaque (Hector).

STEATITE, or SOAPSTONE ! !—Milford Sound, massive; Collingwood, foliated (Hector).

STIBNITE ! !—Otago, Endeavour Inlet, Reefton, Langdon's (Hector, 1865); Thames (Hutton, 1867); Endeavour Inlet (Cox, 1879), in schistose rocks.

STILBITE ! !—Karori, Mangawai, Tokatoka, Dunedin, as radiating pearly crystals forming films in joints of auriferous rocks (Skey), also in trachytic rocks as detached crystals (Haast, Liversidge).

SULPHUR ! ! !—White Island, deposited from fumaroles and geysers and from an enormous spring in the centre of White Island (Hector, 1865); Rotorua and Taupo districts, from hot springs (Hochstetter); Waipara, efflorescence from carbonaceous sandstones (Haast, 1870), efflorescence from pyritous reefs (Davis); Wangapeka. Analyses:—

	Liversidge.		Cox.	
Sulphur ...	99·614	98·888	99·9	62·5
Foreign matters ...	0·386	1·112	0·1	37·5
	100·000	100·000	100·0	100·0

TACHYLITE !—Banks Peninsula, Oamaru, on the sides of fissures where basaltic dykes have intruded (Haast).

TALC ! !—West Coast, South Island, Jackson's Bay, Collingwood, in quartz, and associated with crystalline rocks (Hector).

TARANAKITE !—Taranaki, very much like wavellite; is a double hydrous phosphate of alumina and potash, part of the alumina being replaced by ferric oxide; discovered and described by Skey as a new mineral. Analysis (Skey):—

Phosphoric acid		35·05
Alumina		21·43
Ferrous oxide		4·45
Lime		0·55
Potash		4·20
Soda		Traces.
Chlorine		0·46
Sulphuric acid		Traces.
Insoluble in acid (silica)		0·80
Water driven off at 212° ...	15·46	33·06
Water driven off at red heat ...	17·60	
		100·00

TETRAHEDRITE !—Collingwood, variety *Richmondite*, occurs as a lode at Richmond Hill. Analysis (Skey):—

Sulphide of lead	36·12
,, antimony	22·20
,, bismuth	Traces.
,, copper	19·31
,, iron	13·59
,, zinc	5·87
,, silver	2·39
,, manganese	0·52
	100·00

TIN ! — Reefton, in quartz - grit (alluvial) (McKay, 1874); Stewart Island, in mica-gneiss (Prof. Black, 1888).

TOPAZ !—Chatto Creek, Arrow River, Waipori, in alluvium, mixed with rubies, garnets, &c. (Hector); Stewart Island, with tinstone (McKay); determined by Skey.

TREMOLITE !—Kanieri, Hokitika, Milford Sound, in quartzite (Hector).

VIVIANITE !—Dunedin, Awatere, as prismatic crystals in moa-bones (Hector).

WAD ! !—Auckland, Otago (Hector, 1864); Stewart Island, (McKay, 1886).

WAVELLITE !—Taranaki, occurs in thin seams of a deep yellowish-brown colour, hard, translucent and infusible, traversing the taranakite in various directions (Skey).

WITHERITE, or BARYTO-CALCITE !—Thames, in gold-mines (Skey).

WOLFRAM ! !—Stewart Island, with tinstone (McKay, 1889).

WOLLASTONITE !—Dun Mountain, massive in form. Analyses (Skey):—

Silica ...	48·01	49·30	50·62	58·80
Lime ...	46·20	45·91	44·88	24·60
Magnesia ...	Traces	0·80	Traces	1·60
Alumina ...	1·45	1·41	1·84	12·20
Iron-oxide	Traces	Traces	1·64	
Loss ...	2·19	1·19	Traces	1·40
Water ...	2·15	1·39	1·02	1·40
	100·00	100·00	100·00	100·00

WULFENITE !—Dun Mountain, as crystals of a flat tabular form.

ZINC-BLENDE !—Bedstead Gully, Tararu Creek, Great Barrier Island, associated with gold (Hector, Hutton). Analysis (Skey):—

Sulphide of zinc	77·61
,, cadmium	Traces.
,, iron	20·14
Siliceous matter	2·25
	100·00

ZINCITE !—Collingwood (Skey).

ZIRCON !—Southern Alps, Timbrel's Gully, Doubtful Inlet, associated with platinum and gold and in the wash, and also in biotite rock (Hector).

PETROLEUM IN NEW ZEALAND AND AMERICA.

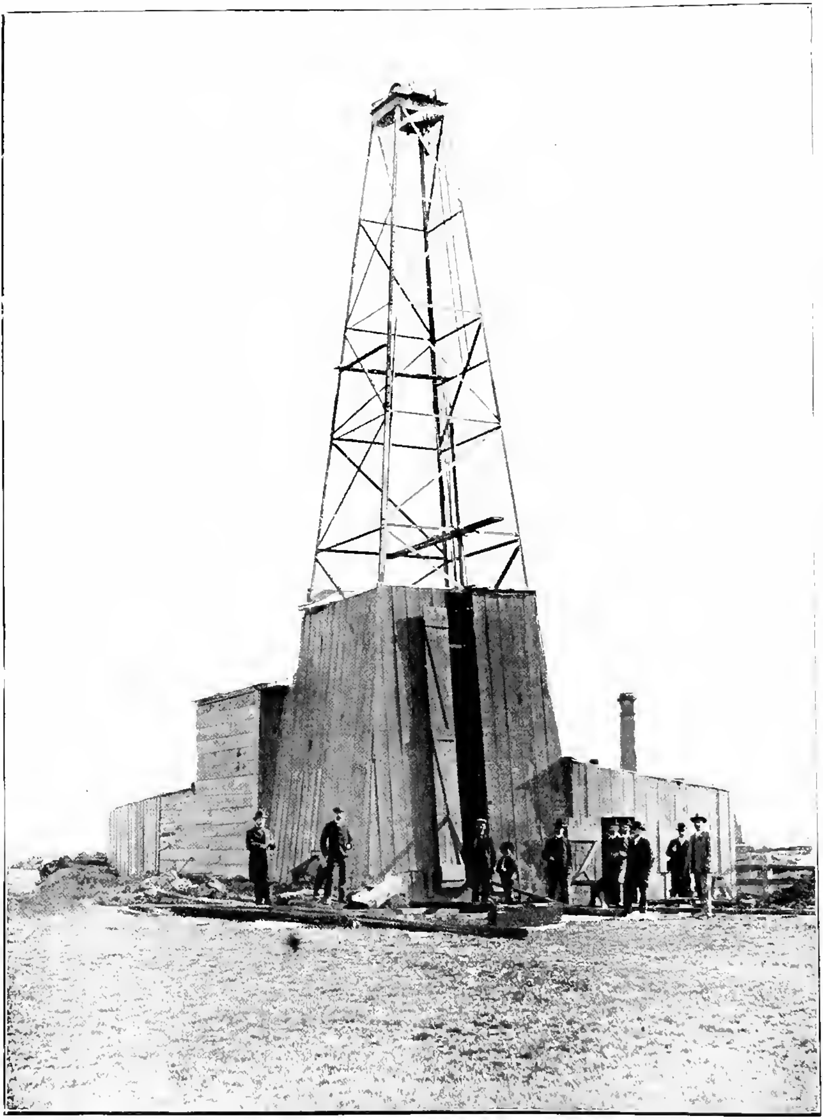
Some Notes as to its Occurrence in New Zealand, and the Efforts made to develop it.*

By Henry A. Gordon, F.G.S., late Inspecting Engineer, Mines Department, New Zealand.

A considerable amount of money has been from time to time expended in New Zealand in prospecting for petroleum—at the East Cape, near Gisborne; at Taranaki; and on Molloy's Pakihi, between the Brown River and Deep Creek, both of which are tributaries of the Arnold River on the West Coast, exudations of petroleum are found on the surface, and in some instances accompanied by large emissions of methane gas.

About twenty-five miles to the south of Gisborne there are exudations of petroleum on the top of a low hill, and large quantities of paraffin wax or butter, imbedded to a considerable depth through the soil. A shaft was sunk on this hill, and several barrels of petroleum got out of it. A bore was started from the bottom of the shaft, but, the ground being of a loose character, a great pressure of gas was met with, the bore could not be put down, or at least abandoned, and another bore was commenced in the valley, which went to a depth of 1,400 ft. without meeting with any success. Gas was met with in the bore, and it was said by those in charge of the boring operations that a little oil was struck. This is open to question, as it was asserted that a quantity of the oil which was exuding into the shaft on the hill previously referred to was brought and put into the bore after the operations were suspended. Previously, however, to suspending operations the drill broke in the bore, and could not be withdrawn. The gas, it was

* Paper contributed to the *New Zealand Mines Record*, 16th March, 1903.



Derrick at Moturoa Petroleum Company's Works, near New Plymouth. Boring for Petroleum Oil.

Mining Handbook.

said, came out of the bore and found its way to the furnace of the boiler and caught fire, burning the plant and derrick, so that no one could tell really how the disasters occurred beyond the man in charge of the plant at the time of the fire.

At Taranaki petroleum could be seen oozing out of the seashore at low water, with bubbles of gas, and in fine weather it could be seen on the surface of the sea between the wharf and the Moturoa Island. A shaft was sunk for some distance above high-water mark, and several barrels of oil were obtained therefrom; but it was alleged that the water in the shaft rose and fell with the tide. A borehole was put down near this place to a considerable depth, but was abandoned, and another bore drilled, some distance back from the beach, to a depth of about 2,000 ft. without meeting with success. Two other bores have been put down on the low flat terrace about 20 chains back from the sea-beach to a depth of nearly 2,000 ft. Oil was struck in one of them, but, as the flow was not considered sufficient, the bore was drilled below the oil stratum, when water was met with, and the pressure at which the water came into the bore had the effect of damming back the flow of oil they had previously struck, only allowing small quantities to come up with the water, which was led into a large tank, and the oil, when gathered, was skimmed off the surface.

The latest find of petroleum exudations on the surface is on the north side of Deep Creek, opposite about the centre of Molloy's Pakihi. It is seen here in three or four places at the side of a small stream about 5 chains from Deep Creek, and again in the bed of a small stream in a by-wash of Deep Creek, about 25 chains further up the stream than the former place. It has also been found at the bottom of a bore put down for about 144 ft. through a compressed mud-deposit in a layer of quartzose sand which rests on sandstone. It may also be mentioned that where the petroleum is oozing out in the bed of the stream in a by-wash of Deep Creek there is a considerable quantity coming out at this point; if the water was diverted, and it was possible to sink a shallow hole at this place, several barrels of petroleum could be easily procured.

Such is an outline of the efforts made to test the oilfields in this colony. Boring for petroleum is a subject which very few persons in New Zealand are acquainted with, and, moreover, as the origin of petroleum has never been definitely settled, it makes it harder for those who have had no experience in connection with the formation in which oil is found to have any definite idea whether it is likely to be produced in payable quantities or not. Some scientists hold that petroleum has its origin in marine animal organisms, while others contend that it is both of animal and vegetable origin. Until this question is finally settled we are in a dilemma as to where we are likely to strike a large supply. We can only arrive at certain conclusions as to where it is found in other countries:—

1. We know that petroleum has never been found in Archæan rocks, which contain but few fossils of animal organisms or vegetable remains.

2. We know that it has been found in the Silurian formation, which in a measure proves that marine organisms—such as saurians, cuttlefishes, and coralloid animalculæ, &c.—have at least contributed petroleum.

3. The question of petroleum being also derived from the decomposition of vegetable matter seems to me of little doubt, as petroleum can be seen throughout the great depth of peaty mud in small cavities, and is in large globules at the hot springs at Ohaeawai, north of Auckland. There are at that place jets of steam issuing out of the ground, and also large quantities of sulpho-carbonic-acid gas. The heat in the ground has distilled the petroleum out of this peaty mud, which is purely of decomposed vegetable origin. Petroleum is found in the immediate vicinity of coal-beds in Pennsylvania, and it is also distilled from shale overlying coal-beds. Notwithstanding that the consensus of scientists' opinions is in favour of petroleum being derived from marine animalculæ, it cannot be contended that it is the only origin; but it may have contributed largely to its supply. It may be said therefore that petroleum has its origin in both animal organic remains and also in a transformation of vegetable matter.

4. The distillation of petroleum has been effected either at high temperatures or under great pressure, and, as far as we know, it is to the latter that its distillation may be attributed, as we know of no highly heated beds or rocks in which it is found, although it has been got at the base of volcanic rocks; but, whether by heat or pressure, the chemical process it has undergone yet remains in oblivion.

In regard to the formation of natural gas, William T. Brannt states that "the same materials, and similar processes as for the formation of petroleum, may be presupposed. The accumulation of both also took place in the same spaces, frequently in such a manner that the gas occupied the higher and the oil the lower sections of the same rock-stratum. No process being known by which petroleum can be formed into natural gas, while the separation of the latter from the former —even at the ordinary temperature—is a well-known fact, it is very probable that petroleum is the primary, and gas the secondary, product, while ozocerite, or paraffin, is formed partially by vaporisation and partly by oxidation of petroleum."

