

mostly of massive hornblendic rocks with diorite dykes, a few quartz blows, and veins of magnetite and manganese. The country is open and well grassed, being timbered only with a few casuarina trees. The conservation of water has been a great expense, as on this elevated tract of country (about 2,000 feet) wells have to be sunk a great depth, and, therefore, it has been found better to make tanks and dams. Most of the country between Dundas and Esperance Bay is thickly covered with mallee, the soil being either sandy or a light calcareous loam, which makes it very heavy for wheel traffic, and as it is so thick with scrub there is very little feed. Mount Ridley is a fine granite outcrop about 50 miles from the coast, around which several nice springs break out. From the top of this hill a good view of the surrounding country, which appears to be extensive sandy plains with salt lakes, and here and there bold granite masses and ranges rising from it. All the bold headland hills at the back of Esperance Bay are granite, but all along the coast in the centre of the bay recent limestones are met with, but these are mostly covered with the blown sandhills. Abundance of fresh water can be obtained by sinking a few feet in this formation.

HARRY P. WOODWARD,
Government Geologist.

December, 1893.

Appendix IV.

Report on the Mines, Coolgardie District,

By S. Göczel.

To the Secretary for Mines.

90-Mile Camp,
July 6th, 1894.

SIR,—

In accordance with instructions I have inspected the most important places in the Coolgardie goldfield, and now I have the honour to send over my preliminary report.

GEOLOGICAL REMARKS.

The general descriptions given in my last year's report, under the title "The Central Goldfields of W.A.," apply fully to the Coolgardie goldfield in particular, and, in the places where prospecting and mining operations were carried out, my theoretical deductions have found practical proof. In some instances, therefore, I will have to refer, for more detailed explanation, to that paper.

The principal rocks of the field are the massive and banded greenstones of palæozoic age. Concerning those rocks, I have observed that, in proceeding from West towards East, the quartzose diorites are gradually replaced by diabases, rich in olivine. The latter mineral, on and near the surface, is mostly altered into a greenish grey serpentinous secondary substance. Magnetite and pyrites are common accessories in both rocks, and limonite, as a product of rock and mineral alteration, is present almost everywhere on the surface.

The ore or gold deposit occurs in rocky areas, rising above the surrounding flat loess and lacustrine country, like islands out of the sea; their average height is moderate; I should estimate it to be 1,200ft or 1,300ft. above sea level.

The general description of the ore deposits would involve repetition of matter already treated, therefore, I will confine myself more to the description of special occurrences, and, in concluding this chapter, I am pleased to say that the wealth of the gold deposits already discovered in the Coolgardie goldfields has surpassed my expectations.

GOLD MINING CENTRES.

Since my arrival on the field I have visited and inspected the following places, viz. :—Coolgardie, Calgoorlie, I.O.U., White Feather, Broad Arrow, the so-called 25-Mile, Siberia, and the 90-Mile; besides I have crossed, from East to West, the Dead Finish and Black Flag country.

COOLGARDIE

Is situated on a contact zone between archæan gneiss-granite, from the West, and diorites and amphibolites from the East. The contact metamorphism offers a study of interest. The gneiss below the houses of the township is altered into a white, friable, quartz-containing rock of kaoline-like appearance. In the Government Well the gneiss is reached at a depth of about 70ft. Here we meet it about a mile West

from the actual contact, and find its original structure retained, although the felspar is kaolinised, and the biotite, through water absorption, has suffered alteration. In this place simple accumulative decomposition has occurred, whereas in the former place the metamorphosis in all probability is due to subterranean solfatara action.

The contact zone has here a more or less North and South strike, and encloses a number of large-sized quartz lodes (reefs) running in a similar direction. These lodes are broken and dislocated (thrown). They carry gold in shoots, and almost in every instance the occurrence of gold is connected with such breaks, throws, or faults. The gold emanation here seems to be of a later period than the formation of the reefs, in all probability during the volcanic after-action, to which the throws and dislocations of the lodes owe also their existence. The throws have mostly a transversal course to the reefs or lodes they cross and dislocate; the former are therefore of later origin. The transversal lodes contain principally so-called dig, that is, crushed and re-solidified country rock, produced by the friction of the walls. This dig in lower levels is heavily impregnated with iron pyrites, and mispickel in the higher levels. The throws appear as ironstone lodes. Quartz is also often met with in them. In many instances those transversal lodes will be auriferous. Both series of lodes are true fissures, and from all I have seen to the present I should judge the latter to be the channels through which the gold and pyrites, and other sulphides, were emanated.

