

## REPORT ON THE MINERAL FIELDS BETWEEN WARATAH AND CORINNA.

(With two plans.)

*Government Geologist's Office, Launceston,  
30th June, 1900.*

SIR,

I HAVE the honour to submit this Report of my inspection of the line of mineral country extending from the township of Waratah, at Mount Bischoff, to Corinna, on the River Pieman, a distance of 40 miles S. and W. from Waratah, by track and road. The geology and mineral features of this district have been reported upon by former Government Geologists (Messrs. G. Thureau, A. Montgomery, and J. Harcourt Smith), but since then some of the mines have been opened out and developed, and this circumstance, taken in connection with the present more favourable market rates for metals generally, has rendered a renewed inspection of the area desirable, with the view, more particularly, of ascertaining whether its geological and mineralogical characters are such as to encourage the hope of its becoming any important factor in the mineral output of the Colony.

### *Topography.*

The township of Waratah is about 2000 feet above sea-level, at the base of and to the south of Mount Bischoff, which rises 500 feet above the Waratah plateau. This is the town for the famous Mount Bischoff Tin Mine, which has its working faces on the mount to within a short distance of the summit, and its ore-dressing floors in the valley below the township. The road from Waratah to Corinna first runs south-west over basaltic table land for some four or five miles, and then proceeds westward, skirting the southern end of the Magnet Range, rising about a couple of hundred feet to the saddle of the hill at the turn-off into the Magnet Mine, about 7 miles from

Waratah. High land rises here on both sides of the road, for the Magnet Range is continued south-west into the Meredith Range. The road then descends 930 feet in three miles, to the Whyte River Bridge. At the hotel near this bridge the old Godkin tram runs off south-west into the Washington Hay, Confidence, and Godkin group of silver-lead mines. Near the hotel is a flat (the 10-mile) being worked for tin, and on the ridge some stanniferous ground is being explored by the Khaki Tin Company.

The road continues west to the Heazlewood through timbered, hilly country. At 13 miles, Jupp's boarding-house is passed, where a track turns off south to the Whyte River Gold Mine and the Result and Discoverer sections (the Result is the old Bell's Reward). The Godkin and Godkin Extended can also be reached this way. The track, as far as I went along it—to the Discoverer—is a good one. It was first made by the Government as a pack-track, and afterwards widened for drays by the Bell's Reward people. Drays can get along, but the track would be all the better for a little adjusting in places. On the main road, five minutes west of Jupp's, a footpath through the swamp leads past the Pinnacles Mine across the Heazlewood River to the Nickel Hill, where the Lord Brassey and Jupp's nickel workings are situate, on the top of the somewhat conical hill, 700 feet above the river. A mile further west along the main road is the old ore-shed of the Heazlewood Mine. A track here goes south to the Heazlewood and South Heazlewood Mines, Binks' and Jupp's copper shows, the Castray River gold-workings, and the Mount Hope, formerly Mount Stewart, Mine. This track is five miles long, and, in some parts, is in bad condition for packing, besides which, I think, a better route might have been followed, so as to avoid some of the steep gradients. The main road to Corinna continues falling down to the Heazlewood Bridge, which is 800 feet below Jupp's, and 1700 feet below the 7-mile peg. The road here crosses the river at 16 miles from Waratah, and skirts the Bald Hill for three miles further west, as far as the roadmakers have got with the construction. On my return at the end of March, the men were giving up work for the season. From the creek at this end a path leads to where Major Hughes' party are washing sand for osmiridium, in the Savage River. The Bald Hill, as its

name implies, is now bare of trees, excepting a patch at the western end, which covers some basalt. At the 19-mile, the pack-track leaves the Bald Hill serpentine, and enters slate and sandstone country, well timbered, from which it emerges on to the treeless button-grass table-land known as Long Plain, 1100 feet above the sea. This plain forms the watershed between the Savage River on the one hand, and the Whyte River on the other, and is famous for the quantity of gold obtained from its detrital capping. At 24 miles from Waratah a newly-made track goes northward to the Specimen Reef gold-workings on Hall's Creek, and 100 yards further west are the Bullock's Head and shelter hut. Here a path turns N. across the plain, and in a mile reaches H. H. Gill's sections, formerly Weetman and Crockford's, where a fair quantity of crystallised gold, perhaps 500 to 600 ozs., has been won.

At the western end of this plain the track descends into the wooded, broken country of the valley of the Whyte River, about 14 miles from Corinna. The bridle-track, for a distance, here, was bad. At 12 miles from Corinna, the roadmakers were constructing the road towards Waratah. The way in which the road was being formed was none of the best, and I doubt whether it will stand much traffic. When I was there I heard talk of impending stoppage of the work, owing to exhaustion of the Parliamentary vote. This would leave a gap of 10 miles bridle track between the two ends of the road, and if the intervening distance is not made available for wheeled traffic, the work already done loses much of its usefulness. At present, the consumer at the Corinna end has to pay more for his stores than the one at the Waratah end, notwithstanding that the sea freight to Corinna, from Launceston, is only 30s. per ton, against £3 a ton railway freight from Burnie to Waratah. The completion of the road will undoubtedly bring an improvement in this respect. Mines in this remote part of the island, where the cost of living, risks, and conditions, are so unfavourable, deserve every encouragement. If adventurers are ready to accept the risks, their work should be facilitated in every way; for it is only by continuous prospecting that the mineral resources of these fastnesses can be explored and exploited.

A little over nine miles from Corinna, a cart-track leads to the Cape Copper Mine, on the Nine-mile Creek, and half a mile further south, the main road enters on Brown's Plain—another button-grass table-land, from 750 feet to 900 ft. above sea-level. The plain extends towards Corinna for about  $2\frac{1}{2}$  miles. At  $7\frac{1}{2}$  miles from Corinna is the mail-hut of the Rocky River Mine, and a track goes east to the mine buildings at the suspension bridge over the Whyte River. Just within six miles from Corinna, wooded country is again met with, and a small patch of Tertiary basalt is seen. After this the road commences to descend, and falls all the way down to Corinna, on the Pieman. The Pieman, at Corinna, is a noble river, about 400 feet wide and 40 feet deep, with a tidal rise of  $2\frac{1}{2}$  to 3 feet. About a couple of miles below the township, the river cuts through the Donaldson Range, exposing lofty cliffs on each side. Here the river is 80 feet deep, and not more than 150 feet wide. The Pieman Heads are 11 miles from Corinna, and the river mouth is faced by a bar a mile out at sea. Vessels of 12 feet draught can pass over the bar, but there is danger of going on shore at the sandspit. Corinna has a deserted aspect, owing to the abandonment of the alluvial workings in its vicinity.

From the above it will be seen that, after the descent from the Waratah plateau to the Heazlewood, the country, to within a few miles of Corinna, is, practically, a lofty plain, 800 to 1100 feet above the sea, rising in parts into high hills. Deep and precipitous gorges have been cut in this plain by the Savage, Whyte, and Heazlewood rivers, with their tributary creeks.

#### *General Geology.*

The stratified rocks along this traverse belong to different geological systems. At the Mt. Bischoff end are highly inclined and contorted slates of, probably, the lower Silurian, succeeded further west by fossiliferous sandstones of middle Silurian age. The bed-rock further to the west, from Long Plain to Corinna, consists of slate and sandstone, interrupted only by the Whyte and Rocky rivers' belts of schist. The slates and sandstones may be lower Silurian, and the schists still older. No light is

thrown upon their age by any discoveries of fossils. The slates and sandstones are a stratified series, and have, as a rule, been subjected to regional metamorphism. The Mt. Bischoff slates are, perhaps, the least altered; and those on the Long Plains, the most so. The Rocky River hornblende gneiss, and schists have been intensely metamorphosed and reconstructed, and they would appear to have originally been eruptive rocks, though any definite genetic theory is at present attended with uncertainty. Long subsequent to the formation of the Rocky River gneiss, I think we may take it that the whole of the lower Silurian (or, to use a term denoting our ignorance of their age, Cambro-Silurian) sediments underwent varying degrees of metamorphism at the close of or after the lower Silurian period, for the middle Silurian sandstones at the Heazlewood, beyond being hard and crystalline, do not bear the marks of severe regional metamorphism. The fossils in the latter have been preserved as tolerably recognisable casts, while all traces of life appear to have been obliterated in the more altered strata of the older date. These older slates and sandstones on the Long Plain, &c., are not only interpenetrated with silica in veins and sheets, but often so saturated with it as to be simply quartz schists, the laminæ being entirely quartzose.

Subsequent to the middle Silurian, basic and ultra-basic eruptions or intrusions took place, penetrating and displacing the buried sedimentary strata, and forming subterranean masses and dykes of gabbro, peridotite, and pyroxenite. There is no evidence that these deep-seated eruptions ever reached the surface, for we see no ancient basalts in this area, unless the diabase porphyrite at the Magnet Mine is regarded as a lava sheet. The gabbros and allied rocks occupy the central part of the field, from 7 miles west of Waratah to the creek at the 19-mile: consequently, with the strata into which they have penetrated, they form a zone 12 miles wide from east to west. This group of rocks has become much serpentinised, the magnesian minerals pyroxene and olivine having been converted into serpentine. The beautiful green and mottled specimens found near Beaconsfield, in the Forth and Dundas districts, are not common here; still, some varieties are pleasing. Bastite, the serpentinous

modification of enstatite, is frequently seen in the serpentine derived from pyroxenites and norites. The pyroxenites and peridotites do not form large masses of rock like gabbros, but dykes and marginal modifications of the gabbro bodies. They sometimes have the appearance of traversing masses of serpentine, as well as intruding into sedimentary strata, but they are all of one geological age, and may be interpreted as differentiations and protrusions from the interior of the gabbroid magma before it had consolidated to the core. There may be some slight differences of age, chronologically, between these dykes, but geologically they belong to one and the same eruptive series. Mr. Geo. A. Waller, Lecturer at the Zeehan School of Mines, in writing to me respecting the relations between peridotites and gabbros, quotes Professor Le Conte's Elements of Geology, as follows:—"Speaking generally, it may be said, that in the gradual cooling of such a mass, the first to crystallise are the more basic minerals. These crystallise first in the outlying parts, where cooling is most rapid, and then similar materials continue to accumulate and crystallise there by migration of the more basic materials to the solidifying parts, leaving a more acid remnant in the centre to solidify last." Mr. Waller then proceeds to say:—"As far as my observations have gone, I have always found the peridotite associated with serpentine on the margin of the gabbro. And my theory is, that the serpentine (*i.e.* pure massive serpentine) is an altered peridotite: and that the differentiation theory shows why the peridotite, and, consequently, serpentine, is always found on the margin of the gabbro." It will be interesting to note occurrences throughout the Colony, and observe whether they tend to confirm this theory or otherwise.

Nowhere else in Tasmania is there such a rich assemblage of rock varieties belonging to the basic and ultra-basic division of eruptives, accompanied, too, by numerous lead and silver bearing lodes. Some more extended remarks upon these rocks will doubtless prove acceptable.

The Gabbroid rocks include—

Gabbro proper (plagioclase + augite).

Olivine norite (plagioclase + enstatite + olivine).

The Peridotites include—

- Harzburgite (olivine + enstatite).
- Lherzolite (olivine + diallage + enstatite).
- Wehrlite (olivine + diallage).

The Pyroxenites include—

- Diallagite (diallage).
- Websterite (enstatite + diallage).
- Bronzitite (bronzite).
- Websterite-porphyrite (enstatite + diallage).

The Gabbroid group belongs to the basic series of rocks, with 45 to 55 per cent. silica, and the Peridotites and Pyroxenites to the ultra-basic, with only 39 to 45 per cent.

#### *Gabbro.*

This rock, which is essentially composed of plagioclase felspar and a pyroxene (monoclinic, as augite or diallage; orthorhombic, as enstatite, bronzite or hypersthene), occupies, in the basic series, taxonomically the same position as granite does in the acid series, *i.e.*, it is the plutonic member of the series. The intrusive members are comprised in the dolerite (diabase) group, and the volcanic ones in the basalts (and melaphyres). Consequently, wherever we see gabbro exposed at surface, we may be sure that a vast amount of denudation has taken place. As the rock is a deep-seated one, and has consolidated under enormous pressure, its texture and structure are granitic: the crystallisation is in large plates, the crystal boundaries being irregular, through the pressure of adjoining crystals. The felspar is always a basic one, generally anorthite (sp. gr. 2.75), sometimes bytownite (sp. gr. 2.71) or labradorite (sp. gr. 2.69).

As the gabbros have very generally succumbed to serpentinisation, it is not easy to find fresh exposures, but the rock can be seen at the side of the road about 14 miles from Waratah, a few hundred paces west of the Heazlewood ore-shed. Going up the Heazlewood River east of the Nickel Hill, a flat occurs at the mouth of a creek coming down from the hills to the west. This delta is strewn with large stones and boulders of basic and ultra-basic rocks, which must have been swept down to their present resting-place by heavy torrential streams. It is a remarkable collection of such rocks as serpentine, gabbro, norite,

saussurite, chromic iron ore, &c. The saussuritic gabbro is a particularly handsome rock, in which the felspar has been converted into milk-white saussurite, leaving the dark crystals of pyroxene scattered through its mass. Some of the dykes, too, between the seven and 10 mile pegs on the Waratah-Corinna road, appear to be gabbros.

#### *Peridotites and Pyroxenites.*

These are the plutonic ultra-basic rocks, composed either solely of pyroxene (pyroxenites) or of pyroxene combined with olivine and (or) hornblende, as in the peridotites. There are dykes of this series at intervals all along the main road from the 7-mile to the 12-mile. It is not always easy to see what country these dykes are running through, but I could sometimes see that they were bounded by decayed igneous rock with spheroidal or concentric weathering, most likely gabbro, originally. Not infrequently the intrusions are through sandstones and slates. From Jupp's westwards the rock on the road, for about a mile, is amphibolite, afterwards serpentinised bronzite or bastite, and then passes into a more decided serpentine. There is a good deal of pyroxenite W. of the bridge across the Heazlewood River—sometimes pure pyroxene, at other times, a websterite (diallage and bronzite). These rocks and serpentine continue westwards all along the road cut in the side of the Bald Hill, as far as the 19-mile gully, where the serpentine, slightly asbestiform, comes to an end, and is succeeded by dark Silurian slates.

This great mass of ultra-basic rock is intersected by dykes and veins containing silver-lead ore, copper, and nickel ore, and is the home of the osmiridium found in small quantities in the alluvial of the rivers. Chromite, found in the sands of the Heazlewood and Arthur rivers, is also derived from the serpentine, and occurs, too, very plentifully, in the solid rock, but is not abundant enough to form a workable ore. The various occurrences of mineral will be alluded to below in the descriptions of the mines.

#### *Granites and Syenites.*

The relative ages of serpentines and granites on the West Coast have never been determined with any degree of certainty, and on my journey I always had this question.

in mind. The mutual relations between these two groups are not easily seen in the field.

Granitic or quartz porphyry rocks, in the form of elvan dykes, appear at Mount Bischoff, where they are tin-bearing, and occur again at four and five miles from Waratah, as granite and porphyritic granite. As far as can be seen they crop up from below the Silurian slates. Further west, at Jupp's, and on the Heazlewood River, east of Nickel Hill, also on the Discoverer section, syenite, granite, hornblende granite, and hornblende granite occur in the area of serpentine rocks, where they are evidently intrusive. Intrusions of granitic rock may be seen along the main road near the 14-mile, and penetrating serpentine on the track to the Heazlewood Mine. These occurrences support the inference that the granitic rocks are later than the serpentines, and the indurated, flinty appearance of the serpentine, near its contact with granite, as seen on the section north of the North Silverstream, near Zeehan, and at Trial Harbour, further confirms it. More observations are still required to enable this relation to be established as a general rule throughout the Colony. It may be recommended to those interested in geology to pay especial attention to sections of serpentine and granite contacts, for they often have a bearing on the continuance of lodes across the contact boundaries.

The serpentines are clearly subsequent to the middle Silurian, for they have lifted sandstones of that age, seen above the S. side of the Main road, near the 14-mile from Waratah.