In regard to the probabilities of petroleum being found between Deep Creek and Brown River, in the vicinity of Kotuku, on the West Coast, the formation of the country has to be considered. About a mile and a half higher up Deep Creek than where the oil is exuding at the surface the creek enters a gorge with very high sandstone-rock banks on each side, having the dip of the strata in a north-easterly direction. On the south side the rocks are broken away as though a dislocation had taken place, and the ground depressed for about 150 ft. Some 10 or 15 chains below the mouth of the gorge the strata in the bed of the creek lie almost horizontal, but below this dip in an opposite direction, mainly south-west towards Lake Brunner. About a mile and a half further down the creek the Gisborne syndicate put down a bore for about 144 ft. through compressed mud, with a loose band of quartz sand directly overlying the hard sandstone, and in this loose layer of sand there is a considerable quantity of methane, or carburetted-hydrogen gas (CH_4), issuing therefrom, and also a certain quantity of oil, from which several barrels have been filled; but there is not a sufficient flow to make it a payable venture. This bore was shut down when the oil was struck, and another started about 2½ chains distant; but, strange to say, very little oil was met with in this bore under the silt or mud bed. This hole is now being drilled in the hard sandstone, and is down at least 420 ft. The water coming out of the first borehole was saline, and contained a little magnesia; but no shells or fossils could be seen to denote whether this deposit of silt is of marine or lake origin. It is plainly to be seen, however, that the land from near the foot-bridge across Deep Creek, on the No Town – Bell Hill Road to Lake Brunner, had at some former period been submerged. The silt-bed was formed in water, but the loose layer of quartzose sand underlying the silt has the appearance of being washed by a slightly flowing stream. Be that as it may, the sandstone rock appears to be gradually dipping towards Lake Brunner, where a greater depth of this silt will have to be gone through as boring is carried on in a south-west direction. To make this clear, the silt-bed commences about a mile and a quarter higher up the creek than where Mr. Cooper* put down his first bore, and where 144 ft. of silt was passed through. He is also putting down another bore about 60 chains further to the south-west, which will have about 220 ft. of this silt to go through—that is, assuming that no faulting or dislocation of the rock has taken place between the two boreholes.

The sandstone underlying the silt is of the same character as seen in the gorge of Deep Creek—namely, sandstone with alternate bands of conglomerate and gravel, resembling what is known as the "Brighton bottom." In the vicinity of No Town, Red Jack's, and Nelson Creek these beds are of a great thickness, overlying the Maitai slate formation. It is, therefore, a question whether there are sufficiently porous bands in this sandstone to contain petroleum, and whether the substance is in these rocks from which petroleum is derived.

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* Mr. William Cooper, since deceased, was a sheep-farmer in Poverty Bay, and had associated with him Messrs. J. D. Ormond and R. D. McLean, sheep-farmers, of Hawke's Bay, who are still interested in oil-boring operations at Kotuku, near Lake Brunner, West Coast.—EDITOR MINING HANDBOOK.

In countries where petroleum has been found the denser oils have been got near the surface, and the lower oil-beds, as is the case in Pennsylvania, contain a much higher percentage of the light illuminating-oil; and the same thing may be expected in any oilfield as vaporisation and oxidation of the oil takes place. The oil near the surface becomes more of a lubricant than of an illuminant.

In all the oilfields in the world petroleum is found in belts, some of which are of considerable width; but, taking into consideration the broken nature of the country in New Zealand—being full of rents, faults, and dislocations—we need not expect that petroleum will be found here in wide belts, nor that the oilfields will be of large extent; but there is no reason why a considerable supply should not be obtained.

PETROLEUM IN TARANAKI.*

Its Early Discovery, and Attempts to Secure it.

Before the first white settlers came to Taranaki—apart from the whalers who lived near, or periodically visited, the Sugar Loaves—oil had been noticed floating on the water around these islands. Dr. Dieffenbach, who visited the locality in 1839, speaks of "a strong smell of sulphuretted-hydrogen gas about a mile from high-water mark." The Natives, he said, had a whimsical story of an *atua* (spirit) who, they say, was drowned here, and is still undergoing decomposition. Mr. Charles Hursthouse also mentions it in his book on Taranaki, and many of the earliest settlers can remember how the water around the Sugar Loaves was sometimes covered with a scum of oily matter, while one had only to disturb a stone on the beach to find beneath it a similar deposit of oil, which was pronounced to be petroleum. No steps were taken, however, to find its source until towards the end of the year 1865.

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* *Taranaki Herald* and *Budget*, 19th May, 1906.

About that time four men, Messrs. J. F. Carter, J. R. Scott, J. Smith, and — Ross, applied to the Provincial Council for a lease of certain lands for the purpose of prospecting, and on the 22nd December, 1865, the Council proposed to grant a lease, in the terms of which the company was to be allowed to occupy 50 acres of the most easterly part of the Sugar Loaves Reserve, divided from the remainder by a line parallel to the Paritutu line, giving about half a mile of sea-frontage from the stream at Honeyfield's farm, the company to have the use of this land for the purpose of prospecting for and working petroleum only, and not in such a manner as to interfere with the use of the land by the Government or any person authorised by the Government for other purposes: Provided that if any well sunk and yielding petroleum, or any building erected with the approval of the Government, shall be found in the way of any public works, the company shall be compensated for any loss they may suffer by the closing of the well or the removal of the building. The exclusive use of the land for the purposes specified was to be granted to the company for two years without royalty or charge of any kind, whether petroleum was found in saleable quantities or not, on the condition that the company shall sink or bore to a depth of not less than 120 ft. from the surface during the first year, and not less than 240 ft. from the surface during the two years, unless petroleum in workable quantities shall be found at a less depth. Should the oil not be found before reaching the depth of 240 ft. the company to be allowed to continue in occupation on condition of reaching a further depth of 120 ft. for each additional year, the royalty commencing whenever the oil was produced in saleable quantities. A royalty, varying according to the depth, was to be paid on the refined produce after the expiration of the first two years, the rate of royalty being also regulated to a certain extent by the success of the undertaking, and not in any case exceeding the following rates: If the oil found within 120 ft. from surface, 7 per cent.; from 120 ft. to 240 ft., 6 per cent.; from 240 ft. to 360 ft., 5 per cent.; from 360 ft. to 480 ft., 4 per cent.; below 480 ft., 3 per cent.

On the 20th February, 1866, the Provincial Council adopted these terms, which the company had practically accepted by commencing work some weeks previously.

The Genesis of the Industry.

Near the end of 1865 Messrs. Carter and Co. commenced sinking a shaft on their lease, just about where the blacksmith's shop now stands at the root of the breakwater. And here let it be stated that Mr. E. M. Smith, M.H.R., may be regarded as the father of the industry, for it was he who directed the attention of "Tinker" Smith, one of the four men named, to the deposits of oil on the beach, and recommended him to exploit it, for "Tinker" Smith was fond of talking of his exploitations of gold, &c., before he came to Taranaki. On the 18th January, 1866, a report spread through the town that the party had met with sudden success. They had got down 20 ft., and found gas coming up in such quantities that they could not work with any comfort in the shaft until they had got a windsail in operation to ventilate it. Indeed, one of the men was so overcome with the gas that he had to be removed to the hospital for treatment. So impressed were the people with the prospects that the Provincial Treasurer, in his financial statement on the 13th February, 1866, referred to "the sanguine hopes entertained of the discovery of the natural reservoir of the petroleum that oozes out at the Sugar Loaves."

About this time, too, the *Hawke's Bay Herald* announced that specimens of petroleum, or rock-oil, had been brought into Napier from the Native country.

On the 17th March, 1866, the *Taranaki Herald* reported that the well was down 60 ft., and that small quantities of oil had been secured. Just a week later, in an editorial, the *Herald* said, "We reported last week that the enterprising men (Messrs. Carter, Smith, Scott, and Ross) at work at the Sugar Loaves had been so far rewarded for their trouble as to find the genuine oil. The oil is thick, and of a greenish-brown colour; it has the genuine kerosene smell, but not so strong as the purified oil. The men had got down just 60 ft. when the oil, which they had met with at several points on their progress downwards, began to ooze out in more respectable quantities, but the bottom of their shaft began to feel so shaky, we believe, that they decided to carry on their further operations by boring." At the top of their shaft was displayed a signboard bearing the legend—

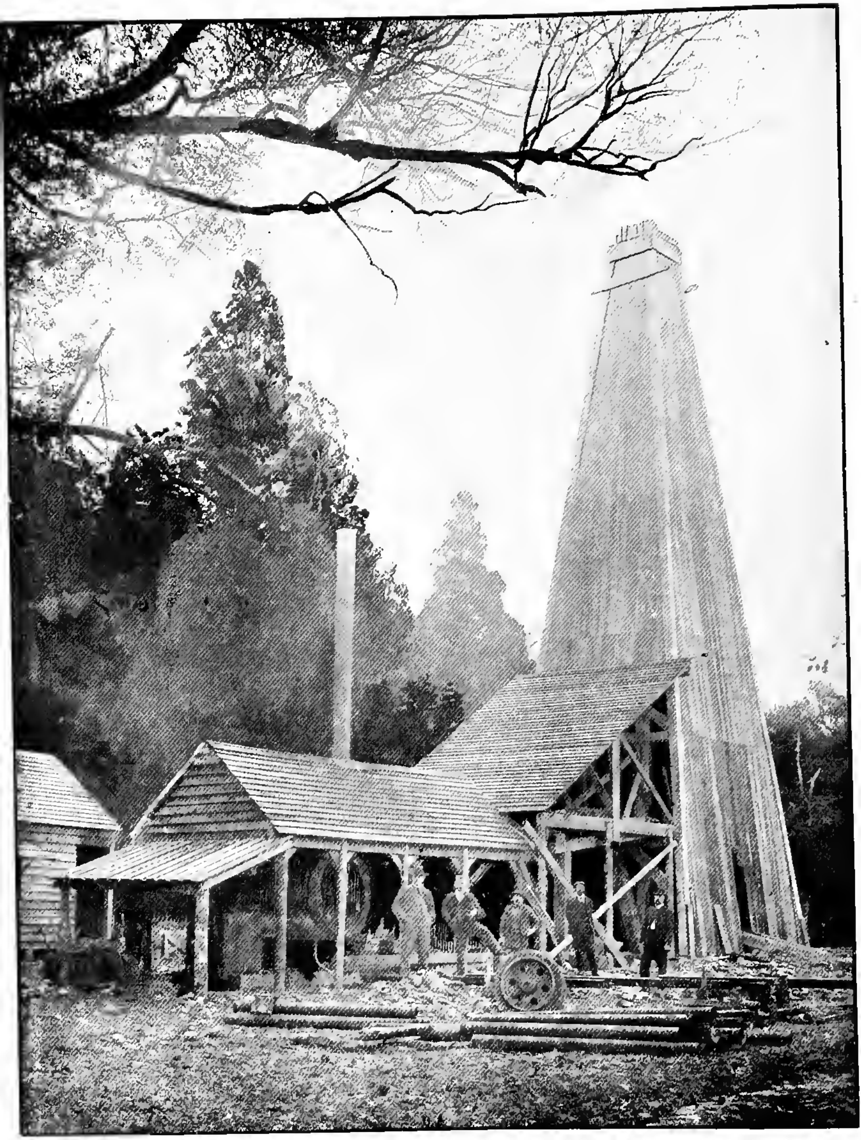
"*To Oil or London*";

and it was in that spirit that they persevered—a spirit which has from time to time animated other prospectors, with little more success than Mr. Carter and his partners achieved.

On the 5th April, 1866, the Provincial Council extended the lease to nine years without payment of royalty.

Foreign Speculators.

The indications and prospects secured by this little company soon attracted outside attention, and Messrs. Bates, Sisely, and Co., of Melbourne, applied for boring-rights, which led to a public meeting on the 10th April, said to be one of the largest meetings held up to that time in Taranaki, passing resolutions protesting against the proposal of the Provincial Council to grant them a lease. The Council proposed to give Messrs. Bates, Sisely, and Co. the right for nine years to prospect or sink for petroleum over the remainder of the Sugar Loaves Reserve, the islands Mikotahi, Pararaki, and Motu-o-tamaetea, a mineral reserve at the Henui River, a reserve on the beach south of the Waireka Stream, and all that portion of land between private lands and low-water mark extending from the north-east boundary of the mineral reserve at Te Henui to the western boundary of the reserve at Waireka, except the portion between Queen Street and Currie Street. It was also proposed to give Messrs. Bates, Sisely, and Co. the right to prospect a portion of the ranges for two years, at a rental of 1s. per acre in addition to royalty on oil, they, on their side, to undertake to raise a company with a capital of not less than £50,000, of which £10,000 was to be reserved for sale in this province, if the people desired it, and to pay a royalty of 10 per cent. of the oil obtained, delivered ready for exportation.



Kotuku Oil Association Plant: View of Derrick and Engine-shed; Derrick, 65 ft. high.

Mining Handbook.

On the 19th April, the Council, after a long debate, rejected the proposed terms by seven votes to five, the demand of the people to "keep the money in the place" apparently influencing some of the members. During the course of the debate, it may be noted, Mr. Thomas Kelly, who was in favour of the lease being granted, drew an alluring picture of "locomotives being driven by oil, and the waters of our future harbour at the Sugar Loaves ploughed by steam-vessels whose motive powers are generated by its combustion." Perhaps he may live to see his prophecy come true.

About the same time there were three other applications for prospecting rights before the Council, the applicants being Mr. Chilman and others, Mr. Johnson and others, and the People's Petroleum Company.

On the 28th April, 1866, the *Herald* reported that the Alpha Well (that being the name by which the well sunk by Mr. Carter and his partners was known) was down about 95 ft., and that oil in paying quantities had been obtained, but that they were going deeper, in hopes of making it a flowing well. At this time two other companies were formed to prospect for oil, but our narrative will be more intelligible perhaps if we follow the fortunes of each one separately, beginning with the

Alpha Well.

By the 19th May Messrs. Carter and Co. had bored to 115 ft., and in face of a most encouraging analysis from Dr. Sydney Gibbons, of Melbourne, who reported that the oil sent him was one of the finest samples of petroleum he had ever seen, they persevered, and erected a new derrick, 60 ft. high, over their shaft. For some weeks boring operations were suspended, but on the 7th August the depth was 145 ft., which was increased on the 25th to 174 ft.

On the 6th October, 1866, encouraging prospects were again obtained, an outburst of gas forcing the water out of the bore, and several gallons of oil being obtained. Shortly afterwards negotiations were commenced, which resulted in the well being purchased about the end of January by the Taranaki Petroleum Company, which carried on the future operations in the bore, and these will be chronicled with the doings of that company.