The gold in the upper levels, as usual, occurs as free gold; below the water level it is associated with pyrites, especially with mispickel. To that fact too much attention cannot be devoted in the preparation of working plans and estimates, and to the deliberate disregard of that well known fact the collapse of many a mining venture in Australasia is due. The free gold to be found, and already found, on the Coolgardie goldfield is only a very small percentage of that associated with sulphides; and especially mines which are in the fortunate position to have large and rich gold shoots in the upper levels should give to that circumstance due consideration in the preparation of their working plan.

BAYLEY'S MINE.

A great amount of work has been done on that mine since the time it was occupied. A shaft over 240ft. deep has been sunk, and the continuance of the already world-famous ore shoot proved. Drives in several levels have been executed, a surprisingly large amount of gold produced, and great quantities of rich gold-bearing stone hoisted as well as exposed. The principal work—productive and preparatory—has been executed in and adjoining the great ore shoot. That work deserves credit for those who have planned and executed it under the existing circumstances, but the future of the mine requires far greater exertions in not too far off time, and it would be only in justice to the richness of the ore deposit, and to the already performed good work, if the preparatory steps would be taken to secure the future greatness of that celebrated gold mine.

The water influx will increase with the increasing depth and extension of the workings. The water, of course, will be salt and mineralized.

The mine requires already a working plan based on an exact mining survey.

The ore deposit in Bayley's Mine is a quartz reef from 4 to 8 feet wide, running in a more or less North-South direction; the reef dips towards East under a steep angle. The country rock is diorite and amphibolite, greatly decomposed towards the surface; the hornblende in it is altered to a chloritic mineral substance, and the felspar (plagioclase) kaolinised.

The quartz lode in its richest part may be considered as a double lode. The primary quartz lode was, during later disturbances, transversally broken, and parts of it dislocated. In the part last formed, the rich gold shoot, a longitudinal break has re-opened the old fissure, the quartz of the primary lode was to some extent broken in fragments, and a new fissure—running sometimes along the walls, sometimes in the middle of the lode—was formed. During the time of the gold emanation (in all probability the time of hydrothermal activity in this part of the earth) this fissure was re-closed by deposition of new quartz, iron pyrites, mispickel, and metallic gold. The mineral solutions have passed, not only the main fissure, but have also entered the spaces between the broken quartz of the primary lode, and their deposits, consisting of the above minerals, have re-cemented the fragments. As these solutions were rich in gold, the origin of the specimens in which barren quartz pieces are held together by metallic gold is explained.

The younger part of the lode appears in the workings in the form of a band of quartz of different colour and structure; it runs sometimes along the walls, at others inside the primary lode; that quartz is exceedingly rich in gold, and carries the metal as coarse and fine impregnation.

The difference in the appearance of the lode in the upper and lower levels lies, as it is generally known, in the decomposition of the sulphides and arsenical pyrites. To that circumstance the prevalence of free gold in the upper levels is due, and so is the presence of the limonite, and that of the pharmacosiderite, both secondary minerals derived from sulphides and arsenical pyrites. In the lower levels the gold is more associated with the latter minerals, but the occurrence of free gold, even below the water level, is of an extraordinary richness, and mispickel crystals, enclosing visible free gold, are not of rare occurrence.

ORE DEPOSIT IN THE VICINITY OF BAYLEY'S MINE.

A number of good gold shoots exist in all probability in the numerous reefs situated in the vicinity of the above mine. In a few instances such shoots have already been struck by enterprising prospectors and companies, but as the horizontal extent of those ore deposits in the reefs is limited, a great deal more prospecting in a downward line will be required before proper estimates as to the payable character of the mine-holdings can be made.