The geological systems represented in this part of the Island, are as follow:—

- (1.) Pre-Cambrian, doubtfully, at the Rocky and Whyte rivers.
- (2.) Silurian slates, and sandstones, everywhere.
- (3.) Devonian, gabbroid, and serpentine rocks intrusive into the aforesaid slates and sandstones, and carrying copper, nickel, and silver-lead ores. At a later stage in this period granite and syenite penetrated both slates and serpentine, carrying, in some places, silver-lead, in others, tin-ore.
- (4.) Jura-Trias.—The mesozoic dolerite or diabase occurred about a mile N.W. of the Magnet

mine, not far from the old track from Waratah. Its structure is identical with that of the same rock in other parts of the Colony.

- (5.) Tertiary.—Tertiary sediments occur at Waratah, on the Magnet range, Brown's Plain, and on the fall of the country down to Corinna, and they are all of pre-basaltic age. A good deal of this country was once covered by the coastal sheet of Tertiary basalt. The line of route from Waratah to Corinna was, approximately, its southern fringe, though, on the meridian of Waratah, basaltic country extends further south towards the Pieman. At Waratah, we have a thick capping of this lava at the township, covering up Tertiary sandstones, which contain fossil leaves of the genera eucalyptus, quercus, laurus, and ulmus. About 4 miles from Waratah, on the old track to Corinna, there is a deposit of Tertiary coal overlaid by basalt. It was bored into several years ago, to a depth of 14 feet, but only shaly coal was found, which burns with a bituminous smell, and has a good deal of ash.

On Brown's Plain, the bed-rock has a thin covering of quartz-pebble wash, often cemented into a conglomerate, which, in its turn, has been degraded, resulting in the release of the pebbles. This conglomerate is firmly bound, and might easily be mistaken for a palaeozoic deposit. I could never find the conglomerate itself in contact with the underlying slates which form the bed-rock. I believe, therefore, that the cementation is purely superficial. Among the stones of the wash are some of quartz-tourmaline rock, which must have come from a stanniferous-granite area. The nearest granite which we know of, and the most likely source, all things considered, is that of the Meredith range, on the south side of the Whyte river, but the occurrence of these stones high up above the White, on its north side, is significant of the amount of denudation which has taken place since Tertiary times. There is a similar cement on Long Plain, 300 or 400 feet higher, but on that plain the stones of quartz are angular, not water-worn, and have most likely been derived from the laminæ and lenticles of quartz abounding in and

between the slates. It did not appear to me that the quartz detritus seen along the track on Long Plain, was at all water-worn; but directly we came to Brown's Plain the majority of the stones are smoothed or rounded by the action of water. At the west end of Brown's Plain a small patch of Tertiary basalt is cut through by the road. It is not more than 100 feet wide, but is evidently posterior to the quartz-wash. Hence the latter cannot be a recent or later Tertiary deposit, but, may be compared with the infra-basaltic or early Tertiary gravels found in other parts of the Colony. Descending hence to Corinna, the pebbles become larger, and the drift itself looser and heavier, and extensive terraces of a more recent wash prevail. In early tertiary times the sea covered the land here, and subsequent elevation of the land has lifted the pebbly drift to its present height

I now proceed to refer to the different mines.

*Mount Bischoff Tin Mine.*

This mine, situate on the slopes of Mount Bischoff, which rises 500 ft. above the Waratah plateau, is too well known to need description. The present company was founded in 1873, nearly two years after the first discovery of tin ore by James ("Philosopher") Smith. The mine has been continuously dividend-paying since 1878, the total dividends paid to date being £1,674,000. The total tin ore obtained to date has been 57,358 tons, value £3,316,528. The output of ore for the past twelve months has been 1945 tons, the average of stuff treated being about two per cent., and the cost of mining, crushing, and dressing, 5s. 7d. a ton, of stuff. Work is being carried on at the White, Brown, and Slaughter-yard faces, and prospecting on the Queen lode and from the main tunnel. The state of the mine-works is fully described in Mr. Kayser's half-yearly reports, and I need only refer to the geology of this remarkable deposit. Several writers have touched upon this from time to time. See

Stanniferous Deposits of Tasmania :  
 Trans. R. S., New South Wales. S. H. Wintle. 1875.  
 New York Year-Book of Mineralogy. G. H. F. Ulrich. 1877.  
 Quarterly Journal Geological Society. Chas. Gould. 1875.

Berichte der Niederrheinischen Gesellschaft.	G. von Rath.	1879.
Report on the Waratah Mining District.	G. Thureau.	1884.
Proc. Roy. Soc. Tasmania.	A. von Groddeck.	1885-6
Geology of Tasmania.	R. M. Johnston.	1888.
Jack's Geology of Queensland.	A. W. Clarke.	1892.
Aust. Ass. Ad. Science.	H. W. F. Kayser.	1892.
Proc. Inst. Civil Engineers.	Kayser & Provis.	1895-6.
Catalogue of the Minerals of Tasmania.	W. F. Petterd.	1896.
Introduction to the Study of Mineralogy.	F. M. Krause.	1896.
Proc. Roy. Soc. Tasmania.	Twelvetrees & Petterd.	1897.
Louis Phillips' Ore Deposits.	—	1896.
Zeitschrift der praktischen Geologie.	W. von Fircks.	1900.

The various allusions and descriptions date from different stages in the history of the mine, and it is only of late years that some approach to a comprehension of the nature of the ore-deposit has been made.

In the first place, we must premise that below the Silurian slates there is a hidden granite mass, which is the source of the tin, and which has communicated with the surface by means of intrusive quartz porphyry or elvan dykes. Opinions have differed as to whether the ore-bearing ground is a hot-spring deposit, or the plug of a volcano, or a stockwerk; but microscopical analyses of the ores and rocks have recently thrown great light upon the subject. The aforesaid dykes bound the Brown Face deposit, near the top of the mountain, on three sides, and dip towards the enclosed central area. This underlay suggests that they will form junctions in depth. The central area is fissured slate, and has been worn down into the form of a basin, which has collected the gossanous and stanniferous waste of the dykes and their contained veins for countless ages. The iron of the gossan has, apparently, been derived from the pyrites abundant in the dykes, and trials, 150 feet below the floor of the Brown Face, have shown pyritic veins carrying tin ore underneath the gossan formation of the face. The veins are, no doubt, contemporaneous with the dykes, dykes and veins belonging to one eruptive phase. The ground enclosed by the dykes is fissured by these veins, in which the tin is largely associated with iron pyrites, an association which prevails elsewhere in the district, notably in the North Valley. The

Queen lode has the appearance of being subsequent to the quartz porphyry dyke, which it traverses, but still belongs to one and the same series of intrusions. I believe the junction of the dykes in the heart of the mountain is still below the trial drives made underneath the Brown Face. It is impossible to predict exactly what will occur at the intersection, but the normal stanniferous contents of the dykes are likely to improve at that point. We must bear in mind, however, that, while the detrital deposits worked at the three faces average between two and three per cent. of cassiterite, the stanniferous dykes themselves are very much poorer, and a good deal of enrichment would be required for the solid dykes to yield a payable return. The detritus and gossan forming the ore-body of the Red or Brown Face may be described as an immense mass of natural concentrates, which have been worked by the Bischoff Company for over a quarter of a century, and remain still unexhausted. With the lapse of time and continuous work the basin will be emptied of its stanniferous contents, and the solid dykes and veins will constitute the material to which the owners will have to look for their supplies of ore.

Referring briefly to the petrological side of the subject, I may describe the groundmass of the dyke rocks as being granular quartz, sometimes felsitic quartz and felspar, and containing scattered crystals of the same minerals. Magnesian mica has not been found in it, but some secondary white mica occurs. I invite particular attention to this, for it thus differs, mineralogically, from the nearest granites. The nearest exposure of granite rock is on the road to Corinna, 4 miles from Waratah, where it is strongly porphyritic, with abundant dark mica. Its porphyritic crystals are orthoclase and plagioclase feldspars, magnesian mica, and quartz, in a groundmass of orthoclase, quartz, and mica, all three minerals occurring as a second generation. A mile further on the same road, at Wombat Hill, the granite (more strictly, granitite or black mica granite) is composed of the same minerals, with the addition of a little green hornblende. About here, too, black tourmaline rock is associated with the granite, and this type of tourmaline is also not met with at Mount Bischoff. It is consequently probable that the Bischoff dykes intersect not only the slates, but also the peripheral

portions of the granite directly below them, proceeding from a deeper unconsolidated part of the granitic magma. Such dykes are called, in Cornwall, "elvans," and though excellent authorities have cast discredit on the term, there really does not seem to be any valid objection to its use, so long as we attach to it a definite and well-understood meaning. Rutley uses it very well as a group name,\* thus:—

*Acid Series (Silica, over 66 %: Orthoclastic Felspars).*

Volcanic (Rhyolite Group)—Obsidian, Rhyolite.

Dykes and Sills (Elvan Group).—Felspar porphyry,

Quartz porphyry, Micro-Granite, Pegmatite.

Plutonic (Granite Group).—Granite and Granite.

The elvan dykes have been invaded by fluoric and boric vapours during the consolidation of the rock, and these have topazised and tourmalinised it. The topaz is developed in three forms—columnar, prismatic, and amorphous. The columnar form is in radiating aggregates, and has received the name of pycnite. Both the radiating and prismatic forms prevail in the rock of the Queen lode. The amorphous, or allotriomorphic, variety is developed where topaz has replaced the rock as a whole. The quartz sinter found at Mt. Bischoff has been thought to indicate a derivation from volcanic springs, but this is a misinterpretation, for there is no volcanic rock associated with the stanniferous deposit. The so-called sinter is an aggregate of quartz crystals, which are often coated with a cloudy peripheral zone of pseudomorphous topaz. This topaz effervesces slightly with acid. This exhibits a second conversion, that of topaz into prosopite, a double fluoride of calcium and aluminium.

The tourmaline at Mt. Bischoff is a green variety, and was at one time mistaken for chlorite. Minute rods or needles of this mineral sometimes fill the whole of the interior of crystals of felspar. This proves the secondary nature of the tourmaline.

These observations permit conclusions to be drawn as to the relative ages of the minerals concerned in the composition of the dyke-rock. In many instances, topaz and

\* Granites and Greenstones. F. Rutley. Page 12.

tourmaline have replaced both porphyritic feldspars and the quartzose groundmass. Professor von Fircks infers from his examinations that the tourmaline is of a later date than the topaz and cassiterite, and remarks that he has noticed it contemporaneous with siderite. It is quite clear that we have here a good example of pneumatolytic action, but it is difficult to separate physically the moments of topazisation, tourmalinisation, and final consolidation, for the dyke, as a whole, or in parts, must have retained still some degree of viscosity while this complex process was going on.

The following is a list, drawn up by Mr. W. F. Petterd,\* of the minerals known to occur in the Mt. Bischoff dykes:—

- Apatite*.—Occasionally obtained in small crystals which can be recognised with unaided vision.
- Arsenopyrite*.—In considerable abundance in the lower levels.
- Arsenic, Native*.—As narrow blades and patches between the laminae of siderite, fluorite, and pyrites in lower level North Valley workings.
- Azurite*.—In bunches of minute crystals, in the Brown Face, with malachite.
- Cassiterite*.—Colour invariably intensely black.
- Chalcopyrite*.—The massive form, only known in limited quantity.
- Copiapite*.—As an efflorescence in the older adits.
- Copper, Native*.—As thin foil interbedded in fissures in the slate, adjacent to the elvans.
- Cyanosite*.—On the roof and sides of adit, North Valley.
- Disapore*.—In the Stanhope mine, but not abundant, as shining, flattened, and brittle prisms of a yellowish-brown colour.
- Fluorite*.—Variety chlorophane. Somewhat plentiful, occasionally in irregular masses without distinct crystallisation.
- Hematite*.—Variety Reddle. The common matrix of the stanniferous portion of the surface workings of the mine.
- Limonite*.—Also abundant.

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\* Proc. Roy. Soc. Tasmania, 1897, pp. 126-128.

- Lithomarge*.—Commonly soft and unctuous, more or less coloured by ferric oxide.
- Malachite*.—In thin coatings and patches in gossan at the Brown Face.
- Melanterite*.—Incrustating in the old adits.
- Monazite*.—In aggregations of small crystals of a light brown colour, with wolframite in the West Bischoff.
- Muscovite*.—The unaltered mineral is extremely rare.
- Orthoclase*.—Can only be distinguished by optical characters.
- Pholerite*.—Met with in masses in the Stanhope Mine. It is an extremely soft aggregate of mineral scales, with a glimmering lustre.
- Pyrolusite*.—The earthy variety is commonly intermixed with limonite.
- Pycnite*.—This form of topaz is one of the most characteristic minerals of the Bischoff elvans.
- Pyrites*.—Abundant.
- Pyrophyllite*.—Very plentiful, in aggregated, fibrous, radiating masses.
- Prosopite*.—On the western side of the surface workings this substance is abundant. It usually forms a kaolin-like friable mass.
- Quartz*.—Of common occurrence.
- Siderite*.—In opaque, interbedded, obtuse rhombohedra of large size, of a yellow-brown colour.
- Sphalerite*.—Rare, in small patches, with pyrites and the last.
- Stilphnosiderite*.—Occasionally met with as thin, varnish-like incrustations of extreme thinness, and of an intensely black colour.
- Sulphur*.—A somewhat large pocket was met with in the Brown Face.
- Topaz*.—This has only been detected of microscopic size.
- Tourmaline*.—Invariably of the peculiar dark-green colour characteristic of Bischoff. It is usually in felted masses of minute crystals, which rarely exceed 18 mm. in length.
- Vivianite*.—Has been obtained in groups of crystals in small fissures in the rocks in one of the adits, and also in amorphous, clay-like masses.

*Wolframite*.—In the West Bischoff, intermixed with apatite and quartz.

There are evidences of underground tin sources for some distance from Mt. Bischoff. There is tin ground at the Whyte River, 10 miles from Waratah, and the metal is met with at the foot of the Meredith Range, to the south of Mt. Hope. Alluvial tin ore is found at—

*Webster's Workings.*

This is a claim covering five 40-acre blocks, five miles out from Waratah on the Corinna Road, and a mile south from the turn-off—first across a small button-grass flat, thence through scrub. The sections are situated along a creek, which is considered to be a tributary of the Coldstream, one of the head streams of the Huskisson. This creek is bordered by flats covered with stanniferous wash from six inches to three feet deep, averaging, perhaps, about two feet, though it has been estimated at 2 ft. 6 inches. The flats altogether are about six chains wide by a mile long. In the creek, the wash, as a rule, is shallow, but in places I could see it was  $1\frac{1}{2}$  feet deep. Sundry holes over the flat denote former prospecting. Some of the ground, about a chain in length by half a chain in width, was worked several years ago, and three-quarters of a ton of tin ore is said to have been got out. In Webster's worked ground I saw some narrow veinlets of pure tin ore in the granite, as thin as a knife-blade, up to a quarter of an inch thick, and in the creek some dishes were washed, the prospects from which were afterwards weighed, with the following results:—

From creek.....	$2\frac{1}{2}$	ounces per dish.
"    ".....	$\frac{3}{4}$	ounce    "
From old hole.....	$\frac{1}{4}$	"    "

This would give an average value of from £600 to £700 per acre. I should say the estimate of  $1\frac{1}{2}$  ounces to the dish is a conservative one. Mr. Downie took several prospects, which he reports as not less than two ounces to the dish, and, in two instances, even six ounces. The question then becomes one of cost of raising. The bulk of the mineral is a fine-grained grey ore, though in the creek which runs through wash about a chain wide, it is pretty coarse. All the dirt would have to be lifted, as it

is too flat to ground-sludge. A track or a tram could be made to connect the claim with the Waratah main road without any difficulty, as the ground rises gently towards that road. The great drawback is the quantity of scrub and fallen timber. The scrub can be got rid of without much trouble, by letting it lie a year or two and then firing it, but the trunks of fallen trees which encumber the ground and creek will be extremely difficult to handle, and will prove a formidable impediment. If these obstacles can be overcome without excessive cost, and further prospecting confirms the results obtained on my visit, the present time would be a favourable one for exploiting this claim.