The People's Petroleum Company

was the second to commence operations. Promoted about the end of April, 1866, with a capital of £1,000, afterwards increased to £3,000, the company obtained a lease of 4½ acres at Moturoa, and on the 19th May received its boring machinery from Nelson. On the 24th May boring operations were commenced on the edge of the sandhills rising from the beach, about 200 yards from the Moturoa Pa, and about 500 yards by the beach from the Alpha Well. The bore was a 4 in. one, and operations were commenced with some little ceremony, the well being christened by Mr. T. Balfour, the name Victoria Well being given to it, the date being Her late Majesty's birthday.

On the 30th June, 1866, at a meeting of the shareholders, the following directors were elected: Messrs. Rundle, Carter, W. Humphries, Lawrence, Windsor, W. R. King, and Snell. (Mr. Humphries, it may be remarked, is a shareholder in the present company.)

By the 21st July the Victoria Well was down 90 ft. About this time, too, a report was circulated that oil-indications had been discovered in the Timaru Block, down the coast.

On the 3rd August, when at 15 ft., indications of oil were obtained. Boring went on satisfactorily until on the 1st September a depth of 165 ft. had been reached in the Victoria Well, and a second shaft had been sunk to a depth of 50 ft., about 150 yards to the south-west of the Victoria Well.

By the 15th September a depth of 180 ft. had been reached, with only slight indications of oil to encourage the company. Undeterred, however, they went on, and by the 13th December the depth was reported as 223 ft., which was increased to 310 ft. by the 11th January, 1867, when the half-yearly meeting was held. Six months later the bore was down 516 ft., and the company had spent £1,260. On the 12th October a special meeting of shareholders was held to consider a proposal made by Mr. Chilman, chairman of the Taranaki Petroleum Company, that the People's Company's funds should be expended, under the joint direction of the two chairmen, in boring the Beta Well. This was approved, and this practically brought the operations of the People's Company to a close, the company being wound up in August, 1868, after spending two-thirds of its capital, or about £2,000.

The Taranaki Petroleum Company.

On the 28th April, 1866, the prospectus of the Taranaki Petroleum Company was issued, with a capital of £10,000 in £10 shares, with power to increase to £100,000. The provisional directors were Messrs. R. Chilman (chairman), Warwick Weston, J. King, C. Brown, and J. C. Sharland, Mr. Weston acting as honorary secretary to save expense. He shortly afterwards resigned to proceed to England, Mr. R. C. Hamerton being appointed permanent secretary, and the vacancy on the Board being filled by Mr. Henry Weston, who is now associated with the present company as a director. Two days previously the Provincial Council had resolved to grant the proposed company the right to sink for petroleum on the part of the Sugar Loaves Reserve west of Carter's lease, 110 acres, also on Pararaki and Mikotahi. The shares were readily subscribed, a total of 1,671 shares being applied for. Towards the end of June operations were commenced by sinking a shaft (No. 1) on the beach near Mikotahi, a few feet above high-water level, and shortly afterwards another shaft (No. 2) was commenced on the beach to the south side of Paritutu, this being down to 51 ft. by the 7th July.

About this time Dr. Hector furnished a report on the subject, in which he stated that he looked for the real source of the oil in the coal-seams belonging to the brown-coal formation, which was supposed to form the base of the Tertiary strata that extend under Mount Egmont and the valleys of the Wanganui and other rivers which enter the sea along the coast between Mokau and Otaki. He calculated that in a vertical boring near the Sugar Loaves the succession of formations would be somewhat as follows: Volcanic breccia, 250 ft. to 300 ft.; newer Tertiary clays, 400 ft.; conglomerate and quartz cement, 100 ft; and older Tertiary marl-stones, 900 ft. He thought that it was just possible that oil and gas might have escaped upwards as far as the base of the three first-mentioned strata, in which case it would be collected in reservoirs at a depth, he surmised, of from 500 ft. to 700 ft., and possibly by following fissures might rise even to the surface. He found, however, no indication of the occurrence near the surface of the regular alternations of sandstones and shales which characterize the best oil-bearing formations, and he considered that boring would have to be carried to a very great depth before a constant or abundant supply of oil could be looked for.

To return to the operations of the Taranaki Petroleum Company, boring apparatus was received on the 12th July, 1866, by which time a third shaft had also been sunk to a depth of 50 ft. on the beach to the north of Mikotahi.

By the 18th August, No. 1 well was down 71 ft., and a week later to 155 ft., boring proceeding fairly rapidly. By the 15th September a depth of 300 ft. was reported in No. 1, and then progress became much slower, only an additional 10 ft. being bored by the 6th October, by which time a new shaft had been sunk on Mikotahi to a depth of 61 ft.

On the 7th January, 1867, the directors reported to the half-yearly meeting of shareholders that the company had spent £2,292, and had bored two holes to depths of 310 ft. and 318 ft. Three weeks later the company purchased the Alpha Well, from which on the 4th May the first barrel of oil was exported, being sent to Sydney. The yield of the well at this time was reported to be about 8 gallons a day, which was obtained at a depth of about 90 ft., the bore being plugged at 110 ft. and a pump worked.

On the 18th June oil was found at a depth of 80 ft. in a new bore, and on the 9th July there was some excitement over the fact of oil being obtained from the Alpha Well at the rate of 80 gallons a day. The yield did not last, however, falling off to one-tenth. At this time the *Herald* began to lament the apathy displayed, so that it was evident all but the most enthusiastic were losing heart.

At the half-yearly meeting on the 5th July, 1867, Mr. Chilman said the Alpha Well had yielded 50 to 60 gallons a week for a time, but fell off to 3 or 4 gallons a day. The new bore, at a depth of 91 ft., had obtained about 40 gallons of oil in ten or twelve hours, but then the yield fell off to the same as the Alpha Well. The new bore (called the Beta) was continued, and by the 7th December was down 380 ft. On the 21st January, 1868, the depth was 490 ft., and it was stated that oil-indications had been met with in the last 100 ft. By this time the company had spent about £3,800. By the end of February the depth was 510 ft., and the indications were very promising, when an accident occurred, the boring-tools being lost in the well. This caused much delay and discouragement, and on the 8th June, 1868, a meeting of shareholders decided to wind up voluntarily. The bore was down 684 ft., quartz cement being met with, but there were no further encouraging indications. Thus, after spending about £4,000, the Taranaki Petroleum Company came to grief, after boring one well to 684 ft., two others to 310 ft. and 318 ft., and sinking two shafts to about 60 ft. each.

Other Early Ventures.

In June, 1866, Mr. Julius Vogel (afterwards Sir Julius, who was connected with later ventures) obtained permission to prospect on the Saddleback, but he actually commenced to bore on ground adjoining Carter and Co.'s lease, and at 17 ft. encouraging indications of gas and oil were met with. No further record appears, however, to exist of his operations.

Some of the Omata settlers also prepared to sink shafts, but did not persevere, and this brings us to the end of the first chapter in the history of boring operations in Taranaki, nothing more being done until about 1888.

The Second Attempt.—Boring in 1888.

Nothing more was done to prospect for oil until 1888, when Sir Julius Vogel, Mr. Oliver Samuel, and others formed a company in England. Plant and drillers were sent out, and a bore was put down at the rear of the breakwater to about 875 ft., when oil was found. Then the boring-tools were lost in the bore, and after fruitless attempts to recover them operations were abandoned, though the driller, Mr. Booth, declared that he could then pump 160 gallons a day, and recommended drilling another 200 ft.

In 1894 Mr. Samuel, to whom great credit must be given for his pluck and persistency, formed a small syndicate in New Plymouth, and, after failing to reopen the last-mentioned bore, sank another a few feet further east to a depth of about 875 ft. Two or three barrels of oil per day was obtained at intervals, but the water could not be overcome, and the bore was abandoned. The next bore was at the Herekawe Stream, close to the main road to Omata, and was sunk to a depth of 1,534 ft. without the slightest indication of oil. A new bore was then started at Moturoa, about a quarter of a mile south-east from the first, at the back of Mr. J. G. Honeyfield's residence. At 908 ft. gas was struck in great volume, and at 910 ft. oil followed, yielding for a time at the rate of ten barrels a day. It suddenly stopped, however, on account, it was thought, of the soft papa above the oil-seam falling in. Drilling was resumed and oil was met with at 1,358 ft., 1,392 ft., and 1,675 ft. At 1,865 ft. soft sandstone was entered, and at 1,976 ft. oil was again met with in quantity, when a fire occurred and destroyed the works. Oil had been pumped at the rate of eight barrels a day, but the water was a difficulty, and oil only came at intervals. Some seventy barrels of oil was sold to the Railway Department at 15s. a barrel. On account of the water, however, the bore was abandoned and another started about 100 yards south-west. Oil and gas were again met with at between 900 ft. and 1,000 ft. At 1,785 ft. sandstone was entered, and at about 1,960 ft. the water was shut off for a time. At 1,963 ft. oil was struck, and again at 1,975 ft., but indications did not improve, and at 2,050 ft. drilling ceased and the bore was abandoned.

In April, 1899, a bore was started on Mr. H. Okey's property, Section 504, Grey district, about four miles south of the breakwater, but this was abandoned on account of the bore caving in, broken volcanic rock, gravel, and sand being met with at about 300 ft.

Another bore was commenced on Mr. Veale's property, about half a mile nearer Moturoa, but no indications being met with it was abandoned when a depth of 1,335 ft. had been reached.

A return was then made to Moturoa, where another bore was started about 200 yards from where the best results had previously been obtained. Oil and gas were met with from 908 ft. to 988 ft., also at 1,388 ft. and 1,452 ft. At 1,710 ft. the gas forced oil out of the bore over the derrick, but it did not continue. At 1,730 ft. oil and mud were again ejected over the derrick, and oil flowed for about an hour, then ceasing. Drilling was resumed, but the indications were lost, and at 2,052 ft. the bore was abandoned.

Still another attempt was made close by, but after boring to 1,055 ft. without result the syndicate, of which Mr. Samuel had been managing director, and superintended the actual operations for a long time, gave up the attempt in despair.

An Adelaide Syndicate.—Present Year's Operations.

In 1904 Mr. G. C. Fair commenced boring at the present site for an Adelaide syndicate, but when a depth of 2,100 ft. had been reached the syndicate, against Mr. Fair's advice, stopped operations, and sold the plant to a small company, with a capital of £2,000, formed in New Plymouth.

Mr. Fair's services were retained, and he continued boring, under considerable difficulties, until the capital was exhausted. A further sum of £400 was subscribed, and work was kept going until the bore reached a depth of 2,331 ft., and the water was successfully shut off at 2,210 ft. by means of 6 in. casing to that depth. This has apparently solved the difficulty, for since the water was shut off pure oil has been obtained in considerable quantity, and can now be run off at the rate of half a barrel a minute at any time. A pump has been installed to a depth of 2,296 ft., but pending the formation of a large company to develop the industry the works are closed.

of miles along the flanks of the Rocky Mountain Range in Montana, Wyoming, Colorado, New Mexico, and beyond and across the range in Utah.

In California the asphalt and oil deposits are in the unaltered Cretaceous and Tertiary rocks of the coast range, and underlie the Sacramento and San Joaquin valleys.

Owing to the vast difference of geological age and position between the eastern fields and those of the west, a prospector must expect great local differences in looking for his accustomed "ear-marks."

"Expert" oil-men sent from the east to examine our western fields may at first find as great difficulties locally as a western man would experience if he were sent to "expert" an Ohio or Pennsylvania oilfield. Grown up in eastern experiences, he naturally looks for the same signs and ear-marks as he has been accustomed to, but fails to find them. Many such experts in the early days of our first oil excitement came to Colorado and assumed that our "oil-sands" must be in Palæozoic sandstones and limestones, and expected at certain given depths the same sands as in the east. Some went so far as to suppose that an unbroken oil-deposit or "oil-sand" underlaid the great plains from the Appalachians to the Rockies and Sierras like a vast coalfield, and, by the way, the same error was made by coal-men from the east in assuming that our coal must occur in rocks of the Carboniferous period, as in Pennsylvania, till they learned they were in a much more recent series—viz., the Cretaceous. The oil-men found neither oil sandstones nor porous dolomitic limestones showing oil signs, nor with depth any so-called "oil-sands," but instead of that a prodigious thickness of most unpromising looking drab impervious Cretaceous shales and clays with "nary an oil-sand" in them; for, singularly enough, at Florence, where is the present productive Colorado oilfield, the wells put down 1,500 ft. to 2,000 ft. have not encountered a "sand" at all, or a porous sandstone even, to serve as a reservoir for the oil, but simply oil came up at a certain depth seemingly from cavities or fissures in the shale, and so far from an "oil-sand" or a big "underground oil-lake" under-

The oil has been analysed under the supervision of Dr. J. Mackintosh Bell, Director Government Geological Survey, and is found to contain—water, 0·04; kerosene, or burning-oil, distilling between 150° and 300° centigrade, 42; lubricating-oil, 20·3; paraffin, 13·3; coke, 5; loss, 4.

PETROLEUM IN WESTERN NORTH AMERICA.*

The Various Conditions under which it Occurs and where it may be Expected.

By Professor ARTHUR LAKES.

THE conditions under which oil occurs in the eastern fields of North America are in many respects different from those in which it has so far been found in the west. In the first place, we may say, generally, that the eastern oil occurrences are in strata far more ancient than those in the west—viz., in Palæozoic limestones and sandstones of the Silurian, Devonian, and Lower Carboniferous; in the west, for the most part, the so-called "oil-sands," or, more strictly, oil-horizons, are found in limestone, shales, and other rocks of Mesozoic and Cenozoic age, from the Jura Trias below to the Tertiary above. A few exceptional cases occur where oil signs are found in the west in rocks also of Palæozoic age. In Colorado the oil-horizons are, so far, found in the Jura Trias and Cretaceous. Signs also, such as gas-springs and bituminous shales and asphalt, have been observed in the Tertiary of North-western Colorado, but developments have not yet shown productive oil.

The productive wells have been confined to the Montana marine group of the Cretaceous, which extends for thousands

* Written specially for *Mines and Minerals*, Scranton, Pennsylvania, U.S.A.