Under the present circumstances, only rich and extensive gold deposits can be worked profitably, and it will take time before lower grade ore can be treated advantageously; therefore, it would be advisable for the different holders of leases of promising character, in the different corners, to amalgamate their holdings, and to put the direction of the prospecting work into the hands of one capable, professional man. There is unity of design and great economy required to create a few payable mines in the vicinity of the celebrated Bayley's Mine, and it would be far better for the future of the gold mining industry in Western Australia—therefore, for the country itself—if, instead of the many leases, only a few large areas would have been secured, and judiciously and energetically prospected.

"CALGOORLIE" (Hannan's).

A large break in the country, consisting principally of coarse-grained diorite, extends over 6 miles from North-North-East to South-South-West, near the township of Calgoorlie, and encloses a countless number of lodes. The line of that break is marked by low, ironstone-covered hills. Diabase dykes seem to have played an important rôle in the formation of the gold deposits here, and it is most probable that the gold emanation in the rich and extensive Calgoorlie district falls in the period following those diabase eruptions.

The gold deposits here are a network of lodes and veins striking in different directions.

A great number of leases are worked in this locality by parties and syndicates, and judging from already exposed ore deposits, Calgoorlie will become one of the richest gold mining centres in the Central goldfields of Western Australia.

To ensure effective and profitable mining, the amalgamation of good holdings would be also recommendable.

There is little machinery on that place yet. Berry Brothers are working three small, more or less, North-South lodes of great richness; the stone is crushed in a grinding mill driven by a small kerosene engine, constructed on the gas engine principle, and the crushed material is washed in a cradle. Twenty ounces of gold are, according to Mr. Berry, obtained weekly by that simple process.

On the Boulder Gold Mining Company's Lease there is a small Otis crusher at work, but the stone treated at the time of my visit came from the rich lode of the Ivanhoe Gold Mining Company.

Several other claims were producing gold with simple hand dollying as means of extraction; among these, the claims owned by Thornett Bros., and by Peet and Espic, were prominent.

Great activity is displayed on this place by the mine owners, and it will not be long before very good practical results will be obtained.

THE I.O.U.

Westward from a large North-South quartz reef, and running parallel with it, extends a stretch of country about two miles long, in which several gold-bearing lodes occur. Hydrothermal action is here plainly traceable. The country rock, in all probability once similar to that in the adjoining hills, is here completely altered, and appears as magnesia, containing ferruginous clay. The country rock in the vicinity is partially diorite and partly diabase.

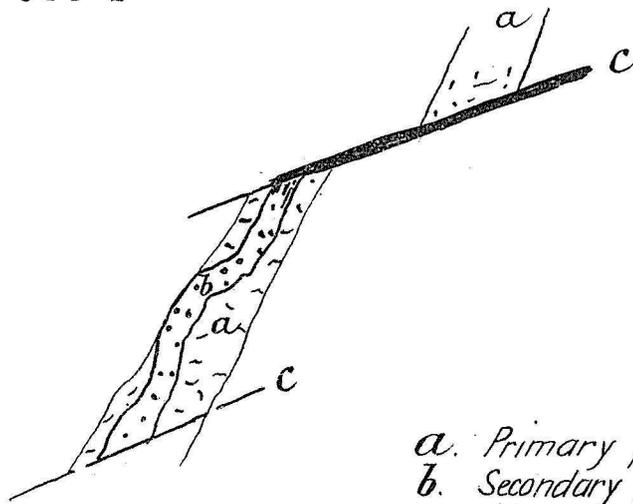
From an auriferous lode exposed in the ground of the Mystery Gold Mining Company, and in the adjoining I.O.U. claim, considerable quantities of gold have been obtained by stripping the surface of the lode to a depth of about 10ft. The lode consists principally of gritty limonite, which is evidently the product of decomposition of pyrites. Quartz occurs in the lode also in the form of grit, intermixed with clayey ironstone. The richness of the upper parts of that ore deposit is a promise that the pyrites in the lower levels will be highly auriferous. Therefore the owners of the mines should be prepared to have soon to employ a more effective method of gold extraction than amalgamation. At present only hand dollying is employed.

A main shaft is sunk on the "Mystery Mine."