The bedrock is a fine-grained grey granite with porphyritic feldspars, abundant dark mica, and a little muscovite. There is a good deal of loose tourmaline in the wash, often seen enclosed in fragments of reef quartz.

*Ten-mile Tin claim at White River Bridge.*

This is on a small flat about a mile south-west of Green's *Whyte River Hotel*, and is reached by walking along the old Godkin tramway. The Whyte River lies to the N.W. of it, and it is bounded on the S.E. by a high hill ridge on the top of which the Khaki adventurers have commenced prospecting some stanniferous veins since my visit. The tin-bearing ground at the foot of the hill is about 500 yards wide, and seems to run up the slope a little, but gives out to the west, for tin is never found in the river. It was worked recently by the Whyte River Tin Mining Company, but a lot of their ore was lost by allowing the stanniferous clay to ball and roll down the race, collecting tin as it went. I saw many of these clay balls: it is evident the ground cannot be worked without puddling. As a tin show, the claim has peculiar features. The material is not alluvial, but a yellow clay formed *in situ* by the decomposition of the bedrock, which is serpentine (?). In places there are ten feet of this clay, resting upon rotten serpentine rock, and up the hillside as much as 14 feet are said to have been passed through without bottoming, but the average depth on the flat is from one and a half to two feet. The included stones are angular, not water-worn, and the tin is crystalline, with the angles very slightly smoothed, and adhering

often to sharp vein quartz. The tin ore has not been brought from a distance; on the other hand, no tin has been observed in any of the numerous quartz veins which intersect the bedrock. Several large, loose lumps of lode quartz, very rich in tin, have been found, and this fact indicates the existence of a tin lode near by, but up to the present it has been searched for fruitlessly. No outcrop is visible anywhere, and from this I infer that its discovery will be difficult, for it has most likely been planed down by denudation to the level of the bedrock, and it will not be found until the latter is exposed at the proper place. The presumption that such a lode exists in the neighbourhood is next to a certainty, and ought to incite systematic search for it, as the quality of the fragmental veinstuff leaves nothing to be desired. Serpentine is an unusual rock for tin-ore veins, and the bedrock, though looking decidedly serpentinous, should be carefully examined to establish its nature definitely. At any rate, the veins have proceeded from adjacent granite, and higher up the hill are Silurian clays and sandstones. Granite rock is not seen at surface nearer than the Magnet and Meredith Ranges, the nearest, half a mile off. In this ground excellent prospects are obtained from the grass-roots, and a few dishes were washed on my visit. Perhaps the whole flat would average half an ounce to one ounce per dish. Water for working can be brought from the Whyte River by going one and a half miles further upstream. The deposit is not of any magnitude, but a few men, either on tribute, or working on their own account, might do fairly well. Leaving the tin deposits, which are so intimately connected with granite, we come to a series of mines whose ores are associated with ultra basic rocks and the serpentine derived therefrom. Though they are not far from granite rocks, the fissures or ore-channels are devoid of free silica, but filled with ultra-basic dyke-matter which can have come only from similar rock magma. Such mines are the Magnet, Confidence, Washington Hay, and certain mines of the Heazlewood group.

A little before reaching the turn-off to the Magnet, a strong lode crops out on the south side of the road, carrying a little pyrites. This will most likely be a silver-lead lode, though there is no distinctive mineral noticeable in the outcrop. Though this lode is barren at surface, it

might very well be prospected, traversing, as it does, a known mineral district.

*The Magnet Silver-lead Mine.*

This mine owns two sections, four miles west of Waratah, as the crow flies—Nos. 3705-87M., 20 acres, and 2075-91M., 40 acres. The mine works are on the 20-acre block, and are proceeding principally in the direction of the 40 acres. The property can be reached from Waratah by the old track to Corinna, in about six and a half miles, if a little rough walking is not objected to, but the most convenient approach is by the macadamised Waratah-Corinna road, to near the 7-mile peg, and thence by the company's tram-line, two and a half miles in length, which leads into the mine. The company is now having a route surveyed for a steam tramway to connect with the Emu Bay railway line a little below Waratah, in about eleven miles from the mine. The proprietors have hitherto been consigning their first-class argentiferous lead ores only, maintaining the standard contents at about 90 ounces silver, and 25 per cent. of lead, per ton. The ores shipped have also carried about one and three-quarter dwts. of gold per ton. The declared policy of the company is to extend the scale of operations by sending to market the large quantities of gossan ores which have been disclosed by the workings, but left untouched, so far, for economic reasons. An alternative which has been put forward is to smelt the total produce on the spot. In view of the risks and losses so often attendant on the inception of metallurgical works, this alternative is not to be recommended. The new tramway is intended to provide the means of conveying the increased output economically to the railway line. The gossan ores, from their fluxing properties, are in favour with lead-smelters, and when the proposed tramway is completed the company anticipate being in a position to maintain a large regular output of ore, increasing up to 1000 tons per month.

The position of the mine is on the south-eastern slope of a part of the Magnet Range, which itself is a continuation of the Meredith Range. The Waratah-Corinna Road passes over a saddle between the two at the 7-mile. The Magnet Range is not a geological unit, the result of upthrow, for it consists of widely-different rocks, slate,

sandstone, diabase, pyroxenites, &c. It is only a geographical feature of the landscape, due to long-continued denudation, combined with the progressive elevation of the land which the northern part of Tasmania has undergone since middle Tertiary times.

The geological formations represented on the range may be stated as follow, in descending order —

*Recent.*—Alluvial with waterworn tin, on North Magnet section.

*Tertiary.*—Basalt, along the old Waratah track, half a mile from the mine. A vesicular olivine basalt, similar to that at Waratah.

Brown coal, on the old track, two miles from Magnet Mine. Underlies the basalt.

*Mesozoic.*—Dolerite (diabase), north of the old track, a mile from the mine.

*Devonian.*—Granite.

Websterite-porphyrity, the Magnet dyke. Much dolomitised.

Orbicular or spheroidal Websterite } hanging-wall  
Diabase porphyrite = variolite } side of dyke.

*Silurian.*—Micaceous sandstone, on foot-wall of dyke.

Slate, west of dyke.

Quartzites, on tram-line south of mine.

It is quite possible that some of these references cannot be sustained with absolute certainty. The granites in different parts of the Colony are assigned to the Devonian, chiefly on the evidence of granite intrusive in the upper Silurian, at Middlesex. Granite rock, in the form of a spherulitic felsite dyke, traverses the middle Silurian, at Zeehan. Nowhere in the Island does it penetrate Permo-Carboniferous strata: on the contrary, erratics are enclosed in the lower beds of that system. Its range is consequently confined to the time between the Permo-Carboniferous and Upper Silurian. I have placed it as the youngest member of the Devonian, because, elsewhere, we have reason to believe it intrusive into the serpentine and pyroxenite rocks. Whether the gabbros and pyroxenites are Lower Devonians or uppermost Silurian cannot yet be settled. At present we can only conclude that they are younger than Middle Silurian, for in the section beyond the 13-mile, on the road through the Heazlewood, the

serpentine impinges upon, and raises fossiliferous sandstone of that age.

The great feature on the Magnet property is the wide dyke of eruptive rock (porphyritic websterite), enclosing the lode or veins of argentiferous galena. This runs through the Magnet ground, with a mean bearing of N. 26° E. It continues into the North Magnet section till it is lost under Silurian strata, half a mile north of the North Magnet Mine. It has not been seen further in that direction, and has either come to an end there, for dykes do not continue indefinitely, or has been faulted, or for some reason has not reached the surface beyond that point. In the other direction it has been traced southwards as far as the Magnet Proprietary section, where a shaft has been sunk over 60 feet deep on its gossanous outcrop. The stuff on the heap at mouth of shaft consists of slate and greenish eruptive rock. From the yellow websterite rock, a few yards north of the track, I infer that the shaft is on or near the dyke-line, and I do not understand why the Proprietary people do not prospect their ground.

The dyke on the Magnet section is 360 feet wide, and courses, for the most part, along a line of contact, being bounded on the east by micaceous sandstone of Silurian age, and on the west by a dark amygdaloidal and nodular variolite. The relations of this variolite are ill-understood. It apparently constitutes the selvage of a band of diabase-porphyrity, the only felspathic rock in this igneous complex. The dyke does not always keep to the contact boundary, for it is separated towards the south from the variolite by a seam of slaty pug of variable width. This comes in from the south like a wedge, gradually widening out in that direction. I think this arises from the dyke being bounded there on the the west by slate country, as is seen very well on the surface coming down the hill from Pasch's trench, where we have slate on the west side, and sandstone on the east side, of the dyke. The sandstone is decidedly hardened by contact with the intrusive rock. The dyke-rock, in its freshest parts, is dark green in colour, compact and tough, with porphyritic crystals of pyroxene (enstatite and augite). For its absolute determination a specimen was sent to Prof. H. Rosenbusch, at Heidelberg the greatest living authority in petrology, and he has, after

microscopical examination, pronounced it to be websterite-porphyrite, *i.e.*, porphyritic websterite, a pyroxenite composed of the two varieties of pyroxene enstatite. His determination of this exceptional rock is so valuable that I quote his remarks :—

“If we follow the rock back to its original and unaltered state, we shall find phenocrysts of bronzite or enstatite (now bastite) in a groundmass of rhombic and monoclinic pyroxenes (now a mixture of serpentine and a chlorite mineral). It is therefore a porphyritic form of websterite—a websterite-porphyrity. Its nearest relations are certain bronzite serpentines (without olivine). In the structure of the groundmass it resembles the South African kimberlite and the mica-peridotites of Kentucky, described by Diller. In this purity of form the type is quite new to me. An analysis is very desirable. It must, free of water, give the formula of the Mg—Fe metasilicates, and exclude orthosilicates.  $Al_2O_3$  would only be present in small quantity. Also, CaO would not be prominent.”

The dyke has undergone very general decomposition, being partly dolomitised, and contains a good deal of calcite as well. It is stained pale green over considerable areas. This colour has been ascertained to be due both to chromium and nickel. In parts of the dyke, particularly near the hanging and foot walls, the rock has been altered into purely white crystalline dolomite. Mr. F. O. Hill, Assayer at the Hercules Mine, has made an analysis of this dolomite, with the following result :—

	per cent.	=		per cent.
Ca O	31.72	=	Ca CO <sub>3</sub>	56.64
Mg O	15.60	=	Mg CO <sub>3</sub>	32.76
Fe	3.92	=	Fe CO <sub>3</sub>	8.26
Mn	1.80	=	Mn CO <sub>3</sub>	3.76

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101.42

Mr. W. A. Macleod, B.Sc., B.A., has also carried out an analysis of the same rock, with similar results.

The dyke is ore-bearing near its hanging-wall. The footwall portion has not been thoroughly explored. The upper part is oxidised, being a ferro-manganese gossan, containing lead carbonate, sulphate and chromate, with

some galena, and good values in silver. 0.03 per cent. arsenious acid has been found in the gossan, and it also shows antimony oxide, derived from the jamesonite (sulphide of antimony and lead) present in the sulphide ore. The sulphates, carbonates, and chromate are sure indicators of the primary lead sulphide beneath. Mr. Alexander Orr, F.C.S., of Sydney, has made the following analysis of a sample of the Magnet gossan:—

	Per cent.
Silica .....	12.00
Oxide of iron .....	44.80
Carbonate of lime .....	1.50
Carbonate of magnesia .....	.80
Oxide of manganese .....	17.80
Carbonate of lead*... ..	14.67
Sulphur .....	.22
Copper.....	Nil.
Alumina .....	6.50
Moisture .....	1.20
	<hr/>
	99.49

Silver, 34 ounces.

The western or hanging-wall portion of the dyke is conveniently described as the lode proper. There are two periods represented. There was an igneous eruption or intrusion when the molten dyke-material burst through the adjacent rock, and a hydrothermal period when the dyke rock was traversed and permeated with metalliferous solutions. The process of deposit has been partly one of precipitation in small fissures; partly one of substitution, as in the concretionary and ring ores. Thus, we have within the dyke a hanging-wall and a foot-wall of the lode proper, and this is what is meant by those terms in the mine reports. The lode has been driven upon by 4 levels:—

No. 1 upper level.....	259 feet
No. 2 level.....	420 "
Intermediate level .....	353 "
No. 4 level .....	310 "

The No 4. is 225 feet from surface, on the underlay, and a lower level, 90 feet vertical below No. 4, will be opened

\* Lead, 12.38 per cent.

out as soon as the tunnel now being driven from the North Magnet section gives access to the lode. The width of the lode in the different levels varies from 5 feet to 31 feet, and is estimated by the manager to average 18 feet. The shoot of ore at the level of No. 2 is 360 feet long: there is a block of ground to stope above this level of, roughly, 200 feet by 80 feet, and new developments have, I understand, taken place since my visit. The intermediate level is 60 feet below this, with good gossan ore in the north drive, and poorer ore in drive S. The bottom level has opened access to a 115-feet by 320-feet block of ground for stoping. Where the No. 4 tunnel intersected the lode, the ore is beautifully banded with carbonate of iron, affording, perhaps, the most striking illustrations of this structure to be found in the Colony. From just behind the south end in this level, the lode-matter was sampled recently, in bulk, and averaged, for a width of 20 feet, 58 ozs. silver, 10 per cent. lead. Further back, the sampling bulked 60 ozs. silver and 16 per cent. lead. The end is gossany, and has small galena veins running through it. The north drive had been suspended at 160 feet from the flat sheet, under the impression that a slide had occurred, cutting off the lode, and a cross-cut W. had been put in behind the face, but I could see no evidence of any fault here. The ore certainly gives out, and is succeeded suddenly by white dolomite, as in No. 2, but, at the most, all that can be said is that the ore-shoot ceases in this direction, and the drive has not been carried far enough to enable even that to be said with safety. I should recommend this drive to be continued. It is desirable that both N. and S. ends should be driven, so as to establish the true length of the ore-shoot at this depth. The upper level (No. 2) has proved the shoot for a longer distance than this (No. 4), and it is highly improbable that the present length of No. 4 is the measure of the shoot of metal, for the ore pitches south, and we may thus expect its S. limit in the lower levels to be further south than in the upper ones. It will take over 300 feet of driving in each direction to bring the respective ends to the boundaries of the section.

The secondary ores, which predominated in the higher levels, and which are derived from the decomposition of sulphide ore, are giving way to the latter as a depth is

attained at which the agencies of decomposition do not operate so freely. Metalliferous gossan, however, is still descending at No. 4 level, and has assayed up to 160 ozs. silver for 40 per cent. lead. The ratio of silver to lead in the Magnet is singularly constant, being 3 to 4 of silver to 1 unit of lead. This is a higher ratio than in any other mine in the Colony. The ratio of the Zeehan field is one or two of silver to the unit of lead. In all probability the deep level from the North Magnet property will show the lode at that horizon to contain a good deal more sulphide than gossan, and once the horizon, vaguely called the water-level, is reached, the deeper zone of purely sulphidic ore will be entered. If the change is not met with in the lower tunnel, it may be looked upon as impending shortly below that. The fine body of gossan which exists in this mine, as much as 29 feet in width in No. 1 level (south), and perhaps wider, shows the oxidising action to have taken place to a remarkable extent. It has been thought that the water of the creek to the west of the dyke has played an important part in the formation of this gossan, and certainly, if any quantity of water from that source has been percolating for ages into the lode, it would contribute largely to the manufacture of gossan, and, in a minor degree, to the decomposition of the dyke-rock. This decomposition, however, and the transformation into dolomite, is mainly associated with the access of the ore-bearing solutions. In the dolomitic part of No. 4 are curious wires and curved threads of native silver, resulting, probably, from the alteration of sulphide or arsenide.

I have been continually asked what I think of the prospects of this mine in depth, but it is impossible for anyone to predict the behaviour of the lode beyond the limits of observation. The low level from the North Magnet will set the question at rest, as far as the additional 90 feet are concerned. I see no reason why the present shoot of ore should not go down to that depth—a total of 320 feet vertical from the surface outcrop. If it continue down further than that, it will have a very fair length for an uninterrupted shoot of silver-lead ore, and it will probably be accompanied by a correspondingly long extension horizontally. There is no known physical cause to prevent its descent to an extreme depth, but that would be exceptional. If, however, the present size and quality of the

ore-shoot are maintained for another 100 feet in depth, it would mean an addition of at least 50 per cent. to the present reserves.