Orepuki Shale-works.

of miles along the flanks of the Rocky Mountain Range in Montana, Wyoming, Colorado, New Mexico, and beyond and across the range in Utah.

In California the asphalt and oil deposits are in the unaltered Cretaceous and Tertiary rocks of the coast range, and underlie the Sacramento and San Joaquin valleys.

Owing to the vast difference of geological age and position between the eastern fields and those of the west, a prospector must expect great local differences in looking for his accustomed "ear-marks."

"Expert" oil-men sent from the east to examine our western fields may at first find as great difficulties locally as a western man would experience if he were sent to "expert" an Ohio or Pennsylvania oilfield. Grown up in eastern experiences, he naturally looks for the same signs and ear-marks as he has been accustomed to, but fails to find them. Many such experts in the early days of our first oil excitement came to Colorado and assumed that our "oil-sands" must be in Palæozoic sandstones and limestones, and expected at certain given depths the same sands as in the east. Some went so far as to suppose that an unbroken oil-deposit or "oil-sand" underlaid the great plains from the Appalachians to the Rockies and Sierras like a vast coalfield, and, by the way, the same error was made by coal-men from the east in assuming that our coal must occur in rocks of the Carboniferous period, as in Pennsylvania, till they learned they were in a much more recent series—viz., the Cretaceous. The oil-men found neither oil sandstones nor porous dolomitic limestones showing oil signs, nor with depth any so-called "oil-sands," but instead of that a prodigious thickness of most unpromising looking drab impervious Cretaceous shales and clays with "nary an oil-sand" in them; for, singularly enough, at Florence, where is the present productive Colorado oilfield, the wells put down 1,500 ft. to 2,000 ft. have not encountered a "sand" at all, or a porous sandstone even, to serve as a reservoir for the oil, but simply oil came up at a certain depth seemingly from cavities or fissures in the shale, and so far from an "oil-sand" or a big "underground oil-lake" underlying the area, a well might be put down to a depth of 2,000 ft. at one point and be productive, whilst another at the same depth but a few yards away would not yield at all. An oil expert from the east, so far as prospecting was concerned, had as much to learn anew of our formations and oil signs as we should have had had we undertaken to "expert" his eastern fields. But as soon as the east man got the "hang of the thing," and learned our western "ropes" in drilling and oil experience, he was usually ahead of our Colorado prospector.

In California, both the Pennsylvania and Colorado oil-prospector would find himself nonplussed by again meeting a very different state of things. Here he has Cretaceous and marine Tertiary rocks to deal with, greatly contorted, and often metamorphosed into serpentine, jaspers, burnt shales, and other forms produced by chemical heat, and large proportions of "oil signs" consist of heavy asphaltum deposits and impregnations of the rocks such as are rarely to be found either in Colorado or the eastern fields.

Another feature is worthy of consideration in the physical and other properties of the oils themselves. Whilst most of the eastern oils have a paraffin base, and are light illuminating-oils, by far the greater proportions of the western oils have an asphaltum base, and are heavy oils adapted principally for fuel and lubricants, the light illuminating element being much in the minority.

Despite, however, many local and wide geological differences, there are certain surface signs common to oilfields the world over, such as iridescent oil floating on water, tar-springs, gas-springs, oil-soaked rocks, and in structural conditions anticlinal arches and synclinal troughs, and so forth. These are common to both the eastern and western fields.

It is of practical importance to the oil-prospector to know the probable origin of petroleum. This interesting subject we cannot discuss here at length, but the theory propounded by Professor Joseph Le Conte and Mr. A. S. Cooper, formerly State Mineralogist of California, both of whom have had abundant opportunities in those field experiences which are often such necessary counterbalances to the theoretical results of the chemist's laboratory, appears to us the most reasonable—viz., that petroleum and bitumens are "principally derived from terrestrial and marine vegetation deposited in sedimentary strata, then changed to carbonaceous matter, and afterwards distilled by the heat of metamorphism." We would emphasize here particularly "marine vegetation" to counteract the popular idea that petroleum, or so-called "coal-oil," has much to do with ordinary coal-deposits, which were formed by ancient peat-mosses and land vegetation. In these petroleum is rarely found, but the world over occurs, for the most part, in strata and periods of strictly marine origin, and with few or no coal-beds. Any one who has lived by the seaside knows how prolific the sea is in vegetable as well as other forms of organic life. Any one who has peered down from a vessel into the ocean-depths knows the vastness, size, rampant growth, and abundance of the seaweeds in those "wild ocean moorlands." Whilst terrestrial vegetation, peat-mosses, and the like formed the coal-beds, these unctuous, gelatinous seaweeds doubtless gave us, after various geological and chemical changes and distillations, the fossil bitumens, asphaltum, and petroleum we find in the rocks.

It is, then, of practical importance to the prospector to become acquainted with the geological occurrence and position of rocks and strata of periods or groups, principally of marine origin in the geological scale, in his search for oil. These he may at times find even retaining the fossil imprints of ancient seaweeds, and they are generally characterized by fossil sea-shells, gypsum, and occasional beds of limestone and calcareous matter.

The geological condition of things in California, according to Mr. Cooper, is: "The rocks underlying the Tertiary and the lower parts of the Tertiary and Cretaceous are often metamorphosed by hydrothermal action, and, if they originally contained carbonaceous material, petroleum was distilled, which ascended in a vaporous condition, and was condensed in the unaltered rocks above. After condensation it was carried upwards by gas and hydrostatic pressure, and in some cases by rock-pressure."

That petroleum and asphaltum can at times be produced by distillation of coal is shown in Scotland, where coalfields pierced by numerous igneous dykes show both petroleum and asphaltum in chinks and veins in sandstone, and sometimes in cavities of the igneous rocks themselves; and in places massive sandstones are filled with solid brown asphalt, which the quarrymen manufacture into candles.

Bitumens in California are found in the unaltered sedimentary rocks, in sandstones, shales, and limestones; but there is no bitumen in the metamorphic rocks. We may suppose that all carbonaceous matter was distilled out of some of these by metamorphic heat, and ascended, accumulated, and condensed in the unaltered rocks above them.

The chief guide to the discovery of bituminous accumulations in California is the character of the rocks constituting the formation, and their structure and position. In California, the bitumens, being migratory fluids and gases, may be found to have ascended into any porous strata lying above the metamorphic ones. Accumulations of bitumens in the domes and summits of anticlines, and the existence of tar- and gas-springs, prove this migrating and ascending character of the bitumens. Some Tertiary formations lying in a favourable position above the metamorphic rocks do not show bitumen signs of accumulations, owing to their having been so much broken and tilted to such high angles that the oil has escaped.

Marine fossil shells are very abundant in the California rocks, showing the marine character of the strata.

Owing to the buoyancy of the bitumens in water their migrations are upward, until checked by impervious strata, or till they have reached the highest point to which water will float them, or till they reach the surface of the earth.

By repeated distillations solid paraffin can be gradually changed into liquid kinds of paraffins and olefins. Even mineral tar can be distilled by superheated steam into gas.

What is known under the general name of petroleum includes a series of hydrocarbon oils, varying widely. Some are liquid fluids, others viscid and tar-like. Hydrocarbons exist as gases, liquids, and solids. Their colour is from light-yellow to orange, and reddish-brown to a dark-green and black. They differ as markedly in odour, some having a disagreeable, others a pleasant smell.

They differ also in quantity in the same series of strata, and even in the same stratum. The products of distillation, such as gasoline, naphtha, benzine, maltha, and paraffin, all gradually merge into one another. The diversity in physical and chemical conditions is attributed by Mr. Cooper to the following causes: (1.) Different kinds of terrestrial and marine vegetation from which is was distilled. (2.) Degree of temperature to which these organic remains were subjected during distillation. (3.) To amount of pressure during distillation. (4.) To time consumed in effecting distillation. (5.) To presence of different substances during distillation, such as sulphur, lime, water, oxygen, nitrogen, &c. (6.) To condensation of bitumen after distillation—rapid, slow, agitated, or quiescent. (7.) To material of the still. (8.) To repeated distillations. (9.) To evaporation. (10.) To sulphuration, oxygenation, &c.

With these prefatory remarks we may turn to the hints given us in Mr. A. S. Cooper's bulletin of the California State Mining Bureau upon the subject of prospecting for oil in California, in which he summarises the conditions and indications favourable for oil-deposits, as follows:—

Anticlines, synclines, monoclinal folds, centroclines, quaquaversal domes, faults, and undulations along the strike of anticlines forming domes from these beds dip away in every direction with a quaquaversal dip.

A quaquaversal dome collects gas and oil at top of dome. Synclinal basins are less favourable, but they may have similar structure and domes.

Anticlines and synclines may be truncated by faults forming segments of sphere or cone.

If an oil-bearing bed ascending to the north is interrupted by an east-and-west fault crossing it, the further ascent of the oil northward is arrested; then look for a good supply of oil by boring on the south side of the fault. For a considerable distance north water may occupy the formation to the exclusion of oil.

Gouge occupying a line of fault forms a sheet of matter impervious to flow of oil or water.

In a formation containing permanent water, oil accumulations will be found near the upper end of the dome; oil will be found floating on the water with gas above; consequently gas, oil, and water will be successively tapped.

Bitumens occur in all the unaltered Cretaceous and Tertiary rocks of California. The aim is to discover accumulations at particular places large enough for development.

The unaltered rocks of California are shales and conglomerates resting on a core of granite. Beds of chemically altered rock, such as serpentines, jaspers, and red burnt shales, may occur associated with the unaltered rocks and bituminous deposits, and are considered as oil signs.

Sandstones and conglomerates are the reservoirs for the accumulation of bitumens, and the shale acts as an encasement to these both above and below. Anticlines exercise great influence in all oil regions in the accumulation of oil. Californian anticlines strike N.W. and S.E. The summit of those anticlines is commonly eroded, exposing a core of metamorphic rock.

Smaller anticlines branch in all directions from the main anticlines and "nose" out in the valleys. Smaller and lower anticlines run parallel with the main ones.

When the apexes of the anticlines are denuded, the bitumens may be drained into the dips on either side the anticlinal arches or domes.

Seepages of oil and flow of gas may be looked for on the outcrops of the denuded anticlines. In the lower undenuded anticlines the oil may lie far below the surface.

The Tertiary rocks of California are thicker in the south and more broken than in the north; hence there is a better storage-room for bitumens south than north.

The unaltered rocks of the coast range are more broken and contorted, and have a larger outcrop than those forming the foothills of the Sierras on the east side of the San Joaquin

Valley; hence there are more visible evidences of bitumen on the west side than on the east side of the valley.

The Cretaceous and Tertiary oil-bearing rocks underlie the Quartenary deposits of the San Joaquin and Sacramento Valleys, as evidenced by gas-wells, which show that the lighter and more volatile parts of petroleum have been preserved; consequently the heavier parts of the oil exist.

Red and white burnt and bleached shales are a common accompaniment of bitumens, caused by chemical heat action connected with the forming of bitumens. Sometimes actual smoke appears. Mineral springs, hot and cold, issue in the vicinity of the shales, and the earth is charged with salts and minerals occasioned by percolation of these mineral waters.

Shales are vitrified by the same agencies. Gas-springs and seepages of bitumen issue in their vicinity by fissures and joints, and porous rocks are filled with asphalt.

Subsidences of land caused by chemical burning of shales below are indirect signs of oil and gas. Signs of such subsidences are sometimes seen along the seashore, as near Santa Barbara. The surface is seamed, and sulphurous vapours rise. The ground is hot. The bluffs are composed of burnt red shales. Salt water seeps from the base of the cliff; shales saturated with bituminous matter appear. Limestones may contain oil when made porous by becoming dolomitic. Shales hold oil by their mechanical banding and cracking, causing storage-room.

Some deposits a short distance from the surface will show a petroleum-oil of 10° Baumé, decreasing at 1,000 ft. to 32°. Bitumens may be hard on the surfaces, and liquid a short distance below. Gold is sometimes found in bituminous sands, protected from being washed away by the bituminous cap.

Jointed sandstones often show their joints filled by bitumen. Leaching of oil may occur along the line of faults and summits of anticlines, as these offer avenues for the egress of water. Calcareous and siliceous cementing of jointed strata are indirect evidences of chemical heat connected with the formation of bituminous deposits. Much California oil comes from cracks and recesses in shale; the same is the case in Colorado. Bituminised strata on land, if dipping towards the sea, may drain their bitumen into the sea and give rise to submarine deposits available for drilling from wharves, as at Summerland.

Fumaroles giving off hot gases, and destitute of surrounding vegetation, are signs of gas and oil in the vicinity.

In the summits of domes and dips of anticlines farthest from the mountains the sands may be bituminised. Such sands are also likely to be calcified and silicified—*i.e.*, cemented by lime and quartz. Dome-like formations are always likely, and should be investigated, as they may carry great bodies of bitumen, either asphalt or oil.

Red shales, earth subsidences, mineral and hot springs, fumarole and gas or sulphur springs, bleached shales and sandstones, and silicified shales are all direct or indirect signs of the presence of bitumens.

Unaltered rocks, sandstones, and shales, alternating with metamorphic cherts, jaspers, and serpentines, together with a general warped condition of the shales, are evidences of bitumen.