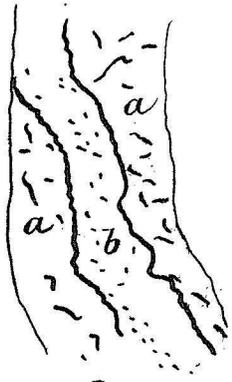
Similar but smaller veins, or so-called "leaders," occur in the vicinity of the mines mentioned, and the gold (about 70oz.) found on the outcrop of such a leader has caused lately a rush for alluvial in that locality.

There is besides a place called the 7-Mile Gully, E.N.E. from the Main Camp, and the 2-Mile Gully to the North from it, where gold has been found.

Nº 1



Vertical Section



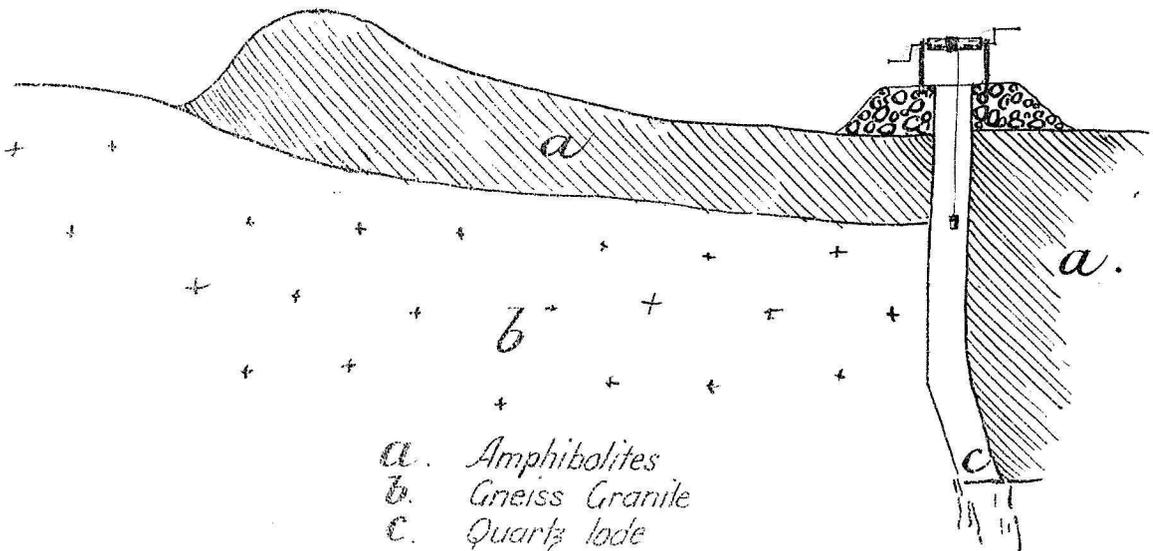
*a. Primary part of lode
b. Secondary part of lode
c. Throws*

Nº 2



*a. Quartz lode
b. Capping of lode
above break*

Nº 3



*a. Amphibolites
b. Gneiss Granite
c. Quartz lode*

THE WHITE FEATHER.

A large quartz lode from 3 to 6 feet wide, and running for miles in a more or less North and South direction, is the main feature of this place. Several other quartz lodes, running parallel to the former, and several cross lodes and leaders accompany it, and the most of them are auriferous. The gold shoots in the main reef contain the metal sometimes in coarse form, and carry besides a considerable quantity of fine gold not visible in the stone. Here the introduction of the gold into the lode has decidedly taken place after the deposition of the quartz. In the lower levels the gold is associated with pyrites (especially chalcopyrite) and mispickel. In one part of the lode the capping of same offers a very interesting feature. Here the diggers, working that portion, are under the impression that they are working an alluvial deposit. Sharp cornered quartz fragments, and such similar pieces of altered country rock, are cemented together by a green and brown coloured earthy mineral substance locally called "cement." The latter is in places very rich in gold. The metal is obtained by crushing and dry blowing. As already mentioned, the quartz fragments, ranging from the size of a walnut to that of a man's head, are sharp cornered, and located in that deposit without regard to size. Each fragment, or groups of them, are isolated by the cement, therefore they are not of alluvial origin. Only hydrothermal activity can offer an explanation. We have here an extinct thermal spring before us. Small quartz crystals, occurring abundantly in the cement, are found to have their edges and corners smoothly rounded; this has been performed by the rise and fall of the waters. Similarly smoothened quartz, and often also other crystals, can be observed in active bubbling springs in many parts of the globe.