The dyke on its W. or hanging-wall side is bounded by a dark nodular variolite merging into vesicular diabase-porphyrityte. The exact relation of this rock to the dyke has not yet been settled. It is the only felspathic rock in the complex, and may turn out to be a later intrusion along the dyke-line. This rock has also been submitted to Professor Rosenbusch, who admits that it is a difficult one to determine. He writes:—

“If a slide be made of the soft dark-green groundmass (which is soft enough to be scratched with a knife), it can be seen to consist of a scaly aggregate, the scales of which can often be recognised as chlorite, with very weak double refraction, and optically positive: optic axial angle very small. Pleochroism weak, normal = green for rays vibrating parallel with the surface of the flake, yellowish-white for those vibrating perpendicular thereto. In it are lying colourless sections, variously bounded, but always with crystallographic contours, long, rectangular, and prismatic, also nearly quadratic, extinguishing sometimes straight, sometimes oblique. In convergent light these often show the emergence of a positive bisectrix of a not very large axial angle, sometimes the emergence of a negative bisectrix of a very large axial angle. In the first case, no structure is recognised; in the second, a more or less scaly or fibrous structure. Their refractive index differs very little from that of the main mass, and there are often seen lying in these apparent crystals green heaps of scales without any clear boundaries, but passing into the colourless substance and having the same optic orientation. In the colourless sections there are also lying homogeneous and homoaxial pseudomorphoses of chlorite, poor in Fe (Leuchtenbergite) after a pyroxene mineral, but I cannot say whether the latter was monoclinic or orthorhombic. Further, in the green mass, there are circular hollow spots (nearly always surrounded by cracks), which were no doubt originally amygdaloidal cavities, but are now filled with mixed chloritic and quartz spherulites of irregular architecture. It is quartz (optically + and uniaxial), not chalcodony (optically — and biaxial). Finally, in the groundmass, are little aggregations of iron ore, which I have not

examined more closely. They dissolve easily in HCl., which also strongly attacks the chlorite and leuchtenbergite. Now, if a slice be made through the nodules, which are much harder than the groundmass, and sometimes cannot be scratched with the knife, here and there chloritic spots are seen, containing small sections of chalcedony amygdules. Inside the nodules is sometimes some groundmass. More frequently, however, the nodules consist of colourless substances. Large aggregates of granular, or even radiating, quartz are seen, sometimes without any regular external boundary, sometimes plainly, and, without doubt, showing the form of felspar. These are replacement metamorphoses of quartz after felspar, of such beauty as I only know in quartz porphyries. Between these pseudomorphoses of quartz after felspar there are roughly-radiate bundles and spherulitic crystals of felspar, which, from their optical behaviour, clearly belong to orthoclase or andesine. They are partly converted into sericite, and, when this happens the nodules can be scratched with a knife. Finally, the nodules are much intersected by veins of quartz, the filling of cracks in the rock. Iron ores are absent; but, from the often quadratic and trigonal outlines of the quartz aggregates, I believe we must conclude that the ores have been removed and their place taken by quartz. After all said and done, I regard the rock as a characteristic variolite, but certainly in a much-altered state."

This variolite and diabase porphyrite rock, traversed by veins of quartz, exists as a band, about 300 feet wide, and is succeeded further west by a yellow-brown soft bronzite or websterite, crowded often with spheres of the same mineralogical constitution, ranging from the size of marbles to that of cannon-balls. These spheres, when broken across, show no concretionary or radial structure, but are exactly similar in apparent texture and architecture to the enclosing rock, from which they are easily released. Pending complete microscopical examination, the rock may be called orbicular or spheroidal websterite or bronzite—in any case, a pyroxenite.

Mr. W. F. Petterd has supplied me with the following list of minerals met with at the Magnet Mine:—

*Anglesite*.—In large crystals; some very fine.

*Jamesonite*.—Occurs in small patches with the galena.

*Galena*.—Usually with a little antimony.

*Cerussite*.—Good maced crystals often met with.

*Pyromorphite*.—Small groups.

*Calcite*.—Milk-white amorphous patches in dolomite.

*Cassiterite*.—In alluvial, at North Magnet.

*Crocoisite*.

*Dolomite*.—In the websterite dyke.

*Limonite*.—Plentiful in upper levels.

*Massicot*.—Abundant.

*Minium*.—With the last.

*Mimetite*.—In small brown crystals.

*Native Silver*.—In hair-like bunches.

*Sphalerite*.—Amorphous; not plentiful.

*Antimonial Silver*.—Species. (?)

*Endichite*.—Minute hexagonal prisms.

*Vanadinite*.—Prismatic; colour, bright yellow-red.

*Bindheimite*.—Pulverulent; plentiful.

*Stibnite*.—Occurs as a gangue mineral.

*Psilomelane*.—Found associated with limonite and bindheimite.

The total output of the mine, sold to date, has been 1761 tons 3 cwt. 0 qrs. 2 lbs. silver-lead ore, realising, after all deductions, £20,628 1s. 4d.

The mine, as it stands at present, has the promise of a bright career. The work done has proved the shoot of ore for 400 feet horizontal length, and at least 230 feet deep. The shoot is still going down, and its length, also, is not yet definitely proved. Judging from its horizontal extension, there is a justifiable expectation of continuance in depth. At the time of my visit, the blocks of veinstuff, which it was anticipated could be profitably worked, supposing easy means of transport into Waratah, aggregated, according to my calculations, 1,080,000 cubic feet. Allowing 25 per cent. for cavities and other deficiencies in the mass, this represents 50,000 tons ore-stuff; and I am informed that, since my visit, the developments in the mine have been such as to warrant a present estimate of 60,000 tons of such ore. The bulk value of this ore has been arrived at to the satisfaction of the owners by systematic sampling and assaying. They claim that the 60,000 tons average 32 ozs. silver, 12 per cent. lead, 1dwt. gold per ton; assay value, at present prices, £5 18s. per ton. They are doing well, however, in negotiating with the New

South Wales smelters, to base their calculations on 30 ozs. silver and 10 per cent. lead, in order to keep within the limit of safety. Besides these 60,000 tons of marketable ore, there are large quantities of lower grade vein-stuff, estimated at 40,000 tons and upwards, which will not pay to work for export. This is said to vary from 1 to 7 per cent. lead, and 5 to 15 ozs. silver per ton. Besides these 40,000 tons of low-grade ore-stuff, there are large quantities of oxidised material of a still lower grade, viz., below 10 ozs. silver, and below 5 per cent. lead.

These latter quantities cannot be estimated, even approximately, and I do not think they ought to be taken into account at all, because, even if mixed with richer ores and smelted on the spot, they would reduce the profit to less than that expected on the 60,000 tons, which it is now intended to send away for treatment. My opinion is that it will be safer for the company to stick to the present idea, and sell all ore of the 60,000 tons grade, which, once the tramway is finished, ought to realise, at present prices, a profit of certainly over 35s. a ton. The low-grade stuff is not available as an asset at present. It could only be utilised in the event of the erection of smelters, which I would strongly deprecate before this mine grows into a much larger concern, and other shows are developed at the 10-mile into permanent mines. When the mine works descend into the purely sulphide zone, concentrating works may be thought of. The oxidised ores, as a whole, cannot be advantageously concentrated, being soft, friable, and having a low specific gravity. The concentration of this class of ore would result in excessive loss of silver. It would involve a preliminary process for leaching out the silver in the wet ores, and leaching the tailings of the dry ores. The loss of silver in dressing is conditioned largely by the nature of the ore, being disproportionately large in light and brittle ores. The sulphide ore of this mine, with a carbonate of iron and dolomitic gangue, is well adapted for concentration, but as the proposed steam tramway will enable the company to get both sulphidic and oxidised ores away at a profit, there seems little doubt that the rational policy would be to export the whole output for smelting on the other side of the straits—at any rate, for the present.

North Magnet Mine.

This mine has its works on a forty-acre section, <sup>north</sup> and ~~south~~ adjoining the Magnet. The line of dyke from the Magnet comes into the section, and is marked by a course of gossan several chains in length. The dyke runs for half a mile <sup>south</sup> north, but has not been traced north of the section. The bottom tunnel in this mine is designed to allow a drive to be put in south on the course of the dyke, and continued into the Magnet property 90 feet below the No. 4 low level in that mine. When I was there this tunnel, a wide one, for a double line of rails, had been driven 174 feet, and it was estimated that another 300 feet would bring it to the intersection of the lode. The driving since has brought it to within 80 feet. The approach to tunnel is through 75 feet of soil, and the adit is then in the footwall country of grey sedimentary grit, with carbonaceous matter, and carrying veinlets of pyrites. The drive on the lode, when the latter is reached, will pass through the south boundary of the section in about 5 chains. There is gossan above all along this line, assaying 3 to 12 ozs. silver, and 2 per cent, to 10 per cent. lead. Carbonates descend 40 feet from surface. There are surface exposures of both lead, carbonate, and sulphide near the southern boundary.

One hundred and eighty-six feet above the low adit, an upper tunnel (No. 1) has been driven into the hill about 360 feet. The first 200 feet were through sandstone, after which the websterite dyke was cut through as far as 76 feet, the last 16 feet of which were in white dolomite. The reef is bounded on the west by diabase porphyrite. Its hanging-wall is slickensided, and divided from the porphyrite by 2 feet of pug. A drive goes 64 feet south on the slickenside, carrying 14 feet of gossan in the far end, but no sulphide ore: this is 94 feet vertical from surface. The quality of the gossan is the best met with, so far, on the North Magnet, but does not exceed 9 per cent. lead and 12 ozs. silver. There are surface signs of better gossan ahead: the gossan on this line appears to pinch going North, and opens out towards the South. There is a chance that ore may be found in continuing the main drive into the Magnet property.

### *Gregory's Galena Mine.*

This is a small show nearly a mile west of the Whyte River Bridge, and situate on the main road. The country rock appears serpentinous. The outcrop, where it has been cut into, shows well-defined walls 4 to 5 feet apart, and the veinstone is quartz with disseminated galena. This cut is an open drive for 14 feet on the course of the lode, which bears east of north. The quartz capping carries some blende, but the ore is free from blende lower down. The lode was cut in the tunnel below the road, but the ore was bunched. Lead carbonate is present, and the galena is banded with carbonate of iron. To develop the mine a tunnel should be put in where the lode crosses the road, then drive on its course.

Between the Magnet ore-shed and the Whyte River Bridge a number of gabbro and pyroxenite dykes cross the road cutting through slates, sandstone, and basic, igneous rock; a good deal of the latter is in an advanced state of decomposition, weathering concentrically.

### *Confidence Mine.*

This is on a 40-acre section, 671-93M, formerly the Washington Extended, now called the Confidence, and held by H. P. M'Creery. It is situate on the Whyte River, two miles south-west of the hotel, and can be reached by walking along the old Godkin tramway. The lode which has been operated upon is a silver-lead ore, running in an eruptive dyke of a basic or ultra-basic nature, and thus presents similar features to other lodes in this district. The ore gangue is the green nickel-stained rock of the dyke, carrying a good deal of calcite. The lode has been attacked by three tunnels—upper, lower, and intermediate, and the Godkin tramway goes past the mine below the latter tunnel. The greatest width of dyke is 75 feet.

The upper or No. 1 tunnel has been driven eastward into the hill, and intersected the lode at 200 feet. The gossan outside the entrance to the tunnel is considered worth 40 to 60 ozs. silver; it contains too much iron to dress easily. 21 lbs. of galena, mixed with an equal weight of gossan, were sent to the Queensland Smelting Company, who bought the mixture on the following assay:—171 ozs. silver, and 45 per cent. lead. The galena

by itself assayed 252 ozs. silver, and 52 per cent lead. A parcel of a ton of seconds sent to the same company assayed 107 ozs. silver, 25 per cent. lead. The lode has been driven upon north and south. The south drive is a short one, and has no metal in the end. The north drive has followed the lode a little east of north for 157 feet. At 30 feet a rise 60 feet to surface gave some good ore, and underfoot there is said to have been 1 foot to 15 inches galena, when last seen. A seam of galena 2 inches to 8 inches wide was found along the footwall at about 120 feet in the drive, also going underfoot. Remnants of galena are seen on wall; this is 90 feet from surface. The lode has split, and the wrong branch apparently followed. The eastern leg has not been followed at all. Just at the split a shaft was begun and 6 tons of ore raised, which is reported to have returned 94 ozs. of silver per ton, but the water was found too heavy, and sinking was suspended.

Since my visit Mr. M'Creery tells me that further work has resulted in proving several inches of galena underfoot on the hanging-wall for 85 feet—nearly all the way from the flat sheet to the winze. In some places he says there is 6 inches to 8 inches of galena, and 1 inch to 3 inches of pug, the latter assaying 112 ozs. silver, and 13 per cent. lead. Samples of galena and pug assayed by Mr. Ward, Government Analyst, gave respectively—lead, 43 per cent, silver, 106 ozs., 19 dwts., 16 grs.; and lead, 8 per cent., silver, 95 ozs., 7 dwts., 17 grs.

The intermediate tunnel is 40 feet below No. 1, and was driven 187 feet, cutting the lode and continuing across it. There the dyke was found dipping W., and contains a little galena. The rock is hard and massive,—to all appearance, unfavourable for metal. The dyke here is 8 to 10 feet wide. It has just been tested a little towards the N., but with no result. As the ore pitches N., about 150 feet more driving would bring the drive under Thorne's winze, as well as under shoots of metal at surface. The country in this tunnel seems to be serpentine, the lode-matter gossanous, with a little galena and carbonate of iron.

The lower tunnel, No. 2, is 40 feet above the Whyte River, and 60 feet below the intermediate one. It has been driven N.E., and the lode met with at 160 feet in. Some doubt has been expressed as to whether the dyke

has been quite cut through in the tunnel; but it appeared to me that the serpentine country had been reached on the other side. After driving 80 feet N., the lode widened, and the drive was continued along the hanging-wall for 100 feet, with splashes of galena now and then, mostly on footwall. Since my visit, the drive has been extended 30 feet: the lode is wider, but not yet payable. The end was striped with dolomite, hanging-wall ragged, foot-wall smooth and puggy. Some distance behind the end, a wall goes off to the E. Up to here, the former workers followed the hanging-wall, but at the split of the lode they crossed the level, and drove on the foot-wall. A mistake has been made in not putting in crosscuts: though the dyke is only 10 feet wide where first intersected, its width is known to be variable, and there is no guarantee that all veins in it have been followed in the drive. No crosscutting has been done for the last hundred feet, and lode-stuff may very well exist alongside: indeed, the water coming through where the lode was first cut in the tunnel suggests this.

Authentic records show that several years ago three tons of ore from here were treated at the Dry Creek Smelting Works, and returned 144 ounces silver and 48 per cent. lead per ton. Picked samples gave a higher assay. In 1892 three tons were sold to the Queensland Smelting Works, for 98 ozs. silver and 37 per cent. lead.

The ore is galena, with accessory lead sulphate and carbonate (anglesite and cerussite). Associated with it are zinc blende and siderite. The gossan is ferromanganese.

#### *Washington Hay Mine.*

This silver-lead mine is north of the Confidence, but I am not sure whether it is on the same line of dyke as that mine. The dyke-matter is similar, stained green with nickel and chromium, with secondary deposition of dolomite and calcite. I regret that it was too late in the day for me to make a proper examination of this mine. I saw blocks of good dressing ore, as well as clean galena, lying outside the mine. About 50 tons are said to have been sent away from the Confidence, and 20 tons from the Hay; but both these properties have been abandoned for some time. However, ore has been shown to exist here; and

this, together with the encouraging nature of the ore-channel, ought to induce further prospecting. As at the Magnet, the dykes here have proceeded from a gabbroid, not a granitic, source.