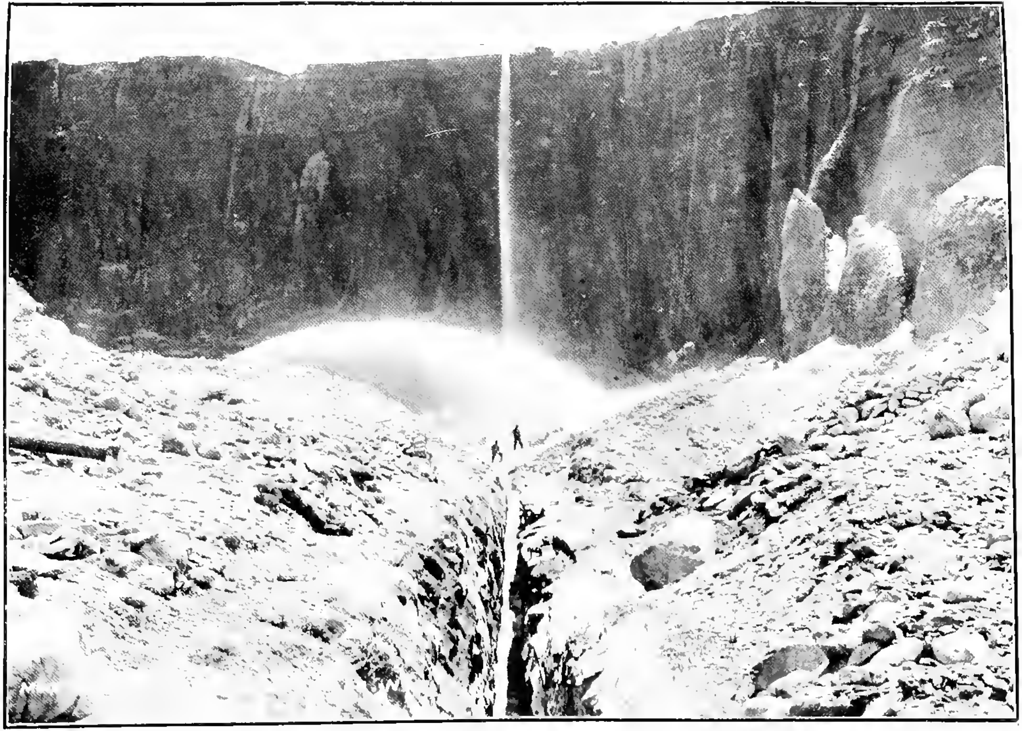
Mineral springs may not contain bitumen, but no bitumens occur unaccompanied by mineral springs.

Bleached white sandstones may be found grading into green serpentine, and if bitumen exists in a formation the bleached shales and sandstones will be found overlying them.

To sum up, Mr. Cooper gives the following brief suggestions for prospecting for petroleum in California: Surface indications of the presence of petroleum consist of unaltered rocks, white-leached shales and sandstones, shales burnt to redness, fumaroles, mineral springs, and the residue of mineral springs, such as selenite-gypsum, &c., subsidences, natural gas, springs of petroleum-oil and maltha, porous rocks saturated with bitumen, cracks in shales, and other rocks filled or partly filled with bitumen, black silicified shales. Petroleum-oil is not to be looked for in metamorphic rocks or granite any more than in a limekiln. The prospector should confine his attention to the unaltered rocks. The colour of bitumens near the surface is black, bluish-black, brown, and

Orepuki Shale-works: Stills.

Mining Handbook.



Moonlight Hydraulic Sluicing Claim, Moke Creek, Otago.

Mining Handbook.

Hydraulic Sluicing, Ross, Westland.

dirty brown. It can be determined from coal, vegetable deposits, iron, and manganese by its bituminous odour and taste, and by melting in the flame of a match with bituminous odour, and by dissolving in bisulphide of carbon, chloroform, and turpentine.

All streams, pools, and other bodies of water should be carefully inspected. If oil is present it floats on the surface, showing prismatic colours. Compounds of iron floating on the surface often show the same iridescent colours, but by stirring the water the iron scum breaks up into irregular fragments like a solid, but oil breaks up into rings like a liquid and forms again, showing bands of colour.

Gases may ascend along the bottom of a creek for a considerable linear distance, which, when lit, burn with a luminous flame. Carburetted hydrogen burning with a yellow flame is a better sign than sulphuretted, which burns with a blue flame and emits a sulphurous odour. A silver coin exposed to it turns black. Carbonic-acid gas does not burn. These gases are indirect evidences of petroleum, especially the carburetted hydrogen. All outcrops of stratified rocks should be examined in banks of streams, gulches, cañons, cuttings, and cliffs, as also the surface on the ground, for appearances of brown or black material or saturated brown porous strata.

If natural gas or bitumen is found upon the surface of shales, it is probable the bitumen has ascended vertically through these rocks from porous strata below through seams and cracks in the shale. When the outcrop is porous sand, the bitumens reached the surface through the sand.

Subsidences are indications of the presence of petroleum, but it will be viscous and heavy, the fractured condition of the earth in the subsidence permitting the escape of the volatile parts of the oil; the same is true of burnt shales.

As mineral waters always accompany the bitumens, mineral springs and the evidences of former mineral springs are, to a limited extent, evidences of the accumulations of bitumens. Selenite, travertine, infusorial earth, and a number of other mineral deposits are evidences of former mineral springs. When bitumens exist in a formation they are often overlaid with white, bleached shales and sandstones; therefore these rocks are, to a certain extent, indications of bitumens, and owing to their conspicuous colour can be seen from a long distance.

If indications are sufficient to justify it, a topographical map should be made of the presumed oil-territory, as also a cross-section of the rock-structure.

Even with the greatest attention given to these details before selecting a place to drill a well, there is a danger that the lower parts of the bituminous strata encountered in the well may contain water in place of gas and oil, or may be calcified or silicified instead of being bituminised, or that water has entered the outcrop of the strata at higher altitudes and ascended through the formation, floating the oil to the surface or carrying the same to the other dip of the anticline.

LIMESTONES IN NEW ZEALAND.

INQUIRIES having been made on several occasions of the Mines Department as to "the occurrence of limestones abounding in carbonates adjacent to a water-supply and accessible by railway or steamer," and suitable for the manufacture of carbide of calcium, the following extract from a memorandum on the subject by Mr. A. McKay, F.G.S., Government Geologist, written in February, 1898, will be of interest to those interested in the acetylene-gas industry:—

"In the north of Auckland limestone occurs abundantly in Whangarei Harbour and on the shores thereof. The north shore of this is hilly, and streams of water abound. In the Kaipara basin limestones of the quality required [for the manufacture of carbide of calcium] occur at Pahi, and shipping of considerable tonnage can reach the place. The adjacent country is hilly, but as to the water-power available I can give no information. In the neighbourhood of Auckland and at Mahurangi there are limestones. Near Auckland, at Papakura, the shipping facilities would prove deficient. At Mahurangi the falls of the river a little above Wilson's lime-works might give the power required, but only vessels of light draught can reach the place. At Whaingaroa (Raglan) there is abundance of good limestone accessible to vessels of light or moderate draught; and above Raglan limestone and power might be obtained, but only small craft could reach where the other conditions would be fulfilled. Much limestone is to be found along the east shore of Kawhia Harbour, but the rivers are for the most part tidal through the limestone gorges, and power would be the difficulty. In the Mokau Valley there is much limestone, a hilly country, and a navigable river, but I am not specially acquainted with the country. Along the west coast of Wellington I do not think the combination of conditions is to be met with, nor can they be found on the Cape Colville Peninsula or along the shores of the Bay of Plenty, nor from the East Cape to Poverty Bay. In Mahia Peninsula two of the conditions could be complied with, but the third (water-power) would most likely be wanting. This also applies to Napier and the south shore of Hawke's Bay. At Cape Turnagain there is limestone, also at Castlepoint, but at neither of these places could shipping be carried on safely. South of Castlepoint to Barton's there is limestone on the coast, but at some places water-power and shipping would be difficult.

"Near Picton, in the South Island, there is limestone and a port, but not sufficient water-power; and from Cape Campbell to Kaikoura there is no sufficient port. From Kaikoura to Motunau there are no good harbours. At Oamaru and Kakanui water-power is not available. At Waikouaiti water would be the difficulty. Green Island is the last place on the east coast where limestone is to be had; here, however, there is no sufficient port. In Caswell Sound limestone abounds, but there are no streams of consequence near where the marble is found. Martin's Bay is not to be thought of. At Jackson's Bay limestone abounds, and there is a fair harbour, but it is doubtful if the required water-power can be obtained. At Greymouth there is a port, and plenty of limestone—not, however, of the best quality. At Westport there is the Cape Foulwind limestone, but no water. The Wanganui, Karamea, and the Heaphy Rivers do not afford shipping facilities. Within Blind Bay, either at Parapara or at Takaka, there would be difficulty as to the required water-power, and also as regards the shipping. There is on the range between the Takaka and the Motueka Valleys a great abundance of limestone as marble. This is not far from the sea. The range is high, and affords water, and there are several ports along the shore between the mouth of the Motueka and Separation Point. The limestone strikes northerly along the range, and should appear near the shore at some place. This is the Riwaka marble, and would doubtless answer the purpose for which it is wanted. Water-power is probably present near a sufficient harbour.

"Here, at Mahurangi, or at Pahi, so far as I can judge, are the three places that appear to afford all three of the conditions that are stipulated for. Whangarei might also be included in the list. In Caswell Sound, though the streams are small, the height of the mountains might afford conveniently sufficient pressure, even if the volume be less than elsewhere. The difficulty is the rarity of the three conditions being satisfied in one place."

LITHOGRAPHIC LIMESTONES.

Notes as to their Occurrence North of Hokianga and the Bay of Islands.

By Alexander McKay, F.G.S., Government Geologist.

Limestones of a cretaceous or non-crystalline character are abundant along the west coast of Auckland, from Kawhia, in the south, to Ahipara, Mongonui County, in the north, and reach to the east coast of peninsular Auckland at Wade, Mahurangi, Whangarei, and Kawakawa. South of Whangarei and the Upper Wairoa watershed these rocks usually assume the character of broken, much-jointed, indurated, fine-grained limestones of a light colour, or, as at Mahurangi, of a friable marly limestone, which is there worked as hydraulic limestone by Wilson and Co., of Mahurangi and Auckland. In Limestone Island, Whangarei Harbour, and along the shores of different arms of the Kaipara Harbour, it is often of a more flaggy character, and might in places be found suitable for lithographic purposes; but the proportion of spoil and rejected rock in all known localities south of Hokianga would probably be so great that it is hardly likely a quarry could be found which would pay to work. Even on the south side of the Hokianga River the limestones of this age and character are thin-bedded, highly tilted, broken, and contorted, and are hydraulic rather than lithographic limestones.

It is only within the limits of Mongonui County, stretching along the northern slope of the Maungataniwha Range, and thence spreading over the lower grounds to the north on both sides of the Kaitaia Valley, that the limestone occurs under conditions such as enables it to be worked and used as a lithographic limestone. Here it is thick-bedded and free from joints so far as to enable the raising of it in blocks of any size likely to be used in lithography. In the hilly country, on the south side of the Middle Kaitaia Valley, there appears to be an abundance of such rock.

During my survey of that district, carried on in 1892, I found this limestone being quarried for road-metal, and on examining the quarry I pointed out to the men engaged the true nature of the rock, and took a small slab of the same for the purpose of having its quality tested on my return to Wellington. This I faced and polished and set in a bed of cement, and Mr. Pierard, draftsman to the Mines Department, placed thereon some shaded drawings, which, on being printed off, proved the stone free from blemishes and defects, and in every way suitable for ordinary lithographic work. The member for the district was then applied to, and in due course a larger block was sent to the Survey Department. This was so unskilfully taken from the quarry, being blasted out with some explosive, that, so produced, it showed rents in various directions which did not originally exist in the rock, and therefore made it unsuitable for the purposes of a lithographic stone. However, it was faced, but no attempt was made to square or size it as regards thickness. A map was traced upon it, and some copies struck off. It was reported as being unsuitable for the purpose for which it was sent, owing to the numerous rents in the stone, the larger of which showed on the prints. How these originated I have explained.

The road-quarry whence the samples experimented upon were obtained lies about thirteen to sixteen miles from Mongonui Township and Port; and in the hills on the south side of the valley stone of good quality might be got at a lesser distance from the shipping-place.

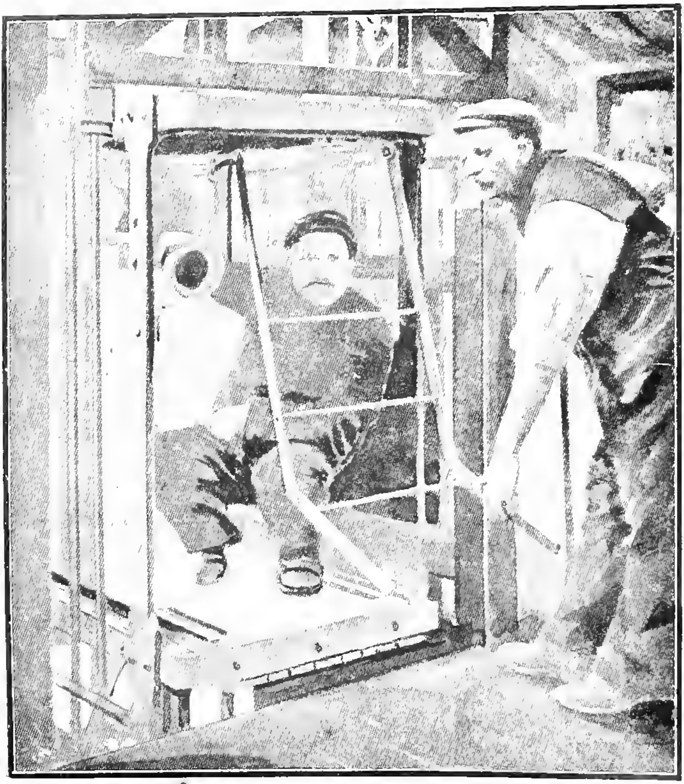
Various qualities of stone, from hard to soft, are likely to be found in the hilly country on both sides of the Kaitaia Valley, but for some reason or another great indifference has been displayed respecting the further prospecting for or development of this stone at known localities.

The limestone is perfectly non-crystalline, and free from iron impurities or minute shells, which have detracted from the value of such stone in other parts of the country. The stone in the quarry referred to is rather soft than hard, but as induration and excessive hardness are what is most common and most to be feared, if we have regard to other localities where this rock is found, this softness is, on the whole, a favourable circumstance.