The quartz lode was here broken, and the water rising in the break has deposited the suspended material, forming now the cement, and also the gold held in solution. Conforming with the principles devolved in my last year's report, this is not an alluvial deposit, but the capping of a rich gold shoot in a large auriferous reef. The block in which this part is located is under dispute between Bissenberger's Syndicate and the Golden Eagle Gold Mining Co. There are several more shoots in that lode, and most of them owe their origin to similar circumstances.

Besides the main reef several parallel lodes and leaders are prospected with very good results; they are all situated East from the main reef, and in several instances rich dollying stone is obtained. An interesting feature occurs in a lease called the "Kanana," held by Doyle and Mason. Here very rich quartz veins of only one to three inches thick, and with a Northward underlay, are worked. The gold is here not only confined to those veins, but often impregnates also the country rock, which consists of coarse grained diabase; very good results are here obtained by dollying. A very rich and extensive gold shoot is worked by Meiklejohn and Cottingham's party on a lode running parallel to the main lode, and having an Easterly steep underlay. On McAuliffe's 4-acre lease also rich gold bearing leaders are worked, and a considerable quantity of gold obtained by hand dollying. On the main reef prospecting work by shaft sinking is carried on, and on the three principal holdings, as McAuliffe's Lease, The Golden Eagle, and Bissenberger's, very promising results have already been obtained; here, as in almost all the other places of the central goldfields, estimates will have to be made according to opened gold shoots and not according to a so many ounce reef.

BROAD ARROW.

Here two principal lines of lodes are worked, an Easterly and a Westerly; they are about one-third of a mile distant from one another, and have both a more or less North-West and South-East course. On the Eastern line, in the *Hill End* 6-acre lease, four leaders with gold have been discovered, main shaft 30ft., a three-headed stamper battery in course of erection, and 400oz. of gold already obtained by hand dollying. On the *Arrow* 15-acre lease the lode opened by a shaft at the time of my visit 70ft. deep, is about 4ft. wide, and has a slight underlay towards N.E. Some of the stone shows coarse and fine gold. About 6oz. have been obtained by hand crushing.

On the *Benchmark* 15-acre lease, with a prospecting shaft, several leaders have been cut, and a drive for the reef is carried on.

On the Western line of lodes on the *Ritanita* 12-acre lease, a reef from 3 to 4 feet wide, and underlaying about 45° East, is exposed. Coarse and fine gold in several leaders is obtained.

The Monte-Cristo Reward Claim and *Reison and Son's* 6-acre lease.—A reef about 10ft. wide, exposed, underlay North. Productive work has here been carried out on a very rich shoot in a branch lode, and very high results with a simple hand-crushing obtained. Three runs of alluvial gold start from this place; in them about 4,000oz. of gold have been obtained. Prospecting is carried on in the adjoining lease *Patience*, held by Anderson Brothers and Reid, and in the *St. George's Proprietary* 18-acre lease, which is held by a Melbourne Company. On the latter tank-making was carried on.

Hughes and party were on two 12-acre leases N.W. of Reison's Claim searching for the continuation of Reison's reef.

DEAD FINISH.

Here *Chipper and party* have in their 6-acre lease, according to the owner, a rich shoot of gold. Samples of stone shown to me were very rich in coarse and fine gold. *Moncrieff and party* are working also two leases of 11 acres.

BLACK FLAG.

Elevation covered with ironstone and quartz. Alluvial workings. Finding gold shoots in the reefs requires prospecting. Have in the vicinity broken a piece of stone in which gold was visible. Want of water retards this place from becoming a reefing locality.

Two miles and a half South from Black Flag two prospecting areas are worked; one man being on a good reef. (Information from Mr. Chipper.)

THE 25-MILE.

This place, and the lodes discovered there are, like Coolgardie, situated on or near the contact zone, between the gneiss granite formation from the West, and the palæozoic greenstones from the East.