On my way to these mines from the Whyte River bridge, I noticed a formation crossing the tramway and consisting apparently of altered country rock, with manganese oxide. This is about 15 feet wide, and deserves some attention.

*Result Mine. (Formerly Bell's Reward.)*

At the 13-mile, Heazlewood, there is a line of lode running N.W.-S.E. through the result, Discoverer, and Godkin sections. The Result sections comprise a 40-acre, 3925-93M, and a 20-acre block, 3952-93M, about half a mile south of Jupp's. The mine used to be known as the Bell's Reward, and the workings are on the 20-acre section. The main adit has been driven about 500 feet S.W. to cut the Godkin Extended lode-line, which bears N.W.-S.E. The roof has fallen in, and I, consequently, could not enter the tunnel, but Mr. W. R. Bell described to me the ground passed through in driving, and his description enables me to form some idea of what really has been done. The adit entrance is in soft slate, and the strata then traversed are as follow:—

Limestone, barren .....	about 130 feet
Soft slate .....	" 25 "
Sandstone, with chloride of silver .....	" 15 "
Sandstone .....	" 7 "
Ferro-manganese gossan .....	" 24 "
Limestone, charged with galena and blende .....	" 130 "
Quartzite and hornblendic rock.....	" 169 "
	<hr/>
	" 500 feet

In this series the gossan is the representative of the lode, and the limestone has been impregnated therefrom.

Another tunnel, the northern upper one, has been driven about 80 feet, passing, first through rotten, puggy limestone, then decomposed slate, then a bed of sandstone, with chloride of silver, then 7 feet of sandstone, carrying galena,

then 24 feet of gossan, with a couple of strings of galena, and finally into a bluish-grey, limestone. At surface the gossan is hidden under clay. A main shaft, well timbered, and with three compartments, has been sunk 154 feet, and, it is said, passed first through 70 feet of decomposed rock, then into solid limestone. The decomposed rock is cavernous, and driving from the bottom was suspended, owing to flooding from a sudden burst of water when the reservoir was tapped. Future work will probably include driving along the course of the gossan cut in the main adit. What I am rather afraid of is that the backs gained in the drive will not give sufficient depth for the sulphide ore to be met with, as we know that in this district the gossanous zone extends to considerable depths. If, however, the water-level is reached, some enrichment may be looked for. As far as I can learn, a few tons of ore were sent to market formerly with between 60 and 70 ounces of silver per ton.

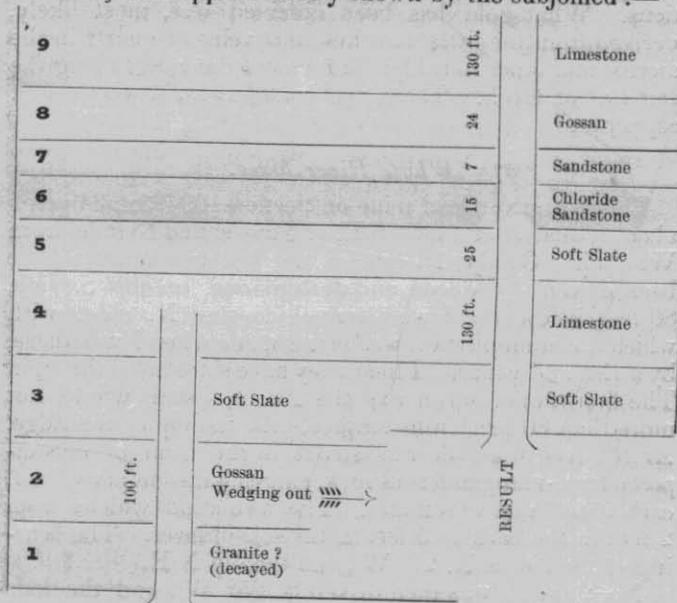
#### *Discoverer Mine.*

To the S.E., and adjoining the previous, is the Discoverer or Smith's section, traversed by the same gossan lodes as pass through the Result. There are two bands of gossan and two tunnels, both of which intersect one of the gossan bands. This band is supposed to be the Godkin lode. In the tunnels it is about 100 feet wide, but, going north, it wedges out, and is only 25 feet in width in the creek opposite the main tunnel of the Result. I could not trace it further north than that. It is, accordingly, not cut in the Result, being outside the adit. The gossan lode which is cut in the Result is not yet intersected in the Discoverer, but is still ahead of the tunnels there.

No. 2 is the bottom tunnel, which has been driven S. 37° W. for 370 feet, first through 150 feet of decomposed, clayey, eruptive rock, the nature of which it is difficult to determine, but I think it has been either syenite or hornblende granite. It then crosses the band of ferromanganese gossan, dipping about 50° E. In the gossan are patches of soft putty-like clay, or kaolin, often forming vughs. This occurrence is strongly suggestive of the gossan band having originally been part of a dyke of eruptive rock. On the footwall of the gossan is a band of black

pug, derived from clay-slate. This is succeeded by limestone, apparently conformable with the gossan. There is a foot of pug just behind the end, which is now in hard limestone. It is intended to drive this tunnel to intersect the Bell's Reward (Godkin Extended) lode cut in the Result. When this is reached, the tunnel will have 200 to 300 feet of backs. No. 1 tunnel is 120 feet above the preceding, and has been driven through 100 feet of gossan, through the slate, and is in the limestone; in all, about 170 feet. It is blocked by a fall of ground.

The relations of the zones passed through in the drives on these two sections (Result and Discoverer) may be conveniently and approximately shown by the subjoined:—



DISCOVERER

S. A. W.

RESULT

— Not drawn to Scale —

No work was being done on these sections when I was there, but, in view of the persistence of the gossan outcrop along a great length of line, I am told that resumption of operations is contemplated. The gossan itself seems very poor, but I think it likely that, when the limit of the oxidation zone is reached, there will be the usual enrichment by leaching from above. If, as I surmise, from the width of the gossan and the aluminous patches contained in it, it is an igneous dyke, it may, in depth, carry more than one ore-vein.

The creek up this valley has been worked, off and on, for gold, with some success. At one time the whole ground was pegged out for gold, with quite unreasonable expectations. What gold has been obtained was, most likely, derived from the little bunches and veins of quartz in the dioritic and other hornblendic rocks of the range along the east side of creek. These rocks also contain veinlets of copper ore.

#### *Whyte River Mine.*

This is a silver-lead mine on Section 109-93M, 34 acres, about a quarter of a mile S.E. of Jupp's, and 13 miles from Waratah. On the N. side of the hill two tunnels have been driven to the lode, and a third one, on the S. side, 80 feet below the lowest tunnel on the N. side, with which a communication was being made when I was there, by a rise and winze. I hear they have since holed through. The first tunnel put in was the No. 1, a shallow one, not more than 30 feet from surface, near the top of the ridge. At 100 feet in a lode was struck in the form of decomposed ferro-manganiferous rock, carrying disseminated lead, carbonates, and chromates. The formation widens from 2 feet in the back to 5 feet in the sole of level. The bearing of the lode is N.  $21^{\circ}$  W., and the dip N.E.

No. 2 tunnel was then driven S.  $25^{\circ}$  W., and the lode cut at 160 feet from approach. This tunnel is 60 feet below No. 1. The lode has been driven on 200 feet S.E. The tunnel passes through decomposed igneous rock, which, from its decayed condition, is difficult to identify. Some of it is serpentinite, and some, after examining a microscopical slice, I am inclined to think, is diorite. The drive is also in these rocks, and follows a thin seam of quartz and clay on which a winze has been sunk (Jupp's winze).

Below the level the lode can be seen about 6 inches wide, lying on a smooth footwall. Most of the lode seems to be in serpentinous rock. It is characterised by lead chromates, carbonates, and oxides of lead and antimony. The lead sulphide is strongly antimonial, and the ratio of silver to lead is 3 ozs. of the former to the unit of lead.

The deep tunnel on the S. side of the hill has been driven 500 feet to the lode, which it has struck 110 feet below No. 2. A drive N.W. then followed the lode for 170 feet, but without payable results. The lode seems to be still in serpentine, and stronger here than in No. 2 level. The walls are 6 feet apart—footwall defined, hanging-wall ragged. The first 300 feet of the tunnel were in serpentine, then a dyke of diorite was passed through, afterwards serpentine was again met with, succeeded by black slate, then serpentine and the lode itself. The occurrences of diorite raise the question whether that rock intruding into the serpentine has not been the ore-producer. At 32 feet up the rise, which has been holed from No. 3 to No. 2, a vein of 6-inch galena was cut and driven on N., but found to be of irregular width. The assay of this has returned 22.7 per cent. lead, 63 ozs. 17 dwts. silver per ton.

Some rich silver chlorides have distinguished the secondary ores in this mine. Unfortunately, the workings have not disclosed a lode which can be described as payable. A few tons of ore-stuff have been broken, but the vein is too irregular to warrant much hope of a payable lode being found in the present levels. The deepest workings, however, are not more than 130 feet below the crown of the hill. The hopes raised by the rich secondary ores have not been justified by the subsequent prospecting, and I am afraid there is not any great chance of improvement at the depth attained.

#### *Heazlewood Silver-lead Mine.*

Following the road westward from Jupp's a line of lode is crossed at the 14-mile below the ore-shed, running west of north in serpentine country through the Heazlewood Extended, Heazlewood, and South Heazlewood sections. A main lode has been described as being con-

tinuous through all these properties, but I think a little attention will convince us that the positions of the alleged lode are at variance with the notion of it being one and the same on the several blocks. I think we have to do with parallel veins more or less discontinuous on their strike. The most northerly of these is the Heazlewood Extended, bounded on the south by the Heazlewood sections, 1309M and 1310M, 80 acres each. The 1309 section is the most important one. A main shaft has been sunk here, 170 feet deep, with which No. 3 tunnel, driven along the lode from the S.E., connects in 390 feet of driving, coming into the shaft at 55 feet from the surface. From here to surface the ground has been stoped out. On the other side of the hill, at nearly the same level, the No. 4 tunnel has been driven about 350 feet towards the main shaft, and short crosscuts put in S.W. and N.E. before reaching the air shaft, but with no result.

A low-level tunnel had been begun, but abandoned, together with all other work on this mine.

The lode proper, *i.e.*, the ore-vein, has not been more than from 2 to 3 inches wide on the whole, though it has widened to as much as 6 inches. The ore is galena, sometimes antimonial, with which is associated a little zinc blende, but not sufficiently so to cause trouble in the treatment. The ratio of silver to lead is not high, as an assay of the clean ore returned 69 per cent. lead, and 95 ozs. silver. The vein is encased in a serpentinous enstatitic dyke, the width of which I could not well determine. The country to the E. of it is serpentine, and to the W., syenitic, with much hornblende and a large development of actinolite. I regard the syenite, or hornblendic granite, as posterior in date to the serpentine and the enstatite dyke, and, consequently, can only consider the juxtaposition of the latter as purely accidental. Just to the E. of the dyke the syenite contains abundant radiating aggregations or bundles of slender prismatic crystals of actinolite two and three inches long. The bearing of the dyke and lode is N. 18° W. The veinstone has the characteristic nickel colouration of these dykes. In past time a few hundred tons of galena were raised and sold from this mine, returning between 50 and 60 per cent. lead and 80 and 90 ozs. silver per ton. A sample, however, taken by myself, and assayed by the Government Analyst, yielded

only 56.21 per cent. lead, 53 ozs. 11 dwts. 11 grs. silver.

On the south section, in serpentine country, an upper tunnel on the main lode has been driven over 500 feet, of which 400 feet were on the course of the lode. A slide was reached at that point, and the drive turned off E. instead of W.: the continuation then became useless. The walls are good, four feet apart, dipping N.E.: the hanging-wall is especially well-defined. In the drive, the lode has been six inches to one inch of galena, banded with carbonate of iron. I saw some nice blocks of this banded galena, four or five inches thick, on the tip outside tunnel. The galena is freely mixed with blende. The gossan of this lode has the usual green nickel stain. The level has 50 or 60 feet of backs, and will eventually have between 200 and 300 feet. A crosscut tunnel from the E. communicates with it, and 40 feet below is Bottrill's crosscut adit. No ore appears to have been sent away in bulk, and the assay results have not given high returns in silver—not more than 40 to 60 ozs.: my own sample, assayed by the Government Analyst, returned 67.55 per cent. lead, 36 ozs. 18 dwts. 6 grs. silver per ton.

On the South Heazlewood ground a good deal of trenching and driving has been carried on. I examined a prospecting tunnel, driven W. 300 feet. Not far from mouth a drive was put in N., on manganese gossan, but in the end there is only a gossan vein crossing the face. An opposite drive S. is in gossan all the way, and the face shows country rock, with a foot of iron pyrites on the E. side. The gossan is rather massive, but there are no walls or other signs of a lode, the country rock—a decomposed igneous one—appearing to be cracked or fissured in the direction of drives. The gossan weathers coal-black, and carries a good deal of carbonate of iron, besides traces of galena and blende. At surface, the hillside is covered with this gossan, which I could not connect with any particular lode. The country rocks seem to be serpentine, limestone, sandstone, and quartzite, but in the short time at my disposal I could not unravel their relations. Further S. are a couple of lodes parallel with the main lode, with a capping of soft gossanous matter, chrome-stained, carrying a little chromate of lead. The western lode is about one foot wide: a little galena has been found in one of the eastern lode-trenches.

I am not at all certain that any one of the lodes worked in the south section is a true continuation of the Heazlewood lode in the north block. The direction of strike does not seem to be exactly preserved, and all the lodes require to be carefully traced on their strike into the adjoining sections before they can be positively asserted to be identical. At the same time, the fissured mineral-bearing zone strikes through all three properties, and even further N., across the Heazlewood River.

*Heazlewood Extended.*

I had a look at some of these abandoned workings on Sections 4-87M (40 acres), 825-87M (80 acres), and 1596M (19½ acres). Prospecting was evidently carried on pretty vigorously, but with unfortunate results. Several lodes have been cut in different places, showing galena, chromates, and blende here and there, but nothing payable in respect of quantity. A little good ore is said to have been sent away, but I could obtain no details. Fifty feet below the main road is a tunnel, now blocked, and lower down is a deep tunnel from the river, intended to cut and follow the lode in depth. The ore occurs as galena veins in an enstatite dyke rock, stained green and dolomitised, like that of the Magnet Mine, and the country traversed by it is serpentine and gabbro. If this company decide to resume work, they should continue the long tunnel near the river, as the upper one is far too shallow. This will enable them to follow the lode at a very considerable depth, and to explore for parallel veins E. and W. Though a good deal of preliminary work has been done, and without any favourable results so far, the property cannot be said to have had a fair trial, at least not a sufficient trial to warrant its final abandonment.

*Binks' Copper.*

This is situate to the S.W. of the Heazlewood Co.'s northern block, close to the track leading to the Castray Gold Workings and Mt. Hope. There has been much talk about this copper, but, so far, it is only an exposure, and it is impossible to say what it is likely to become before further work is done. A small cutting into the hill-side has bared a face of iron and copper pyrites, 5 or 6 feet in length and 2 feet thick, running about N. and

S. Chips knocked off with the hammer show solid pyrites, highly cupriferous. The purity of the metal and the absence of any veinstone are features of the occurrence. An assay by the Government Analyst returned 39.2 per cent. copper, with traces of gold and silver. The surrounding rock is greatly decayed, and in a highly unfavourable state for determination; but the microscopic examination of a selected specimen points to it being an amphibolite. A short open drive has been put in a few yards lower down the hill, but is not far enough in. It is perfectly useless to leave this lode undeveloped, for there is not enough work done to warrant flotation. It should be opened out without delay, and would then, most likely, be placed easily, for the outcrop is a promising one.

#### *Jupp's Copper.*

A quarter of a mile W. of Binks' lode is what is known as Jupp's Copper Show, where a shaft has been sunk 26 feet on a quartz lode containing copper pyrites. At 10 feet down, the lode is wide, but below that to the bottom, the width is not known. Assays of picked specimens are reported to have returned 17 per cent. and 9 per cent. copper, with 7 dwts. and 5 dwts. gold.