What remains to be done is to prospect the district for different varieties of the stone, have slabs raised in a proper and workmanlike fashion, and fairly tested as to quality and the purposes for which the different varieties are most suitable.

SCHOOLS OF MINES.

With the view of affording technical instruction in subjects relating to metals and minerals, mines and mining, Schools of Mines were started in various parts of New Zealand over twenty years ago. The scheme originated at Lawrence, Otago, where, in 1884, Professor Black, of the Otago University, delivered three lectures on the chemistry of minerals at the Lawrence Athenæum and Mining Institute. Encouraged by the enthusiasm created among the miners, an extended course of lectures, and practical classes for the testing of minerals, were immediately organized by the Lawrence Athenæum Committee, and carried out with great success. The scheme in connection with the goldfields Schools of Mines did not aim at imparting an exhaustive course of instruction, that being left to the Otago School of Mines and the University colleges. Its aim was to give miners and students an elementary, but at the same time a practical, acquaintance with a few of the branches of science relating to minerals, such as would be of most advantage to them in their daily work, and through them to the colony at large. The Mines Department, in 1885, imported from London, for the use of the schools, chemicals and apparatus to the value of £400, and procured from Germany eleven collections of ores, rocks, and other minerals for distribution amongst them. Each of these collections cost about £35, and included 200 specimens of metallic ores, fifty specimens of rocks, and thirty specimens of minerals that accompany the metallic ores and are indicative of the same; also an assortment of minerals to show degrees of hardness, and 110 samples for blowpipe testing, with blowpipes for same. The result of that encouragement by the State and the enthusiasm which Professor Black, who was intrusted with the organization of the schools, aroused in the mining community was that a School of Mines



Protective Gate for Cages.

Mining Handbook.

was established at the Thames, with branch classes at Coromandel, Waihi, Karangahake, Te Aroha, and Waiorongomai; on the west coast of the Middle Island schools were established at Westport, Waimangaroa, Reefton, Boatman's, Greymouth, Kumara, Stafford, Hokitika, Kanieri, and Ross; in Otago, at Lawrence (with branch classes at Bluespur, Weatherstone's, and Waitahuna), Waipori, Roxburgh, Bannockburn, Bendigo, St. Bathan's, Naseby, Arrowtown, Skipper's Point, Queenstown, Riverton, and Orepuki. Steps were also taken about the same period for opening schools at Collingwood, Lyell, Charleston, Ahaura, Nelson Creek, and at other small mining camps. Subscriptions liberally flowed in for a time, but the enthusiasm did not last, and there was some disappointment; yet, on the whole, the movement for the technical education of the miner, mining engineer, battery-superintendent, and dredgemaster has borne good fruit for the colony, and a number of graduates from the Otago, Thames, and other Schools of Mines now occupy leading positions in New Zealand, the Australian Commonwealth, the Transvaal, the United States, and Canada. Indeed, it would be difficult to point to any country where European enterprise is engaged in the development of mining operations where the New-Zealander cannot be found, and his success is in no small measure due to the knowledge he first acquired at the School of Mines. There are at the present time Schools of Mines in connection with the Otago University and Auckland University College. The Thames School of Mines is the most important school on the goldfields, and there are also well-attended schools at Waihi, Karangahake, and Coromandel, the principal centrés in the Hauraki goldfields; and at Nelson, Reefton, and Westport in the Middle Island. All these schools, which are subsidised by Government but controlled by local Councils, continue to do good service. A short summary of the work carried on at some of these schools, furnished by the Directors, will be of interest.

OTAGO UNIVERSITY SCHOOL OF MINES.

By Professor JAMES PARK, F.G.S.

THE University of Otago was opened in July, 1871, with a staff of three professors—namely, Professor Sale, in the chair of classics and English language and literature; Professor Shand, in the chair of mathematics and natural philosophy; and Professor MacGregor, in the chair of mental and moral science. The idea of the founders seems clearly to have been that the University should be a central department of higher general education, around which should grow up a group of professional and technical schools as the needs of the colony demanded. How well this sagacious conception has been fulfilled is seen in the four professional schools now attached to the University—namely, the School of Mines, the School of Medicine, the School of Law, and the School of Dentistry.

Almost from the foundation of the University the intention of establishing a School of Mines seems to have occupied a foremost place in the minds of the founders. Thus we find that in the very year of its opening a grant of £300 was made by the Provincial Government to aid the University Council in establishing a chair of chemistry and mineralogy, and His Honour the Superintendent, Mr. James Macandrew, in announcing the grant, pointed out that this was the first step towards the establishment of a School of Mines. Professor Black was elected for the chair, and joined the staff at the beginning of 1872. In 1874 Captain Hutton was appointed lecturer in geology and zoology, the appointment being made with the intention of facilitating equally the establishment of a School of Mines and a School of Medicine.

Although steps had been taken to establish a School of Mines at almost the inception of the University itself, it was not until 1877, when the Colonial Government offered an annual grant of £500 as an endowment to the chair of mining, that the University Council found itself in a position to create a School of Mines as a separate faculty of the University.

In 1878 Professor G. H. F. Ulrich, a field officer of the Victorian Geological Survey, was appointed Director of the School of Mines, at the same time assuming the chair of mining. A systematic course of study was drawn up for the different divisions of the school, which was formally opened in 1879.

The financial exigencies of the University greatly retarded the development of the School of Mines, and it was not until 1885 that the Council was able to complete the staff by the appointment of three additional lecturers on subjects required to complete the full mining course.

In 1891 the school was accommodated in a separate building—a portion of the Exhibition Building of 1889–90. In the same year the staff was further strengthened by the appointment of Mr. David Wilkinson, of the Royal School of Mines, London, as lecturer in metallurgy and assaying. The school was now fully equipped with a teaching staff and the appliances necessary to give a complete course of instruction for the diploma of associate in the divisions of mining, metallurgy, and geology.

In 1894 Mr. Wilkinson resigned the lectureship in metallurgy and assaying, and was succeeded successively by Mr. P. Fitzgerald, appointed in 1895; Mr. F. B. Stevens, appointed in 1897; and Mr. D. B. Waters, appointed in 1900. On the death of Professor Ulrich, in 1900, Professor Park, the present Director of the school, was appointed to the chair of mining and mining geology, and in the same year Dr. P. Marshall was appointed lecturer in general geology and mineralogy. At the request of the University Council, Professor Park revised the syllabus of instruction and the regulations relating to the issue of diplomas and certificates. At the same time, he arranged with the staff of lecturers that the instruction for the associate course in the different divisions should be raised to the standard required by the New Zealand University for the B.Sc. degrees in mining and metallurgy. This innovation has been attended with the most beneficial results, and many students, after sitting for the School of Mines examinations prescribed for the diploma courses, go up in November for the B.Sc. examinations of the University of New Zealand without further instruction.

The session commences on the first Wednesday in April, and ends on the Friday following the third Wednesday in October. There is a midwinter vacation of three weeks. The mode of instruction is by systematic courses of lectures in the prescribed branches of study, in connection with written and oral examinations; by practical work in the laboratories; and also, according to circumstances and opportunities, by inspection of mines and by field excursions.

The school is open to all persons over seventeen years of age. Candidates for admission to the School of Mines are required to pass the Matriculation Examination of the New Zealand University: Provided that candidates who are over twenty years of age may be admitted to the school if they pass an examination held by the Professorial Board in English, arithmetic, algebra, and Euclid, or have previously passed an examination in those subjects approved as satisfactory by the Professorial Board: provided also that the obtaining of a Government scholarship at a School of Mines be deemed equal to passing the Matriculation Examination for the purposes of the regulation. The preliminary examination for non-matriculated candidates for admission to the Mining School is held during the first week in April. Candidates who intend to appear at this examination are required to communicate with the Registrar before the 14th March. The fee for the examination is £2 2s. Before being admitted to the classes in mineralogy, assaying, and metallurgy a student must have passed the examinations in the first year's course in mathematics and chemistry; and, before being admitted to the classes in surveying, he must have passed the examination in the first year's course in mathematics.

The fees are the same as those charged in the arts course—namely, three guineas for each course of lectures, occupying not less than three hours per week during the whole session; a guinea and a half for any course occupying two hours per week; and one guinea for a course of one hour per week. All students are required to pay a college fee of £1 1s.; students attending petrography, a microscope fee of 10s.; and students attending practical chemistry, quantitative analysis, or assaying, a laboratory fee of £1 1s.

There are four divisions in the Mining School—mining, metallurgical, geological, and mining and land surveying.

The Associate course takes three years, and the B.Sc. course in mining or metallurgy four years. For the B.Sc. course the fees and cost of text-books amount altogether to about £75.

The diploma of Associate of the Otago University School of Mines was first issued in 1887. The diplomas granted in the divisions of mining, metallurgy, and geology since that date are—Mining, 76; metallurgy, 37; geology, 13: total, 126.

The number of mining graduates who have taken the ordinary B.Sc. and Engineering B.Sc. since 1901 is as follows: Ordinary B.Sc., 9; Engineering B.Sc., 5: total, 14.

Scholarships won by Mining Students.

1904. Rhodes Scholarship (first), J. Allan Thomson.
1906. Rhodes Scholarship, A. R. Farquharson.
1904. 1851 Exhibition Scholarship, A. R. Andrew.
1904. 1851 Exhibition Scholarship, J. Allan Thomson.
1906. 1851 Exhibition Scholarship, A. R. Farquharson.
1902. Sir George Grey Scholarship, A. R. Andrew.
1903. Sir George Grey Scholarship, C. N. Boult.
1904. Sir George Grey Scholarship, A. R. Farquharson.
1905. Sir George Grey Scholarship, A. M. Finlayson.

Practical Work for Students.

At times our students have found a difficulty in obtaining work in mines or mills, and in the divisions of surveying and geology it was almost impossible to obtain the practical experience required by the regulations. Towards the end of 1904 Professor Park wrote to the Hon. James McGowan, Minister of Mines, pointing out the disability of Otago mining students in respect to practical work, and requested him to provide employment in the Government Departments for eight students in the summer vacation—namely, for two in the Survey Department, two in the Public Works Department, two in the State Coal-mines, and two in the Geological Survey. The Minister approved of the suggestion, and instructions were issued to the several Departments to give the needed employment. The work thus provided for the students has proved of great value, as it enables them to not only comply with the Mining School Regulations relating to practical work, but also initiates them into every-day professional methods of conducting field operations.

Value of Technical Education.

The unexampled progress of gold-mining in all parts of the world during the past decade can be traced directly to the introduction and successful operation of the cyanide process of gold-extraction. Many mines that were formerly closed down, or working at a loss, are now paying regular dividends; and piles of tailings, at one time regarded as useless sands, are yielding a profitable return through the application of this process.

The cyanide process depends on a series of highly complex chemical reactions, and for this reason ranks among the most difficult and technical of present-day metallurgical processes. Its successful introduction in the Australian Colonies and New Zealand, often under the most adverse conditions, is a splendid tribute to the value of the training imparted in our mining schools. The process may truly be said to have revolutionised the art of gold-mining, which now occupies a foremost position among the established industries of the world. In the past seventeen years it has already added over £100,000,000 to the wealth of the world, and its possibilities in the future seem almost without limitation. Moreover, it came most opportunely. It is almost certain that had the process been discovered twenty years ago its introduction had been well-nigh impossible through the lack of men possessing the high technological skill required for its successful operation; but it so happened that it came when the mining schools were fairly established and in full swing. The schools were called on to supply the men to work the process. In a sense, they were placed on their trial, and for the first time since their establishment were required to justify their existence. This period was an anxious and critical time in the history of New Zealand mining schools, and writing now, fifteen years after, it is gratifying to record that the reliable and successful work of our students, who were thus suddenly called upon to take the place of the old-time millman and battery-manager, dispelled for all time any lingering doubts of the value of a technical mining education.

Since filling all the available positions at the New Zealand mines, the overflow of our certificated students has found its way to responsible positions in connection with the process in all parts of the world wherever gold-mining is conducted on scientific principles.

If the colonies are to stem the tide of foreign competition, greater facilities must be provided for the acquirement of a technical training in the higher branches of applied science It is not so much in the manual occupations that we feel the stress of foreign competition as in the domain of mining, metallurgy, engineering, chemistry, electricity, and manufacturing industries.

Mining has already afforded a wide field for hundreds of our more intelligent youth, who have discovered not only a remunerative source of employment for themselves, but one in the pursuit of which they contribute largely to the wealth of the nation. Hitherto, mining is the only industry in New Zealand in connection with which any serious attempt has been made to introduce technical education. That the results have already more than justified the expenditure is clearly shown in the more systematic development of our mines, and the yearly increasing value of the colony's mineral productions. There is therefore no need to go to Germany or America to discover that money spent on technical education is money well invested on behalf of the community.

THAMES SCHOOL OF MINES.

Under the Mines Department of New Zealand.
Established 1885.