On the *Premier Mine* a large main lode running 50° West of North is worked. The underlay is about 45° in the North shaft. The latter is sunk on the underlay, and was at the time of my visit about 46ft. deep. The stone raised carries fine gold, some pieces showing it to the naked eye. The second or South shaft is distant from the first about 5 chains; it was 45ft. deep. The reef is here almost vertical, and about 15in. wide, whereas in the first place it has a width of about 6ft. on surface, and 12ft. on bottom. The country rock West is fine grained diorite; to the East amphibolite, altered into a sort of chloritic schist. A grinding pan driven by a small steam engine is at work; this arrangement will be of great service in ascertaining the approximate value of the opened-up parts of the lode.

On the adjoining *Premier Extended* 15-acre lease a shaft opens the reef to a depth of about 40ft. This reef contains the Southern continuation of the Premier reef. The width of it is here about 2ft., and it goes down almost vertical. The stone raised is ferruginous quartz, containing some fine gold.

The Royal Sovereign 24-acre lease, is about 2 miles South from the Premier mine. Here two parallel reefs, about 30 yards distant from each other, are exposed. Their course is N.N.W., their underlay East, under a steep angle. The Eastern lode is worked; its average width is 18in.; the main shaft is 80ft. deep, stone raised showing coarse and fine gold. Country rock West, gneiss; East, banded amphibolite; therefore, contact lode.

The Southern continuation of the Royal Sovereign reef is partly exposed in the adjoining *Westralia* 13-acre lease. Stone showing some fine gold.

The True Blue, or "Dunn's," consisting of three blocks (one 12-acre and two 9-acre leases). These three leases are named:—The True Blue, The Sunbeam, and The Lone Hand. Shaft in True Blue 60 ft. deep; lode 5 to 6 feet wide. Stone carrying fine gold. Amphibolite here altered into ferruginous clay. Shaft in Sunbeam 20ft. deep on a lode or reef of about 2ft. thickness. Country rock decomposed amphibolites. Fine gold in stone. Two parallel lodes. Shaft in Lone Hand, at the time of my visit, 61ft. deep. Lately a rich shoot dipping South has been struck. The lodes in those three leases seem to me to come together, and to form one large lode at a depth.

MOUNT BURGESS.

In this locality I have visited the following claims, viz. :—

Bendigo and Coolgardie Proprietary Co.—Through the five leases of that company several reefs of a North-Westerly course are running. In stone obtained in one place coarse gold is visible. The same lode contains also zinblende in small crystals. A large tank, capable of holding 120,000 gallons, has been excavated, and a water shaft is being sunk.

New Victoria 17-acre lease has two more or less N.W. running parallel lodes exposed. Both are dipping about 45° towards East. The main shaft was, at time of my visit, about 55ft. deep. The country rock is here kaolinised gneiss. The quartz raised contains mostly fine gold; some pieces also coarse. The main shaft follows the Eastern lode down. The quartz obtained from the Western lode contains, besides free gold, also arsenical pyrites.

The Westralia 25-acre lease (McLennan's) is North of New Victoria, and on the same reef, which is here about 4ft. wide. The main shaft is here 39ft. deep. The raised quartz contains, besides visible free gold, pyrites, and zinblende in crystals.

The Mount Burgess Company (leases 75 acres).—On the Northern end a water shaft, at present 110ft. deep. Water obtained at a depth of 93ft. Influx at time of my visit was 150 gallons per hour. The main reef has a more or less North-South course; underlay, about 45° W. It is crossed by an East-West lode. The width of the former is about 5ft.; that of latter about 3ft., with a dip of 45° North. The East-West lode is younger, and is proved to be auriferous along its course. Rich stone, carrying coarse and fine gold, is obtained at the lode cross. Here also the traces of thermal activity are visible, and the almost complete alteration of the amphibolite country rock into a white, friable silicate of alumina and magnesia, is due to that action. Depth of main shaft at time of my visit 85ft. A large dam is under construction.

SIBERIA.

Prospecting is carried on on *Christie's Reward Claim* and Lease. The main shaft is about 30ft. deep, and started on.