#### *Mt. Stewart, now Mt. Hope, Silver-Lead Mine.*

This mine is situate 5 miles south of the road at the Heazlewood, on Section 763-93M, 80 acres, on a plateau or flat hill, which is one of the foothills of the Meredith Range, 1200 to 1400 feet above the level of the sea. Work has been recently abandoned here, notwithstanding that the ore won was of a high class, containing as much as 130 ozs. silver per ton for 24 per cent. lead. A few tons were sent away, but the silver contents are said to have been reduced to 98 ozs. by an injudicious preliminary washing. A pack track, five miles long, and in none too good condition, connects the mine with the Heazlewood ore-shed, on the main road, 14 miles from Waratah. Though the transport cost to Waratah is quoted at 50s. per ton, it is questionable whether any considerable quantity could be got away under £3, for it would not take much traffic to knock the present track to pieces. However, it seems certain that the ore is worth, at least,

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£15 per ton, and if there is any quantity of such ore within five miles of a main road, it is also tolerably certain that means will be devised for getting it to market.

Six chains south of the northern boundary of Section 763-93M, 80 acres, a shaft has been sunk 43 feet on a galena lode, which runs through the property, with a bearing slightly to the west of N. The country-rock is slate, presumably of Silurian age, striking N. 5° W., and dipping at a high angle to the W. The lode appears to run with the country on a strike, and with a dip parallel to those of the enclosing slates. In the bottom of the shaft, which was unwatered for my inspection, the lode consists of alternate bands of quartz and galena. From west to east the formation is six inches quartz, a few inches of country-rock, 18 inches of quartz, and six inches of silver-lead ore, the best ore being on the footwall side, and seeming to widen out of sight on that side (E.). There is no defined wall on the W. side, the lode there being interstratified with country. The quartz crystals are in combings at right angles to the veins. The lode in the upper part of the shaft consists of crusty quartz and galena, with zinc blende, and has improved going down. Lower down the hill there is another shaft, about 20 feet deep, but it has no galena to speak of. Two tunnels have been driven to develop this lode, one shallow and useless, the other a long one, which ought to give 100 feet of backs when it gets to the shaft, which is now about 160 feet ahead of the end. This tunnel cut the lode at 100 feet, and has been driven a long distance, not always quite on the lode line. With the exception of one point, where a few tons of galena were stoped from over back of level, no ore was won in driving, the lode line being marked only by a band of quartz throughout a course of several hundred feet. A sample of ore from stope was assayed by Mr. Ward, Government Analyst, returning lead 23 per cent., silver 215 ozs. 12 dwts.

The proper programme in recommencing work on this property would be to continue the long level, so as to come under the 43-foot shaft; then connect shaft with level, and extend the latter to the N. boundary. It would then be seen whether the result justified the starting of lower adits, which would be rather long ones. In driving N., serpentine country would be entered. The

rock there at surface is talcose serpentine, and the lode runs into gossan. The N. section, 3299-93M, 80 acres, is serpentine, widely overspread with gossan; but it is by no means certain that it is lode gossan. A good deal of it may be formed by iron derived from the serpentine. The extension of the drive N. of the shaft would also solve the question whether the serpentine cuts the lode off or not. On purely geological grounds, I believe the lode will be found to continue through both slate and serpentine.

Chalcedony and opalised serpentine are found on the serpentine portion of the property. I did not see the talc vein, which is to the S.W., and which may have some connection either with the serpentine or the beautiful amphibolites which occur about here. The S.E. bank of the river at the mine appears to be granite, but the hill over the long tunnel, or just E. of it, is strewn with blocks of decayed igneous rock, looking like serpentine or amphibolite, and suggesting that the tunnel is partly in that rock, which, however, I did not detect underground, and I did not see any of it on the tip. The main lode has been traced a long way, and is evidently persistent as far as regards its line. A somewhat unfavourable sign is the absence of walls, it being made up of parallel independent bands; but this is not looked upon as so essential now-a-days as it used to be. Still, such a lode is very apt to split up into stringers. The long distance it runs without payable ore is also a drawback, for a good part of the section is thereby rendered unprofitable. Nevertheless, there is an undoubted ore-shoot, which requires developing, and the way to do this is as suggested above. If this trial work is successful it will lead to more prospecting in this locality, which, being near the contact with the granite of the Meredith Range, is a favourable one for deposits of mineral.

Samples of galena which I took from the shaft have been assayed by Mr. F. Ward, Government Analyst, as follows:—

From bottom of shaft.....	Lead, 58·12 <sub>0</sub> ⁄ <sub>100</sub> .
From stope over tunnel .....	Silver, 83 oz. 12 dwts. 12 grs.

#### *Lord Brassey Nickel Mine.*

This is on Section 1758-91M, 80 acres, at the top of a lofty hill of serpentine rock, called Nickel Hill, north of

the bridge over the Heazlewood River at the 16-mile. The summit is about 700 feet above the river. Mining operations have been carried on here by the Lord Brassey Nickel Company for winning nickel-ore, which is found in two forms, viz., nickel-iron-sulphide and hydrated nickel carbonate, zaratite. The latter is more abundant near the surface, and often lines the walls of the numerous joints which intersect the serpentine. As a mineral, it is said to be the finest zaratite in the world. Its colour is pure emerald green, changing, in an encrusting variety associated with it, to a greenish-yellow. The sulphide occurs as a new mineral, called heazlewoodite, and is referred to by Dana, in his 1899 appendix to the System of Mineralogy, p. 33, in the following terms:—

“Heazlewoodite. W.F. Petterd, Catalogue of Minerals of Tasmania, p. 47, 1896. A sulphide of nickel and iron related to pentlandite, occurring in narrow bands in the serpentine of Heazlewood, Tasmania. Colour, light-yellow bronze; streak, light bronze. Highly magnetic. H.=5. G.=4.61. Rich in nickel, up to 38 %, but not analysed.”

In this mine the heazlewoodite occurs in small veins, running through the serpentine along irregular slickensided planes, and also disseminated in the country-rock itself in the neighbourhood of the joints. It seems often to be associated with a vein matrix of carbonate of iron. The company have spent money very perseveringly in working this nickel deposit, but when I was at the mine, underground operations had ceased, and work was confined to classifying the ores which had been raised, i.e., separating the carbonate from the sulphide. The shaft at the top of the hill is about 25 ft. deep, and has yielded a fair quantity of zaratite. I saw here, too, a piece of the best sulphide vein stuff, being solid-looking heazlewoodite,  $2\frac{1}{2}$ " to 3" thick. The fineness of the grain, and the very light colour, cause the mineral to be overlooked, unless the stone is examined carefully. A tunnel has been driven into the hill S. 48° E. for 570 feet, attaining a maximum depth of 100 feet from surface at the extreme end. At 119 feet in, a crosscut (Skinner's drive) has been driven 90 feet in a crooked fashion to the S.W., and 222 feet further along the main tunnel is another crosscut driven 95 feet, also S.W., and also crooked. Both of these

crosscuts have such sharp bends that they now head in a direction nearly parallel with the main tunnel. The entrance to the latter crosscut is just beyond the shaft from surface, and the tunnel beyond this, for 150 feet, is below the surface trenches at a depth of about 80 feet. The tunnel end seems to be about 80 feet from the E. boundary of the section. The nickeliferous veins and bands have been persistently followed in their windings along the numerous smooth planes, the polished serpentine faces of which mimic the slickensides of true fissure lodes. These shining surfaces tell of movement within the rock mass, probably consequent on swelling during the process of hydration. The plane faces also constantly cut off, and displace the veinlets of nickeliferous sulphide, showing that the ore had segregated from the surrounding rock before hydration set in.

The work done so far has not established the existence of ore at a shallow level in remunerative quantities. The present levels, if continued, can gain no additional backs, and a lower tunnel from the Heazlewood side of the hill would be a long piece of work. The usual practice in mining is to aim at depth, but in working this kind of ore, that practice is not in accord with geological theory. We are not dealing now with fissures and injection-veins, but with segregations of sulphides from a heavy, cooling rock magma. According to Soret's principle, the magmatic ore segregations take place in the coolest portions of the magma. These are the portions near the contact of the igneous rock with the adjacent rocks, into which the former was intruded. The surrounding and overlying rocks have been removed by denudation from the Nickel Hill serpentine, but the parts near the present surface must have been nearer to the original margin of the rock mass than those at a greater depth. The probability, therefore, is that greater success will not attend greater depth. The smallness of the quantity of ore obtained here bars profitable working, though fine nickel, 98-99 per cent, is quoted at £160 per ton. This Heazlewood ore has its peculiarities, and it is not likely that it can be mixed with other ores in the furnaces without disturbing the delicate reactions which are involved in the reduction of nickel ores. On the other hand, this bar may be removed at any time by metallurgical improve-

ments, and as the increased demand for nickel steel is sustaining the market, the search for nickel ore should not be altogether abandoned.

#### *Jupp's Nickel.*

This section, 3273-93M (12 acres), situated south of the Lord Brassey property, was formerly held by the Roy's Luck Company, but is now known as Jupp's. It is serpentine country, and, like the preceding mine, is on the flat at the top of the Nickel Hill. Along the north line of the section a tunnel has been driven about 113 feet E., to intersect two veins bearing N. 60° W., which have been noticed and trenched at surface. A shaft has been sunk on the westerly vein to a depth of 24 feet, and the most solid nickel sulphidic ore got on the hill has been obtained from this shaft. At the N.E. angle of the section are veinlets bearing N. 70° W. and N. 25° W., trenched just at the section corner. These run into the Lord Brassey and Lacey's sections, and are of no use whatever to the Roy's Luck holders. The line of the principal vein is in a diagonal direction across the section, but its continuity must not be assumed without proof. For satisfactory prospecting, the nickel-bearing properties on this hill ought to be amalgamated. One drawback to mining work is the absence of good timber. The serpentine nourishes only stunted trees.

In the triangle formed by the Corinna Road, Heazlewood River, and 13-mile Creek is one of the hills called "The Pinnacles." On the W. side of the creek, about 40 feet up the hill, a short tunnel has been driven W., in actinolitic rock, to cut a copper formation, but was suspended before reaching it. On the side of the hill lumps of oxidised lode stuff are visible. Native copper has been found in the creek below. It is to the E. of the Heazlewood line of lode, and is probably connected in some way with the contact of hornblendic rock with serpentine. N. of this, just below the junction of the 13-mile Creek with the Heazlewood River, there is a low ridge, running N.W., and separated from the Pinnacles by the river. This hard spur has caused the river to make a wide loop, not charted in the map of mineral-sections. The rock is syenite, very rich in hornblende, and has, most likely, some relation to the actinolite rock at the Pinnacles.

### *Long Plains Gold Mine.*

This used to be known as Weetman and Crockford's, and is now held under lease, in the name of H. H. Gill. The reward claims comprise 2-85 (15 acres) and 3-85 (15 acres), on the Long Plain, about a mile in from the Bullock's Head, or 16-mile peg from Corinna—24 miles from Waratah. At the time of my visit, Mr. T.M. Grath was in charge, and courteously showed me round. The only other man on the claim was Chris. Janssen, who was fossicking in the creek. The mine is on a spur of the Long Plains, about 1100 feet above sea-level, lightly timbered and surrounded by button-grass country. This ridge runs about N. 10° E., and, like the surface of all the plain, is covered with quartz detritus, which has been called alluvial. It is, however, in no sense of the term an alluvial deposit, for the fragments, large and small, are angular in outline, and not a waterworn pebble can be seen among them. In places, there is a prodigious quantity of this covering, which varies from 2 feet to 5 feet in thickness, lying on the vertical edges of the schists or quartzose slates. From this layer of detritus, a good deal of gold has been won from time to time—at least 600 ozs., and perhaps more. The metal is generally found, not lying on the bed-rock, as in alluvial deposits, but on the top of a cemented upper part of the detritus. It has been noticed that when gold occurs upon this cement layer it is most likely to be found below it also. The cement, resembling a breccia of angular pieces of reef quartz, bound by a siliceous paste, is plentiful all over the Long Plain. It is very likely of the same age as the cemented alluvial on Brown's Plain, near Corinna. Now, at the Long Plain Mine it is very easy to see where this quartz came from. Between the laminae of the schists there are everywhere thin sheets of quartz from  $\frac{1}{2}$  inch to  $2\frac{1}{2}$  inches thick, and even a greater thickness has been attained where lenticular patches have been formed in the schist. Wherever gold occurs in the schist outside of any veins, it is contained in bands of soft decomposed schist or sandstone, well within the range of surface water, which, owing to the vertical lamination of the country, may descend to a very considerable depth. The gold is found in ragged, peculiar forms. Hollow skeletal, coralloid, crustiform shapes prevail, with a frosted appearance. The

specimens are very light, and enclose much quartz, occasionally slate, and sometimes both quartz and slate. In one instance, I noticed a piece of gold enwrapping small pebbles or grains of quartz and green schist, a strong indication that the gold crystallised after the stones had been detached from their parent rock. This, I believe, explains the origin of the specimen gold for which the claim has been so famous. It has been produced by the re-crystallisation in the superficial covering of gold dissolved out of the the quartz lenticles, set free by the disintegration of the bedrock. Incessant dissolution of gold is probably going on in all quartz mines in the upper part of auriferous quartz reefs, and the Long Plains quartz lenticles, wherever gold-bearing, are not likely to form any exception to the rule. But the organic matter of the button-grass soil may be expected to act as a powerful precipitant of any such gold from its solution, and has, no doubt, given to the encrusting gold the peculiar sponge-like and hollow forms so common in the specimens found here. Consequently, wherever the quartz underneath is gold-bearing, patches of auriferous detritus may be expected in the neighbourhood. The idea entertained on the spot is, that sinking in the solid below these points ought to result in the discovery of payable gold: I think this by no means follows. The gold precipitated at surface may have been collected from a wider and a comparatively poor area underground.

Cox's face on this property is an open cut in the schist, in a couple of benches about 25 feet in height altogether. The silvery schist is split up into thin, often wavy, laminae, between which are sheets of quartz, mostly lenticular. A band of soft decayed quartz schist is said to have yielded the most gold. The quartz in the lenticles is pure, white, dense, and looks unfavourable for gold. I was told, however, that from 70 to 80 ounces had come from this face, with a very primitive arrangement for washing, and altogether too little water for proper sluicing. A tunnel 300 feet long has been driven into the hill from the E., to intersect the formation exposed in Cox's face, but it is believed not to be far enough in. It passes through greenish quartzose, soft slates, or schists. About 50 feet up, a manhole has been cut into the north side, where there

is a band of decayed slate, which looks as if it might contain something. Further in, a seam of red and yellow clay, 2 inches to 5 inches thick, has given gold on assay. Just behind the end there is a 16-inch band of rather soft graphitic slate, which has not been tested for gold. The face is in talcose schist. A south drive, 15 feet, has been put in from this tunnel, with no result.

On the western side of the spur, opposite this tunnel, 12 ounces of gold were found in prospecting at surface. A short drive was begun a few feet lower down, but it is very shallow. On this side of the hill a small tunnel has been put in, from which a short drive was extended N. : nothing was obtained from the drive beyond a few colours. The tunnel is in talcose schist. There is an upper cutting, from which a winze descends over 200 feet, as far as 38 feet below the lower of two tunnels below this cutting. The winze is said to go down on two veins, and to have yielded gold. No. 2 tunnel, beneath this, was too wet to enter. It is said to have been driven 1000 feet into the hill, cutting Cox's formation and two or three others, but with no result, except colours only. No. 3 tunnel, still lower down, has been extended 400 feet, cutting a thin vein, which was driven upon N. Where this was intersected it looks like a mere joint. Higher up it was said to be good, but poor when they knocked off work. I was told the greatest width it attained between the two tunnels was a foot.

The claim appears to have been well prospected in different directions, and of course this work can be continued, but it is difficult to see where the rock warrants any considerable outlay. There are no signs of solid reefs existing at any reasonable depth, and I believe money would only be frittered away looking for them. On the other hand, any day may witness a rush to these plains on the discovery of new patches, with rich surface precipitates. These will almost certainly be found, but, most probably, accidentally. The gold is of excellent quality, realising £4 to £4 ls. per ounce.