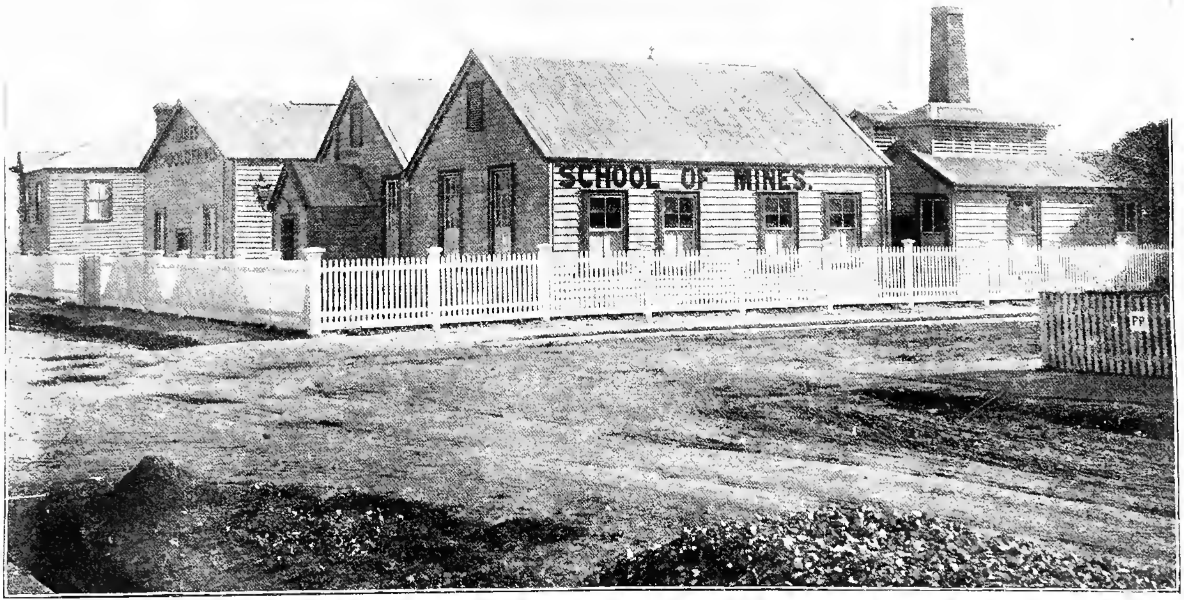
Director: O. Gore Adams, A.O.S.M., F.C.S., &c.
Assistant Lecturer: W. A. Given, M.A., B.E.
Drawing-master: T. J. Mountain, L.S.
Lecturer on Electricity: J. G. Lancaster, M.Sc.
Hon. Secretary: Albert Bruce.

Subjects of Instruction.

Mathematics: Pure, practical, and applied.
Mining engineering: Including mining, ventilation, explosives, pumping, hauling, winding, and applied mechanics.
Surveying: Including land and mine surveying.
Practical astronomy.
Metallurgy: Including applied mechanics.
Assaying: Wet and dry.
Chemistry: Theoretical and practical.
Geology: General and mining geology.
Mineralogy and blowpipe analysis.
Petrology.
Drawing: Geometrical, mechanical, and map-drawing.
Electrical engineering: Theoretical and practical.

The Thames School of Mines prepares candidates for the Government certificates of mine-manager, battery-superintendent, engineer, and licensed assayer. It gives a complete training in mining engineering, metallurgical engineering, and electrical engineering. Any class or course of classes may be taken, but students are advised to take at least one complete course, and thoroughly master it.

The annual examinations are held in December, and candidates who pass are awarded certificates in their respective subjects. Seventy per cent. and over entitles the candidate to a first-class certificate, 55 to 70 per cent. to a second-class certificate, and 40 to 55 per cent. to a third-class certificate.



THAMES SCHOOL OF MINES: VIEW OF SCHOOL BUILDINGS.

Another branch of the work of the school is the assaying, analytical, and ore-treatment department. Ores are assayed and analysed for the public, and reports furnished thereon, for very reasonable fees. In the experimental metallurgical plant, bulk samples up to 3 tons are treated by various processes, and complete reports issued, stating the best method of treatment, probable extraction to be expected, and other details.

The Buildings, Battery, and Museum.

The School of Mines buildings comprise lecture-rooms, assay-rooms, experimental metallurgical plant, electrical power-house and laboratory, and museum.

In the main building there are three lecture-rooms, one fitted with chemical-lecture bench, and one with an electric arc-light optical lantern for projecting lantern views on the screen. This lantern is largely used for demonstration purposes, and gives very clear pictures owing to the strong light. The chemical benches are capable of accommodating a large number of students.

The drawing-tables are arranged with 32-candle-power movable electric lights, which give a clear, steady light. They are so arranged that no objectionable shadows are thrown on the work.

The assay-furnaces are well arranged, and every appliance provided for quick and accurate assaying. There is also an entirely separate assay office, reserved exclusively for the staff, where all public assays are made. The school is provided with five Oertling balances; three of these are bullion-balances, and the remaining two are chemical balances.

The rest of the main building, which comprises ten rooms in all, is occupied with the Director's room, staff-room, and store-room.

The electrical power-house and laboratory contains a 5-horse-power Pelton water-wheel and a 3-kilowatt dynamo, which supplies the power for lighting the school. A large quantity of electrical apparatus is kept in this laboratory, so that students may carry on a variety of experiments.

The experimental metallurgical plant consists of reverberatory roasting-furnace, sampling-floor, rock-breaker, automatic ore-feeder, three heads of stamps, elevator, amalgamating-pan, settler, berdan pan, tailings-pits, two cyanide-vats, solution-vat, vacuum-cylinder and air-pump, precipitating-boxes, sumps, centrifugal pump, &c. The whole plant is driven by a Pelton water-wheel. Ores can be treated by amalgamation in berdan pans, or in amalgamating-pan, by the hot or the cold process, with or without roasting and the use of chemicals, &c. They can also be treated by the cyanide process in any of its branches.

The museum is a lofty building, 60 ft. by 25 ft., built in 1900. It is well stocked with rocks, minerals, and fossils. Special attention has been paid to the geology of the Hauraki Peninsula, and a very comprehensive collection of local rocks is on view. This museum is open to the public every Thursday afternoon during the school session, and visitors to the district are admitted at any reasonable time on application to the Director.

Fees and Terms.

The fees for classes are extremely reasonable, and well within the means of almost every one. Each student must pay a membership fee of 10s. per annum, and the fee for each class is 5s. per term. There are three terms during the year: the first extends from the first Tuesday in February to the 30th April; the second from the 9th May to the 20th August; and the last from the 9th September till the end of the annual examinations, which usually finish about the 20th December.

General.

The Thames School of Mines, being situated in the centre of the Thames mining district, affords exceptional facilities to students to acquire practical experience in mining and metallurgy. From a geological standpoint, the district surrounding Thames is the most interesting in New Zealand, and full advantage is taken of this fact in the teaching of geology. Whilst the theoretical instruction is very thorough, the class subjects are treated as far as possible from the practical side. and the lectures are illustrated by periodical visits to the mines and batteries, and by field-days for geology and surveying.

Lectures are given in the mornings and evenings to suit students working in mines, and students are allowed to carry on experiments in the assay, chemical, and electrical laboratories during the afternoons.

Practical instruction is also given in the metallurgical plant, and students are thus enabled to obtain a working knowledge of machinery, and of the treatment of all classes of ore by the various processes.

Students from outside Thames can find good accommodation at moderate terms within easy distance of the school. The Railway Department makes special concessions to country students.

No less than sixty-five students of the Thames School of Mines have gained first-class mine-manager's certificates, entitling them to manage mines in New Zealand, and fifty-three students possess the battery-superintendent's certificate. Six University scholarships have been granted to Thames School of Mines students since 1894, out of a total of eight for the whole of New Zealand.

Thames is situated on the shores of the Hauraki Gulf, four hours by a daily steamer from Auckland. The trip down the gulf is a very interesting one, for the steamer threads its way through picturesque islands, and is never more than a few miles from land. Thames is also connected with Auckland by rail, whilst the completion of the Waihi Railway allows of visits being paid to the up-country mines at Waihi, Karangahake, &c. The climate at Thames is somewhat similar to that of Auckland, but is more bracing.

WAIHI SCHOOL OF MINES.

Director: A. H. V. Morgan, M.A.

THE first steps towards the establishment of a School of Mines in Waihi were taken in June, 1896, when at a public meeting a provisional committee was elected. It would seem that the chief credit for bringing about this development belonged to the local journal. The committee at once took active steps towards the object in view. The Government gave a subsidy of £1 for £1 on all subscriptions, and the Auckland Education Board granted a quarter-acre of the public-school reserve as a site for the school. Before the end of the year a £250 contract was let for the erection of a building, which was completed in February, 1897. A few months later Mr. Percy G. Morgan, M.A., A.O.S.M., was appointed Director, and on the 1st July, 1897, the school was formally opened. Since that date the school has made great strides. The first building has been enlarged three times, and now contains two large lecture-rooms, chemical laboratory, assaying-laboratory, balance-room, office, store-room, &c. The chemical laboratory is well furnished with benches, draught cupboards, sinks, &c., for the use of students, while the assay laboratory contains two large wind furnaces, two muffles, bullion-rolls, pulp-scales, cupel-machine, &c. The building is lighted throughout by electricity, which is generated in a separate building in the school grounds. The plant consists of a 4-horse-power "A.B." oil-engine, driving a 3-kilowatt 4-pole compound-wound Brush dynamo. Gas is also laid on throughout the laboratories and chemical lecture-room for heating purposes. The teaching staff of the school consists of A. H. V. Morgan, M.A., Director; F. T. Seelye, A.O.S.M., assistant lecturer; R. H. Mitchell, drawing-master; and J. G. Lancaster, M.Sc., lecturer on electricity.

The following are the subjects upon which lectures are delivered: Mining and applied mechanics, mathematics, general and mining geology, mineralogy and blowpipe determination, land and mine surveying, theoretical chemistry, practical chemistry, wet and dry assaying, metallurgy of gold and silver, geometrical and mechanical drawing, and electricity.

In all, about five hundred assays and analyses of all kinds have been made for the public by the staff. The charge for determinations of gold and silver is 5s., but assays are made for *bona fide* prospectors free of charge. In addition to the above, a large number of minerals have been identified without charge.

The number of students at present attending the school is sixty-eight. The number of School of Mines certificates issued up to 1905 is 263, but it is probable that the total number of students who have passed through the school exceeds three hundred.

The school possesses a splendid collection of mineralogical and geological specimens, comprising about three thousand exhibits of minerals, rocks, fossils, &c. This is being continually increased by donations from past and present students, and others.

The reference library contains upwards of 120 volumes on all the subjects included in the syllabus. New books are constantly being added, and it has just been decided to spend £20 in bringing the library thoroughly up to date. A number of mining and metallurgical journals are also subscribed to by the school.

The annual expenditure amounts to slightly under £1,000. This sum is met principally by the Government, which subsidises all fees, donations, &c., at the rate of £1 for £1, and also pays half the salaries of the staff. The balance is made up of public subscriptions and donations, fees, assay charges, &c.

The school year is divided into three terms as follows: First term, first Monday in February to 30th April; second term, 9th May to 20th August; third term, 9th September to 20th December. Membership fee, 10s. per annum, payable half-yearly; class fees, 5s. per term for each subject.

During December of each year examinations are held in the various subjects of instruction. The examiners are men of high standing, appointed by the Government, and their certificates therefore have considerable value. The percentage necessary for the different grades of certificates is as follows: First class, 70 per cent. or over; second class, 55 per cent. or over; third class, 40 per cent. or over.

Since January, 1899, the Waihi School of Mines has been a centre for the Government examinations for mine-managers' and battery-superintendents' certificates. During that time twenty-one first-class mine-managers', two first-class coal-mine managers', and thirty battery-superintendents' certificates have been gained by students of this school. In addition to these, some ten or a dozen certificates were obtained by ex-pupils who were attending other Schools of Mines, or by pupils who had been in the Waihi School of Mines too short a time to be counted as regular students. To the above figures must be added a number of second-class mine-managers' certificates, winding-engineers' certificates, assayers' certificates, &c.

COROMANDEL SCHOOL OF MINES.

Director: D. V. Allen, B.Sc., A.O.S.M.

ALTHOUGH the Coromandel School of Mines has been in existence since the year 1887, it was not until the beginning of 1898 that a permanent Director was appointed and a regular syllabus of instruction adopted. The old building proving totally inadequate, both as regards accommodation and convenience, was replaced by the present substantial and up-to-date structure. It was then that the famous Hauraki Mine was yielding handsome returns, and the Coromandel Goldfield as a whole was in a flourishing condition. The time was therefore ripe for the erection of a modern School of Mines, where young men engaged in mining pursuits might profitably devote their spare time to study. Thanks to the energetic efforts of the committee then in power, the required money was raised, and, with a subsidy from the Government, the new school was erected, and the first Director, J. Malcolm Maclaren, B.Sc.,* appointed. Students enrolled in large numbers, and the greatest of interest was manifested in the institution. It was not long before Mr. Maclaren accepted an offer of a better position, and he resigned He was succeeded by P. J. MacLeod, B.A., who took up his duties towards the end of 1899. Resigning early in 1901, he was succeeded by D. V. Allen, B.Sc, A.O.S.M., the present Director. The course of instruction at the school is a comprehensive one, and embraces all the subjects necessary to qualify in the various branches of the mining profession. It includes mathematics, mining, surveying, chemistry, quantitative analysis, assaying, metallurgy, geology, mechanical drawing, and electricity. Candidates are also prepared for the mine-managers' and battery-superintendents' examinations.

One scholarship, tenable for three years at the New Zealand University, is annually offered by the Government for competition by the various Schools of Mines in the colony. It has been secured on one occasion by a student from this school.

The practical side is not neglected, the school being well provided with everything necessary for the efficient carrying-on of the various classes. The laboratory is well stocked with chemicals and all the requisite apparatus for making experiments. The assay department is equipped with all modern appliances for the smelting and assay of ores of all kinds. A good set of bullion-rolls is provided, and the weighing-room is replete with balances of the best type. A splendid selection of rocks and minerals is at the command of the student in geology.

The collection of minerals, &c., from this school was given first award at the Auckland Mining and Industrial Exhibition of 1898–99, together with the only gold medal of merit given. Later, in 1902, it was awarded a first-class certificate at the Coromandel Gold Jubilee Exhibition.

A complete grinding plant, driven by water-power, is provided for the making of rock-sections, together with a fine petrological microscope for the examination thereof. In con-

* Now Mining Geologist to the Government of India.

nection with the surveying class, a certain amount of field-work is done with the instruments, enabling students to attain a practical insight into the methods of traversing, levelling, &c., while at the school there is every facility for the plotting of surveys.

There is a good reference library, containing standard works on scientific subjects and the usual mining journals and publications.

PUBLIC BATTERY.