Cook's Lease (12 acres) lately taken. Both on parallel reefs of a W.S.W. course. Country rock fine grained diorite. Both claims have very promising features. Gold is visible in some of the stone obtained. Some of the gullies have supplied a considerable amount of alluvial gold, especially "The Prospector's Gully," "The Big Nuggetty Gully," and "The Deep Lead." There is alluvial digging still carried on, and at *Little Siberia* (about four miles from Siberia) a number of men are employed in alluvial digging.

(90-MILE (*Roaring Gimlet*)).

The reefs worked at this place are situated on a very large break in the country. The longitudinal extent of this break runs more or less North-South, and forms now the Western shore of a dry salt lake. The main quartz lodes are mostly running North-South, but they are again broken and dislocated by countless numbers of transversal lodes. The introduction of gold into the broken main reefs is due to the disturbances by which the latter lodes were formed. Prospecting and mining operations extend over a length of 5 miles on the South-Western shore of the above-mentioned lake, and in some of the leases very rich gold shoots have been already opened.

Beginning from North-West :

Lynch and Party, one 6-acre lease.—Several prospecting shafts. Exposed a reef 2ft. 6in. wide, running North-North-West. Western underlay shaft 20ft. deep. Coarse and fine gold visible in stone.

One 10-acre lease East of former.—Two shafts. No. 1, 42ft. deep, stone showing gold. No. 2, 25ft. deep; reef here about 6ft. wide; reef here broken, thrown about 20 yards.

Caledonia, 10-acre lease (Robertson).—Perpendicular reef running North-West; average width, 3½ft.; shaft sunk on a break; at time of visit 50ft. deep; very rich gold shoot, with coarse and fine gold; adjoining an alluvial gully.

Lynch and Party, 10-acre lease.—Greatly disturbed reef and cross reefs; gold in several places visible. Main shaft at time of inspection 50ft. deep. Several trenches. Very promising.

Gull's lease (6-acres).—North shaft at time of inspection 30ft. deep. Stone raised showing some fine gold. South shaft on break 25ft.

Moss & Lynch's 6-acre lease.—Stripping of reef. Stone with fine gold obtained.

W. Hicks' 5-acre lease.—Three reefs exposed. Course more or less North-South. Principal reef underlaying about 75° West. Main shaft sunk on a very rich shoot; at time of inspection about 40ft. deep. Owner has obtained out of it, by hand dollying, from 700 to 800oz. of gold. The two Western reefs underlaying East. Stone showing fine gold.

Hawson's 10-acre lease.—Network of lodes. Two shafts. North shaft at time of inspection 35ft. deep. Reef exposed 2ft. wide. Stone raised rich in coarse and fine gold. Underlay of reef steep towards West. South shaft 25ft. on reef, showing also coarse and fine gold.

Curts' Blow or Golden Lake.—Four men's ground, two miles south from Hick's claim. Lode cross. Gold visible in stone.

Featherstonechough's two leases.—No. 1, 12 acres. Cross of two lodes. Small shaft. Stone showing gold. No. 2, 12-acre lease, adjoining No. 1 on South. Network of lodes.

Lynch and party, 15-acre lease, at the Four-Mile.—Large quartz outcrop, some places showing gold. The presence of an adjoining rich alluvial patch makes this place promising.

"*The Birthday*," *March's* 18-acre lease.—Network of lodes. Fine gold in stone visible. Very good prospects obtained by crushing and washing.

The Cushman's Reef (18-acres).—Network of reefs. Shaft 24ft. deep at time of inspection. Fine gold in stone raised.

Otto and Boddington's 12-acre lease.—Large reef running more or less N.W. Width averages 4ft. Underlay steep, Westwards. Shaft at time of inspection 84ft. deep, following a very rich and extensive gold shoot. Considerable quantity of gold obtained by hand dollying. Gold in stone coarse and fine. There is also a cross reef running N.-East, rich in gold, and crossing the main reef in the place where the rich gold shoot occurs. The continuation of that cross lode is known in an adjoining claim known as

Con's Leader, where a considerable quantity of gold was obtained by dollying.

I have, &c.,

S. GÖCZEL,

Government Assistant Geologist,

Inspector of Mines.