All the neighbouring creeks have yielded gold. Over 4000 ounces are said to have been collected on these plains, and the gold seems to have come from more than one source. We have a quartz source, as above; but it has also been found in direct association with magnetite

and carbonate of iron. This part of Long Plains is just to the E. of the Rocky River and Rio Tinto magnetic belt of country. The whole belt of country between the Rocky and Savage rivers, and up Hall's Creek, deserves a thorough geological examination.

*Cape Copper Mine (Mt. Donaldson Section).*

This property is charted as Heaps and Simpson's two sections, 1027-93M (79 acres), and 1028-93M (80 acres), on the 9-mile Creek, which falls into the Whyte River, just east of the latter section. The company has made a narrow cart-road, about  $\frac{3}{4}$  mile long, for connecting the mine with the Corinna main road, at a point about  $9\frac{1}{2}$  miles from the township. This road terminates at the top of a steep incline tramway, 9 chains in length, which descends the rather precipitous side of the gorge, 350 feet below. The mine-works are in the creek, 80 or 100 feet below the camp. Both sides of the creek are lofty and steep; and this mine, placed at the bottom of the dark narrow gorge, cut almost canyon-like in the table land above, occupies as strange and romantic a position as any in the Colony.

The country-rock may be classed in two groups. The upper and eastern part of the hill consists of quartz schist, inclined to be micaceous. It is light in colour. The schist in the creek, to the south and west, is dark grey and green, and carries copper pyrites. Its foliation planes are glossy with graphite, which, on being rubbed, leaves plum-bago marks on the fingers. A little loose porous fibrous graphite (graphitoid?), of remarkable lightness, has been found in a seam in No. 1 level, near the entrance; and a kind of plumbago mud, resembling soot, occurs in the overburden, just above the schist, in the short trial crosscut from creek (above the adit). Some of the schist is massively bedded, especially towards the junction of the creek with the Whyte River. Here dark, and sometimes glistening, crystals of hornblende may be seen in the rock with the naked eye. The rock is one of the crystalline schists, largely actinolitic, is non-felspathic, and requires extended microscopical examination before its exact nature can be safely determined. For the present, it can only be vaguely termed "hornblende schist." Wherever the foliation is

most complete, the formation of lenticles and leaders of quartz is most marked. Then, where the quartz leaders and the schists carry iron pyrites, copper pyrites are also apt to occur, though, so far, the latter ore has not been found in any quantity outside the old prospecting shaft sunk in the graphitic schist in the bed of the creek. All through the mine a soft band of this schist is being followed, as a guide in tracking the ore formation. This formation and the enclosing schists run parallel with one another; and, although the soft band is rather constant, I look upon it as indicating a plane of weakness, allowing easy percolation of water, rather than anything of the nature of a fissure, the existence of which is altogether conjectural. The whole mass of schist has a strike N. 20° W., and a normal dip to the N.E., though the latter varies in direction here and there. I believe the whole group of schists will be eventually found to belong to the Cambrian or pre-Cambrian rocks; but the evidence is not sufficient, at present, to enable a definite conclusion to be arrived at.

The first work done on the property seems to have been a small shaft, sunk in an extraordinary position, viz., in the bed of a creek not more than 12 feet wide. The early prospectors sank this to a depth of 22 feet in graphitic schist carrying quartz, barytes, and good copper pyrites. The late Mr. J. Harcourt Smith quotes samples of the pyrites as assaying 28% copper, 8 dwts. gold, and 10 ozs. silver per ton. Mr. F. J. Rich, the present manager, continued the sinking down to 31 feet, leaving the formation in bottom, consisting of a couple of somewhat solid bands of copper pyrites, 3 or 4 feet wide, and 2 feet of mineralised rock. Influx of water stopped further sinking. I saw a few hundredweights of the copper ore from the shaft. It was being sorted and bagged, and I estimated its contents at from 20 to 25% copper. As all the ore has come from this awkwardly-placed shaft, the only course open for the company is to get underneath it as quickly as possible, and the management is doing this in the best way. A new shaft is being sunk on the eastern side of the creek, a few fathoms from the old one. The schist is running parallel with the creek, so that drives will be opened up up the creek, first at a depth of about 60 feet, the same level as No. 1 tunnel, and again at a further depth of 80 feet,

where the main adit will communicate with it when driven far enough. The strata dip easterly, therefore the new shaft is on the east side of the creek. This is the most important and necessary work at present proceeding on the mine. It will prove the value of this course of ore in particular, and, I may add, the value of the mine as a whole; for, if the contemplated drives do not disclose anything worth working, the outlook will be far from bright, as I do not see any other point which offers any strong inducement for further prospecting. The one thing about the work in the creek at this shaft which is encouraging and invites perseverance is that fair-quality metal has unquestionably been won here, and the solid quartz, with abundant iron pyrites and a little barytes, are favourable indications. The Whyte River flows over a hornblende schist bottom, in a narrow gorge, 18 feet vertical below the main adit. The adit is driven 212 feet, first in the massive hornblende schist, then cutting the graphitic schist alluded to above. The schist here has a westerly dip, and is seamed with vertical and horizontal strings and veins of quartz, but the drive has yielded nothing so far except a few little veins of iron pyrites.

About 65 feet above the adit, a short trial crosscut has been put in from the creek. Up to now it has been passing through the heavy overburden of schist detritus which rests upon the bed-rock, but in the face the solid schist is just now beginning to show in the sole.

No. 1 level is 90 feet above the adit, and has been driven 320 feet, first in grey, and then in graphitic schist. In the end is a soft seam of this schist, which has been followed all along. The schist right across the face is veined with horizontal and vertical leaders of quartz, 1 inch and 2 inches wide. Samples of iron pyrites have been obtained from this level, but no copper ore.

No. 2 tunnel, 60 feet above No. 1, has been driven 60 feet in, and levels put in right and left in graphitic schist, but with no result. No. 3 is the top tunnel, 60 feet higher than No. 2, but is only 16 feet in, having been just started.

In the hill detritus are immense blocks of white reef-quartz, which have, apparently, rolled down from higher ground, and a good deal of loose big quartz is seen in the soil between the mine and the Corinna road. It is,

possible that a reef crosses the track, and it might be worth while to look for it, though the quartz which I saw is pure white, dense, barren-looking rock, devoid of pyrites, and has an unfavourable appearance for gold.

Since my visit I have received news that a shoot of ore has been reached at the tunnel level, 55 feet from surface, about 25 feet long. This is satisfactory, so far as it goes, and further developments will be looked for. It is quite possible that, as a small mine, some success may be attained. Whether there is scope enough in this property for the important company who are now carrying on operations there is another question. This belt of country is cupriferous to some extent, and though no payable mines have been opened in it so far, there are possibilities which it would be foolish to deny.

#### *Rocky River Mine.*

This mine is situate in the angle formed by the junction of the Whyte and Rocky rivers. It is reached by turning off the Waratah-Corinna road, at the company's mail hut,  $7\frac{1}{2}$  miles from Corinna, and descending into the valley of the Whyte River by a winding course of a couple of miles. A suspension bridge crosses the Whyte River to the mine on the south bank.

The mining works, outside prospecting shafts and trenches, consist of tunnels driven north-west and south-east into the hill from opposite sides to prove a large formation or deposit of copper-bearing magnetite, which, with breaks, has been traced at surface through a long distance of the same country-rock as far, it is said, as 25 miles. At any rate, on a minimum computation, it extends, at intervals, for 14 miles, with a bearing of about N.  $20^{\circ}$  W. Whether the identical lode is continuous for this distance may well be doubted. That the same belt of country, with similar magnetite deposits, continues on the same strike, is undeniable.

In the No. 2, or main adit, tunnel, at 20 feet above the Whyte River, the deposit of magnetite has been followed S.  $18^{\circ}$  E. for 796 feet from the entrance. The face of the tunnel is 360 feet below the magnetic iron outcrop at surface. The tunnel, for about 225 feet, follows the course of the lode, about 10 feet E. of it, and then, from the No. 2

west crosscut into the end, another 190 feet, it skirts close along the E. wall of the lode itself. Several crosscuts have been put in from the drive to prove the width of the magnetite, and have disclosed it as forming an elongated ore-body of somewhat lenticular shape, attaining a maximum diameter of 30 feet, and thinning towards the ends. Its bearing and dip are parallel with those of the talcose, quartzose, and hornblendic schists, which enclose it. A great variety of minerals—gold, copper, silver, magnetic iron, nickel, barium, cobalt, asbestos, molybdenum, &c.—have been reported as occurring in the ore-body, some of them of economic value, others of purely scientific interest. But, however apparently unimportant the non-economic minerals may seem, these and the surrounding rocks require attention, as helping to elucidate the genetic history of the ore-body. Such schists as these, and their associated deposits of magnetite in other parts of the world, have been subjects of much debate, and the origin of both is frequently obscure. One fact observed in connection with many of them is noticeable, viz., that these large lenses of magnetite occur in areas of hornblende schist (amphibolite) and gneiss. The same condition of things prevails at the Rocky River. On each side of the ore-body, and separated from it only by bands of more siliceous schist, is hornblendic rock, sometimes a gneiss, with bands of green hornblende, quartz, and plagioclase felspar, sometimes dark, compact, and fissile, plentifully sprinkled with specular iron. To the E. of the line of lode these hornblende schists form the bed of the Rocky River, where they are massively developed. The talcose schists, which accompany the hornblende schists and gneiss, have, I believe, an identical origin. The same rock as the gneiss occurs also devoid of banding or foliation, looking something like a gabbro to the naked eye, and consisting, as ascertained by micro-optical analysis, of green hornblende, large plates of plagioclase felspar, with apatite, quartz, and a quantity of epidote. The hornblende schists have the same constituents, drawn out into bands, parallel with the foliation. The talc, asbestos, calcite, dolomite, and serpentine present in the rock are secondary products. The schist sometimes occurs in the middle of the lens of magnetite. The proper interpretation of this interesting rock is naturally a difficult task. In such ancient areas of crystalline schists and

gneisses, even the mere differentiation into sedimentary and igneous divisions is no easy matter. Igneous rocks become masked and altered by tangential pressure, due to the secular cooling of our planet, by consequent foliation and the development of new minerals, resulting sometimes in the complete reconstruction of the rock. Sedimentary rocks under the same influence are deformed, crushed, and become crystalline to an extent which finally obliterates all recognisable distinctions between eruptive and sedimentary. In the present case we cannot be quite clear as to how the gneissic structure has been induced. Is it the result of a re-distribution, by gravity, of the separate minerals upon recrystallisation of the rock?—or has it proceeded from the crystallisation of certain minerals along planes of weakness, thus giving to the rock the banded appearance characteristic of gneiss? Looking at the microscopical characters of the rock, and taking into account its mineralogical associations, I tentatively advance the theory that the gneiss and the less gneissose hornblende rock are modifications of original gabbro through crushing and shearing; and the enclosing talc schists represent a further stage of metamorphism. Professor Rosenbusch (in his "Massige Gesteine") goes very fully into the metamorphosis of gabbro rock, in which process the augite is completely replaced by hornblende, and the basic felspar is transformed into a granular aggregate of more acid plagioclase and quartz. Such a rock, a marginally-modified gabbro, Rosenbusch would call hyperite-amphibolite. (Hyperite is a rock between gabbro and norite: its constituents are basic plagioclase, augite, hypersthene, olivine, ilmenite, and some apatite.) He refers to hyperite and magnetite-gneiss, where these changes have produced diorite schists and hornblende-gneiss. Gabbrodiorites are such gabbros as have been converted into diorite, with acid plagioclase and quartz. Rosenbusch prefers to call them gabbro-amphibolites when hornblende has been developed in them; or by a shorter name, zobtenite. He says, with reference to Justus Roth's proposal to adopt the term zobtenite for such rocks\*—"If we would adopt this name, it would be, according to Justus Roth's own showing, a collective name for very

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\* Massige Gesteine: page 326.

heterogeneous things, comprising the gabbro-diorites and hyperite-diorites, or gabbro-ampibolites and their schistose forms. Zobtenite would then be any amphibolitic rock derived from gabbro through dynamic metamorphism. In this sense, it would be a desirable and short designation."

The mode of origin of lenses or beds of magnetite is obscure, notwithstanding all that has been written upon the subject. Professor Kemp, in his "Ore Deposits of the United States" (pp. 152-3), gives eight different hypotheses:—

1. As intruded masses, *i.e.*, dykes.
2. As segregations during the cooling of basic magmas.
3. As metamorphosed limonite beds.
4. As replaced limestone beds, or as siderite beds subsequently metamorphosed.
5. As submarine chemical precipitates.
6. As beach sands.
7. As river bars: concentration of magnetite sands.
8. As segregated veins: concentration in a state of solution from the wall-rock.

In 1897 the same author advanced a theory of the origin of some magnetites near Port Henry, N.Y.,\* supposing them to be contact deposits formed by the influence and stimulus of gabbro intrusions, forming coarse hornblende-magnetite-pegmatite masses, with associated apatites and zircons, during which time heated solutions of iron were emitted, which attacked the wall-rocks, and gave rise to the ore bodies.

Under circumstances surrounded with admitted difficulties, I only advance my own interpretation hesitatingly, and subject to correction upon closer examination in the field. But, if I am correct, it is improper to speak of this magnetite body as a bedded deposit. I am rather disposed to believe it to be the effect of direct differentiation from the cooling magma of ferriferous gabbro, and the lenses to be subsequently stretched forms of the original differentiated masses of magnetite. The progressive separation of the iron from the fused magma would increase the percentage of  $\text{Si O}_2$  in the residue, and this may have facilitated the development of the quartz and acid plagioclase during

\* J. F. Kemp. The Geology of the Magnetites near Port Henry, N.Y. Trans. Am. Inst. M.E., 1897.

the later metamorphic processes. On this theory, the nickel ore found in the magnetite has originated by the ordinary process of sulphidic segregation from a cooling basic magma.

Assuming the hornblende-gneiss to have been originally gabbro, there are two possibilities, geologically. Is it an injection gneiss, *i.e.*, an intrusive dyke or sill penetrating between the foliation or bedding of the enclosing rocks, or was it an exposed mass *in situ* prior to the deposition of surrounding sediments, and at a later time involved, together with these, in the earth movements which have converted the whole complex into schists? Microscopical and chemical examinations, as well as field studies, must be conducted before these points can be elucidated. Perhaps, in the future, the services of an officer may be available for purely scientific work in connection with the geological survey of the Colony, and then this district, with others now neglected under the pressure and exigencies of routine work and economic enquiries, may receive the scientific attention which they deserve.

I will now briefly record my notes of inspection of the mine, beginning with the No. 2 long tunnel from the Whyte River. This is driven in quartzose, talcose, and hornblendic schist 796 feet, and on the line of the schists. The schist is impregnated with a little copper and iron pyrites and galena. The tunnel comes into indications of magnetite a little over 100 feet from the entrance, but the solid lens itself does not seem to be present much before reaching the No. 1., or nickel, winze, another 200 feet. This winze has been carried down 150 feet. At the 110-foot level it has been driven N. for 100 feet, but work was stopped owing to heavy water and bad air. Some veins of nickel ore, a few inches thick, were found in the winze, with a carbonate of iron gangue in serpentinous-looking rock. In following the vein northwards the grade is said to have become lower. The winze being under water, I could not descend. The ore is an unusual one, and has been referred to in several assays of it published by the company. Mr. A. J. Bolton, the company's metallurgist, and Mr. E. M. Cairnes, were the first to recognise the peculiarity of the ore, and referred it to siegenite, a nickeliferous sulphide of cobalt. I was informed by Mr. Bolton that it has since been determined in

Germany as rammelsbergite = nickel diarsenide. As will be seen presently, there is reason to believe that neither of these determinations is admissible. The published assays are as follows:—

	Gold.	Nickel.	Cobalt.
A. J. Bolton .....	1 oz. 5 dwts.	51·75%	10%
Gilfillan & M'Creery...	1 oz. 6 dwts. 3 grs.	29·5%	
F. Dunn, F.C.S.....	2 ozs. 10 dwts. 22 grs.	26·4%	

Mr. O. E. White, of Hobart, has made an assay of this ore, with the following result:—

	Per cent.
Nickel.....	34·8
Antimony.....	2·0
Cobalt .....	2·0
Arsenic, large quantity.	