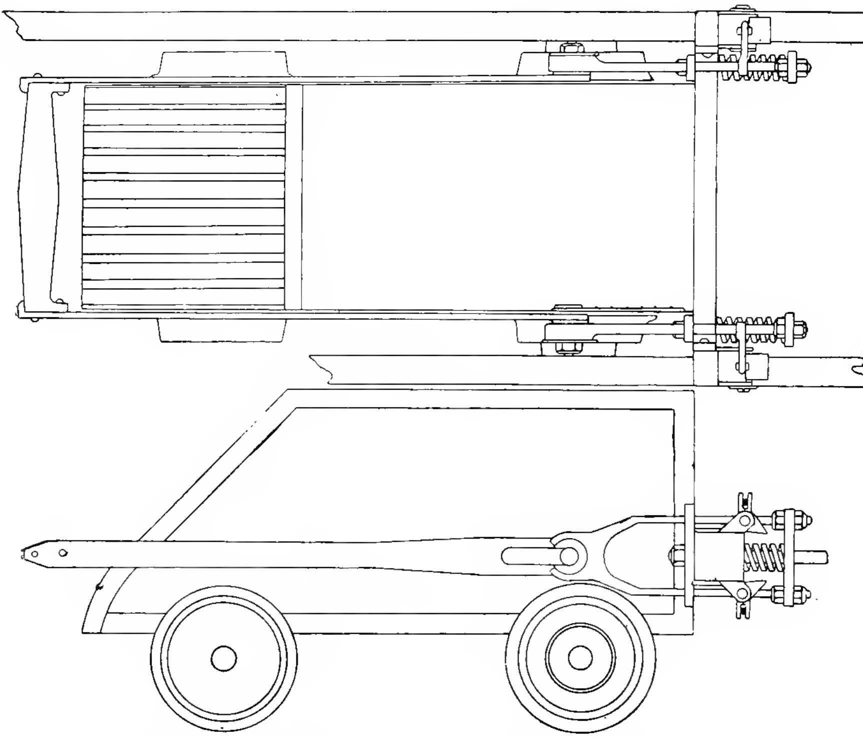
A public battery, under the control of the School of Mines Council, was erected towards the close of 1900. It has proved a boon to prospectors and tributers, enabling them to get trial parcels of ore treated at a moderate cost, the charges being such as merely to defray expenses of treatment. The plant consists of five head of stamps, one specimen-stamp, four berdans, furnace, retorts, &c. The whole is driven by a 9-horse-power oil-engine, making 250 revolutions per minute.

The bulk of the gold in the locality is coarse and free-milling, and the method of ore-treatment is wet crushing, with outside amalgamation.

Up to the end of 1905 a total of 472 tons of general ore and 2,739 lb. of picked stone has been treated at the battery, the whole resulting in a return of 3,007 oz. of retorted gold, valued approximately at £9,000.

Every opportunity is given students to inspect the battery while working, and thus obtain a general knowledge of the process of gold-saving. It will thus be seen that students attending this school are fortunate in having so well-equipped an establishment wherein to pursue their studies, and obtain instruction, at low cost, to fit them for a successful mining career.

Although in time past Coromandel has proved a very remunerative goldfield, it is at the present time passing through a period of depression. Still, there is every assurance that, with the development of the mines at greater depth, a new era of prosperity is in store for the district. Many students from this school are now occupying responsible positions in various parts of the world.



Taylor's Self-dumping Skip, with Safety-catches.

Mining Handbook.

NELSON SCHOOL OF MINES.

Director: W. F. Worley.

THE Nelson School of Mines was inaugurated in the early part of the year 1888. At that time, throughout the colony, a good deal of interest was shown in mining matters, owing to several metalliferous lodes having been then recently discovered, and Nelson had its share of the mining interest. The Owen Gold-field had just been discovered; fresh finds of rich copper-ore had been made in Aniseed Valley, and a lode of very rich silver-ore had been unearthed near Collingwood. Great things were expected from each of these finds. Large amounts of capital—partly local, partly foreign—were invested in them, but the brains necessary to direct the development of these mineral resources were not forthcoming, and share-raising seemed more important than ore-raising. To impress the unwary speculator, much capital was, in some cases, spent in showy outside works, while the proper development of the mine was starved by a too-meagre expenditure. About this time Professor Black visited Nelson, and delivered a course of lectures on practical chemistry, emphasizing the chemical methods employed in the extraction of metals from their ores. He had with him his assistant and a set of assay apparatus, and demonstrated in Nelson City, as well as in the outlying mining districts, how assaying was done. Professor Black's visit aroused a great deal of interest in scientific mining. A public meeting was held, at which it was resolved to establish a School of Mines in Nelson. About £60 was raised by public subscription, to which the Government added a subsidy of another £60. Both sums of money (£120) were spent in the purchase of chemicals, a portion of which has not yet been used, showing that at least some of the money was spent unwisely. A room was hired, classes formed, and a lot of feverish and crude assaying done. There was no systematic teaching; each member of the class was a professor, and in a short time the interest flagged and the school was closed. Several efforts were made to restart it, but without success. The Committee (practically the Nelson Philosophical Society) had then to face the difficulty of finding rent for the hired room in which the chemicals and apparatus were stored. For a time they paid the rent out of their own private funds; but finding ultimately that there was no possible chance of resuscitating the school, the chemicals and apparatus were handed over to the care of Mr. W. F. Worley, the writer of this paper, in the year 1891.* Since that time, by means of a small grant annually from the Government, school-of-mines work has been carried on, though there is no building in Nelson which can consistently be called a School of Mines. The school-of-mines work above referred to may be mentioned under three heads:—

First, the teaching of mineralogy, blowpipe analysis, and a little prospecting to some of the elder boys belonging to the State School: Since these classes were started 275 boys have received instruction and training in these subjects. Most of them, at the end of a two-years course, acquired sufficient skill in the use of the blowpipe to be able to identify with ease all the ordinary ores of commerce. Only a few of these lads, after leaving Nelson, seem to have taken to mining as a profession, but several of them have become school-teachers, and in their turn have become teachers of science. The scientific methods which they learned in the blowpipe-analysis class are now being passed on to the rising generation, so that the work here, though humble in its way, is far-reaching in its effects. A few members of the class have distinguished themselves in science in their later educational career, and have also become teachers, but in secondary schools. The greater part of the honour of their success belongs undoubtedly to themselves and to the learned professors who taught them, but their earliest training in science was unquestionably received in the Nelson School of Mines blowpipe-analysis class. It was there that they received their bias in the direction of science. Without it their inherent abilities would have been directed into other channels—probably classical studies. As most Nelson young

* It is entirely a labour of love on Mr. Worley's part.—Editor Mining Handbook.

men have to leave here in order to get employment, it is not easy to follow the career of those who have been members of the School of Mines classes, but some are known to occupy responsible positions in connection with mining. The blowpipe-analysis classes have undoubtedly borne fruit.

Second, the making of assays for the public: This branch of our work, though small in its way, is of importance to the district. When a prospector brings in a new find he can generally get it tested within a day or two, and thus save the delay that would be caused by sending to Auckland or Wellington. During the past eighteen years about six hundred assays have been made for the public at a mere nominal charge for the assay. Several samples of quartz, up to 14 lb. weight, have been treated for the extraction of the gold. This is a much better test than the ordinary assay, as one generally gets a better average sample of the reef to work upon, and the errors which are likely to arise from the use of small quantities are much reduced.

Third, delivering public lectures: During the winter months one or two lectures on some scientific subject are usually given. These lectures are free to the public, and are nearly always given under the auspices of some public body, such as the Nelson Philosophical Society or the Wakefield Branch of the Farmers' Union. These lectures are generally well appreciated, and tend to foster an interest in scientific subjects. General chemistry, agricultural chemistry, and geology are the subjects usually chosen for lecture purposes. It is intended in the near future to still further popularise these lectures by using a magic lantern for illustrative purposes.

The foregoing is a brief outline of our history and of our usual run of work. As occasion requires, other work, such as the teaching of assaying or chemistry, is undertaken. As this work has to be done in one's spare time its extent is naturally limited, but sufficient has been adduced to show that, at least, a useful work is being accomplished.

WESTPORT SCHOOL OF MINES.

Director: Sidney Fry.

This school was instituted in 1886, at the time when Schools of Mines were being organized all over the colony, and during the earlier period of its existence it underwent some vicissitudes. The school was maintained partly by revenue derived from class fees, membership fees, and assay fees, this revenue being subsidised by the Mines Department at the rate of £1 for £1. After being carried on in this manner for some little time the attendance dwindled down, and finally ceased altogether, and the school closed. In 1897 it was reorganized, a committee of management was formed, and Mr. James, assayer to the Anglo-German Exploration Company, was appointed Director. Classes were carried on with an attendance of six or eight students for the greater part of two years, when it again closed for want of attendance. After lying dormant for about a year, classes were reopened under the tuition of Mr. D. A. Strachan, M.A., who conducted them for about three years; the subjects were chemistry, assaying, and metallurgy; eight students attended. This gentleman gave his services free, but at this time the school lost its teacher, Mr. Strachan being promoted from teacher of the High School at Westport to Inspector of Schools in Marlborough. One of the students, Mr. Sidney Fry, then undertook to teach the classes, and, after doing so for about a year without receiving any remuneration, he was formally appointed as a salaried Director, and has retained that position up to the present time. The Mines Department now allows the school half the cost of the Director's salary. Shortly after the appointment of the present Director classes were instituted at Denniston, and later on at Millerton and Granity, thus bringing the means of a technical education in mining within easy reach of those working in the mines in the outlying parts of the district. The total attendance at the school and its country branches is forty-three students, three of these being young ladies. The subjects taught at the central and branch schools are mining, steam and applied mechanics, land and mine surveying, mathematics, mechanical drawing, mineralogy, theoretical and practical chemistry, assaying, and metallurgy, all the classes being taught by the Director.

In 1904 the School of Mines examinations were held for the first time, and then again in December of last year, and the students who sat acquitted themselves very well, one student, Master Leo Harney, at the last examination, gaining the highest in the colony for one subject—viz., 93 per cent. in mathematics. During the past five years all those students who have sat for mine-managers' and engine-drivers' certificates have passed without difficulty.

In addition to the teaching of students, considerable assay and analytical work is done at a moderate charge, such work including assays for gold, silver, copper, tin, lead, &c., as well as analyses for rare metals—a subject in which the present Director has to some extent specialised; analyses of coal, shale, boiler-feed water, and boiler-scale, and water for milling purposes; also tests of the efficiency of various chemical processes and machines for the treatment of ores.

One of the chief aims of the school has been to stimulate in its students the spirit of research, and to encourage them in the construction of mechanical appliances such as are applicable to mining or metallurgy. In these things some students have shown marked ability. Mr. Kenneth Ross, an ex-student, has made some interesting experiments on the chemical treatment of gold-bearing sands and cements, and has endeavoured to interest Mr. Thomas A. Edison in the enormous deposits of black sand in the West Coast districts, and to induce him to try his gold-saving appliance on these low-grade deposits. As a result of close search amongst the black-sand deposits which abound in this district, Mr. Fry has discovered the mineral "monazite" in those sands. Up to the time of this discovery that mineral was supposed to be non-existent in New Zealand, as it had been sought after to some extent without any positive result.

EXPORT OF GOLD AND SILVER.

Year.	Gold.		Silver.	
	Oz.	£	Oz.	£
1857 ..	10,437	40,422	..	..
1858 ..	13,534	52,464	..	..
1859 ..	7,336	28,427	..	..
1860 ..	4,538	17,585	..	..
1861 ..	194,031	751,873	..	..
1862 ..	410,862	1,591,389	..	..
1863 ..	628,450	2,431,723	..	..
1864 ..	480,171	1,856,837	..	..
1865 ..	574,574	2,226,474	..	..
1866 ..	735,376	2,844,517	..	..
1867 ..	686,905	2,698,862	..	..
1868 ..	637,474	2,504,326	..	..
1869 ..	614,281	2,362,995	11,063	2,993
1870 ..	544,880	2,157,585	37,123	11,383
1871 ..	730,029	2,787,520	80,272	23,146
1872 ..	445,370	1,731,261	37,064	9,913
1873 ..	505,337	1,987,425	36,187	9,850
1874 ..	376,388	1,505,331	40,566	10,385
1875 ..	355,322	1,407,770	29,085	7,560
1876 ..	322,016	1,284,328	12,683	3,170
1877 ..	371,685	1,496,080	33,893	7,550
1878 ..	310,486	1,240,079	23,019	5,759
1879 ..	287,464	1,148,108	20,645	4,511
1880 ..	305,248	1,227,252	20,005	4,506
1881 ..	270,561	1,080,790	18,885	4,235
1882 ..	251,204	1,002,720	5,694	1,282
1883 ..	248,374	993,352	16,826	3,780
1884 ..	229,946	921,797	24,914	5,125
1885 ..	237,371	948,615	16,624	3,166
1886 ..	227,079	903,569	12,108	2,945
1887 ..	203,869	811,100	20,809	3,453
1888 ..	201,219	801,066	403	72
1889 ..	203,211	808,549	24,105	4,041
1890 ..	193,193	773,438	32,637	6,166
1891 ..	251,996	1,007,488	28,023	5,159
1892 ..	238,079	954,744	22,053	3,996
1893 ..	226,811	913,138	63,076	9,741
1894 ..	221,615	887,839	54,177	6,697
1895 ..	293,491	1,162,164	85,024	10,679
1896 ..	263,694	1,041,428	94,307	10,589
1897 ..	251,645	980,204	183,892	20,872
1898 ..	280,175	1,080,691	293,851	33,107
1899 ..	389,558	1,513,173	349,338	40,838
1900 ..	373,616	1,439,602	326,457	38,879
1901 ..	455,561	1,753,783	571,134	65,258
1902 ..	508,045	1,951,433	673,986	72,001
1903 ..	533,314	2,037,831	911 914	91,497
1904 ..	520,320	1,987,501	1,094,461	112,875
1905 ..	520,486	2,093,936	1,179,903	120,549
Totals	17,146,627	67,230,584	6,486,416	777,702

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