Mr. W. A. Macleod, B. Sc., University of Tasmania, further assayed it for gold and silver, when it returned 9 ozs. 16 dwts. silver, and 6 dwts. 12·8 grs. gold per ton.

The new feature revealed by this last analysis is the presence of antimony, which makes the ore an antimonial sulpharsenide of nickel. Mr. W. F. Petterd has pointed out to me that there are two distinct nickel ores in these samples—Kupfer-nickel (nickel arsenide), with a copper-red colour, and the antimonial sulpharsenide, near corynite, of a white, steely colour. With this ore, Mr. Bolton tells me he has found pateraite, a molybdate of cobalt.

At 45 feet past this winze the first crosscut (No. 1. W.) has been driven 56 feet, crossing the magnetite lode, which is here about 10 feet wide, and 15 feet west of level. The crosscut is in hard pyritic schist, and though the lode is fully passed through, much magnetite is not disclosed. 172 feet further in, No. 2 crosscut (W.) has been driven right through the magnetite lens at nearly its thickest part. The crosscut has been extended 360 feet, and goes through to the line of the Sawpit Lode. At 20 feet W. of the main tunnel the magnetite lode was struck, and driven across, proving to be 20 feet wide. The magnetite here is a solid body, showing no signs of lamination, sharply separated from the country, but enclosing in the middle a couple of bands of schist. After traversing the ore-body, the crosscut continues in schist, till the sawpit lode is intersected, on which a south drive has been extended 32 feet. This lode is represented here by a band of pyritic

quartz and graphitic schist. Dolomite and a vein of pyrites are seen in the face of drive. Mustard gold is said to have been observed on the carbon. The schist is gossanous and ochreous in colour where exposed in the end, while both footwall and hanging-wall of drive are soft and graphitic. Back in the crosscut, according to an assay made by Mr. Bolton, a 3-foot band of arsenical iron pyrites carried 22 dwts. gold.

From this crosscut the main level has been continued south all the way to the end along the eastern side of the magnetite lode, which has been further proved by three more crosscuts, No. 3, No. 4, No. 5, W. No 3, which has been driven at 49 feet further in, has passed through the ore lens at its greatest diameter, it being there 32 feet across. The lode here also encloses a band of schist. Some good yellow copper ore is said to have come from this crosscut. 52 feet further in, No. 4 crosscut (W.) has been driven across the lode, which has already begun to grow narrower, being only 17 feet in width, and enclosing a wide band of schist. 87 feet beyond this is No. 5 crosscut, which has intersected the lode with a width of only 14 feet. When I was there, this was 10 feet behind the face of tunnel. The ore still continues, as shown by pyritic magnetite seen in the footwall of drive, 3 feet behind the end.

Thus, this lode has been tested by crosscuts for a couple of hundred feet behind the end of tunnel very systematically, but for an equal distance north of No. 2 crosscut (W.) has been left alone and untried.

An upper tunnel (No. 1), about 150 feet above the Whyte River, has been driven S., with long crosscuts E. and W. No copper ore worth speaking of was found here, but the lode, 8 feet wide, is said to improve going down.

The nickel winze workings expose what is called No. 2 lode, and further in, along E. of tunnel, 3 crosscuts E. have cut the extension of the same lode, called here No. 3. Judging by positions, Nos. 2 and 3 appear to be identical. At one time, this line of lode was looked upon as very important, from its nickel, gold, and copper contents in the vicinity of the winze, but though gold has been reported from other parts of the lode, there is no solid ore-body exposed; still, the winze ground requires prospecting. At 98 feet beyond this winze, a crosscut (No. 1) has been

driven E. for 50 feet, and at 15 feet intersected the track of a lode with veins of specular iron, reported as assaying 5 dwts. to 1 oz.  $2\frac{1}{2}$  dwts. of gold. The face of this cross-cut is in hard rock, impregnated with specular iron, and seamed with pyritiferous quartz. The veins have been driven on a few feet north. About 120 feet further south No. 2 cross-cut (E.) has been driven 27 feet, crossing the same lode track in pyritic schist, with much quartz. Behind the end, in main tunnel, No. 3 cross-cut (E.) has intersected this lode again at 114 feet, but here it is magnetite, about 2 feet in width, and softer than usual.

I did not see any magnetite on the south side of the hill, but I believe the lode-line has been traced across the Rocky River.

On the south side of the hill, No. 3 tunnel has been driven N.W. from the Rocky River about 290 feet on what is called the Sawpit Lode, and this tunnel, if continued, will eventually connect with the south drive from No. 2 crosscut (W.). About another 400 feet of driving should effect this connection. The tunnel entrance is in a bold outcrop of mineralised hornblendic schist. The feature of the alleged lode is the occurrence of auriferous graphite, reported to assay up to 17 dwts. in specimens. The country is mineralised, but there is not any evidence of true lode-matter. About 80 feet in, a winze was sunk 9 feet on a vein of quartz. Mineralised schist and bands of iron pyrites are the characteristics of the cross-cuts, which, if extended, would probably intersect the graphite, as the latter strikes across the tunnel some way in. The face of the tunnel is in schist and what looks like quartzite, with a seam of dolomite 4 inches wide.

The work in this mine which may be said to be naturally impending is—

1. To complete the connection between both sides of the hill, as the Rocky River side is the natural and most suitable outlet.

2. To advance the S. drive on the No. 1 magnetite lode, which is the mainstay of the mine. The extension of this lode must be proved and established.

3. In view of the long line of magnetite already proved, there need be no hurry to start a main shaft, but it will have to be put down to drain the nickel winze and develop that vein. I may here say that, although the nickel ore

constitutes an attractive feature, I look upon it as altogether subordinate to the main resource of the property, the cupriferos magnetite.

The magnetite ore taken out in driving has been stacked, partly at the approach to No. 2 tunnel, partly in a closed drive inside the entrance, and is estimated by the manager at 2500 tons. No stoping is going on, as the company intends first to construct its tramway along the Whyte River valley to Corinna. They are, apparently, anxious to refrain from doing anything involving double handling of the ore, but, all the same, as soon as the outlet from the mine at the Rocky River side is secured, it will be well to get ore out, and establish the value of the mine in a satisfactory way. A selected specimen, of very promising appearance, was assayed by Mr. Ward, Government Analyst, and yielded, copper, 0.1 (one-tenth) per cent.; silver, 9 dwts. 19 grs.; gold, trace; while a bulk sampling made by Mr. Wilks, the mine manager, and assayed by Mr. Bolton, is published as returning 5 per cent. copper, and 3 dwts. gold per ton. But it must be borne in mind that this is essentially a low-grade ore, and everything depends upon the sampling being representative of the bulk, as a little difference will affect the result to an extent that would be inappreciable in the case of richer material. There is not enough margin in the ore value to allow any errors of judgment in planning a programme for work. I do not regard mere sampling from a standing lode as a safe method of arriving at the average value of the ore. Small trial shipments ought to have been got away and smelted long ago: the owners would then by this time have had something much more secure to go upon than they have now. After getting in this way a good idea of bulk values, the ore could be proved both above and below adit level, for, although it has been disclosed by that level for a long distance, no horizontal extension can be a satisfactory basis for permanent ore-winning.

But, above all, I am disposed to insist very strenuously upon the necessity for a more satisfactory assurance as to the bulk value of the ore, especially as I have not been fortunate enough to secure samples of it showing payable percentages of metals. Two samples, one a poor looking magnetite (A) ore from the stack outside the main adit on No. 1 lode; the other, a coppery-looking specimen (B),

which, from its appearance, looked rather above average quality, were assayed, with the following results:—

B.—*Assay by Mr. W. F. Ward, Government Analyst—*

Gold .....	Trace.
Silver.....	$\frac{1}{2}$ oz. per ton.
Copper .....	0.1 %.

A.—*Assay by Mr. W. A. Macleod, B.Sc., B.A.,  
University of Tasmania.*

Gold .....	1 $\frac{1}{2}$ dwts. per ton.
Silver.....	15 $\frac{1}{2}$ dwts. per ton.
Copper .....	?

On the other hand, the assays published by the company vary from traces up to 5 % copper, and traces up to 1 oz. 5 dwts. 8 grs. gold per ton, in ore from the same lode.

This only shows the imperative necessity for ascertaining values by means of a bulk shipment of ore taken from all parts of the lode; and I would recommend that this be done before beginning to lay out money in the construction of the tramway to the Pieman. The company has been working steadily for 5 $\frac{1}{2}$  years, and have distributed a good deal of money in the district. It is now about to spend £20,000 on its tramway, which is surveyed 7 $\frac{1}{2}$  miles to the Pieman. At the time of my visit, 27 hands were employed at the mine. Since I was there, a new copper lode has been found at the Whyte River, in the 80-acre section. Rich copper ore is stated to be present, and shaft-sinking has been begun. This has been called the Western lode, and is altogether distinct from the large lens of magnetite ore described above.

*Rocky River Associated Mine.*

This mine is on the west side of the Rocky River, Section 1829, a little above where the celebrated nugget was found. About 30 feet above the river a crosscut tunnel is being driven across quartzose country and limestone. The quartzose country appears to be big barren quartzite. Behind the end is a band of white limestone, 40 feet in width, but green talcose schist is just appearing in the face. At 90 feet in, a 22-foot belt of mineralised schist was passed through: it is intended to drive south upon it. This is supposed to be the southern extension of the Rocky River No. 1 lode, and the tunnel is being

continued, in the hope of intersecting the Sawpit Lode, 200 feet further on; at least, the supposed outcrop is traced at that distance, on the top of the hill. The mine is in the hornblendic zone, and massive quartz and hornblende rock forms the bed of the river along here. The owners of this mine are very plucky, because it is by no means certain that the lodes on the property will be found remunerative.

On the adjoining 10-acre section, further south, a quartz-copper lode is being opened upon the opposite side of the river. This is called the eastern lode. The veinstone is the dense white quartz characteristic of these schists, and shows clean, nice-looking copper pyrites, with iron pyrite. The outcrop has been traced some 5 or 6 chains. The drive, if continued, will give between 300 and 400 feet of backs. The intention is to drive another 15 feet, and then put down a trial sink.

The workers on these sections deserve credit for courageously undertaking mining under difficult conditions. Mr. M. Blaney, the manager, took the trouble to show me round.

*Corinna Gravels.*

At and near the township, the Silurian bedrock lies under sands and gravels, sometimes 50 or 60 feet deep, though often so shallow that the slates rise to the surface. Mr. Harry White informs me that some of his bores on the north bank of the Whyte River, above its junction with the Pieman, bottomed at 36 feet and 60 feet, while another reached 60 feet, without bottoming. The different sluicing companies which began to work the Corinna series of auriferous gravels some years ago have all stopped work, so that there were really no sluicing properties for me to inspect round Corinna. From some of the abandoned claims which I passed over, I should judge that the true bottom ought to yield payable gold in places where there was any action at work tending to arrest the current. There is such an extensive area of slightly auriferous wash, that there is not much hope of payable results outside certain selected spots. These low-level gravels are the result of the destruction of higher-level gravels, so that it is unreasonable to expect any uniformity of distribution throughout the mass. Besides gold, a little tin is present in the wash; but, as far as the country which is fed by

rivers from the Meredith Range is concerned, much tin need not be anticipated. It is different, however, with the country to the north. We may safely say that the gold is derived from the degradation of the country which is now watered by the Pieman, Whyte, and Savage rivers, with their tributaries. These creeks and rivers all carry gold; and, before their existence, the same auriferous country was sluiced partly by the sea, partly by other watercourses. The lenticular quartz patches in the schists, the auriferous magnetite, the serpentine country, all must have contributed their quota to the sum total, and account for the gold, despite the singular absence of auriferous quartz reefs.

#### *Osmiridium Sands.*

The natural alloy known under the name of iridosmine, or osmiridium occurs as flakes and flattened grains in the sands of the Savage River and tributaries, Badger Plains Creek, and generally in the streams flowing, at some part of their course, over serpentine country. In the Badger Plains sands it used to be as plentiful as the gold, and was looked upon as a nuisance. New uses for iridium have recently raised the market value of the metal, and a party of men are now working the Savage River sands, diverting the streams, etc., and regularly take small quantities in to Waratah for sale; I believe, a few pounds weight per month. The prices realised have gone up from 30s. to 50s. per oz., and quite a new industry seems to have been initiated.

No analysis of this alloy appears to have been made in the Colony, but it is highly probable that the constitution is iridium and platinum, with a little osmium and the other rare metals usually associated with these. Its source is in our serpentines, and especially such serpentines as have resulted from peridotites and pyroxenites.

The present rise in price is believed to be the result of some new use being found for iridium, but what this is, is not yet known. It is also reported that osmium is chiefly sought. It is not known, either, whether, the miners are getting full price for their product. Osmiridium and phospho-iridium are used largely for tipping gold pens, and an alloy of iridium and platinum is employed as standards for weights and measures. Iridium has some

limited application also in the ceramic art, and phosphoridium is used for the knife-edges of certain chemical balances. Iridium has been used experimentally for electrical contact points, but there is no demand for it commercially, at present, in that direction. It is also being employed for the anode and cathode points in radiography.

#### *Conclusion.*

From the preceding remarks it will be seen that the only mines on this route now sending ore to market are the Mount Bischoff Tin and the Magnet Silver Lead. Looked at from this point of view, the line of country, as a whole, does not present a cheerful aspect, especially when we take into account the number of mines formerly worked and now abandoned. This gloomy view, however, may be discounted, if we find, upon examining the circumstances more particularly, that insufficient prospecting, half-hearted, or injudicious mining, and, sometimes, financial mismanagement, combined with low market rates and defective means of communication, with correspondingly high freights, have been responsible for some of these failures. In these remote places the mere discovery of ore is not sufficient: the discovery must be accompanied by conditions and circumstances which will allow the ore to be raised and placed on the market at a profit; otherwise, the mineral, whatever the quantity may be, might just as well be non-existent. A pound or two in the market rate for lead may make all the difference between profit and loss: and if an untoward circumstance like this causes work to be suspended on any individual mine, the chances are that it also checks or absolutely prevents the development of others in the vicinity. In this way we see how possible it is for the misfortunes of a single mine to throw a whole district back for years, and to bar the discovery of even richer ore deposits in the same neighbourhood. Because the mines at the Heazlewood and the Whyte rivers have been abandoned in the past, it does not follow that some of them could not be worked at a profit now, when market values and freights are more favourable, and *a fortiori*, it is not safe to assume that the indications of ore in so many places only point to worthless lodes. On the contrary, I think it very likely that the more favourable conditions which at present

surround the inception of mining work, will lead to the resumption of exploration at some of these neglected centres. The pyroxene country between the 7-mile and the 16-mile from Waratah is distinctly favourable for lead ores, with a good percentage of silver. The numerous ultra-basic dykes are so many channels, if not stimuli, of ore-deposition: and it may be also that the later granitic intrusions have played a part in influencing some of the ore-carrying solutions. The mere fact that some of the ore-shoots contracted at the shallow depth of a hundred feet from the surface, does not furnish the slightest reason for not pursuing the ore-channel down to reasonable distances. But so it is: and investors look askance on neglected districts, and prefer to take even off chances on a field which is alive. I have not the slightest doubt but that this 9-mile stretch of country will have its turn again, and when it comes, adventurers will wonder how it lay dormant for so long.

The nickel deposits at the Heazlewood are not so encouraging, the country rock,—serpentinised pyroxenite, is favourable enough, being the proper home of the metal, but no solid veins of any thickness have been met with in the superficial *i.e.*, the more or less marginal parts of the rock-mass, and geological theory rather discourages the idea that greater depth brings increased deposits of this metal: on the other hand, it is from this rock that the osmiridium has come, which is being turned into money on a rising market by a few indefatigable prospectors on the Savage River.

Gold-mining on Long Plains is, I am bound to confess, a precarious occupation, and, I am afraid, will never give permanent work to any considerable number of miners. The field however is still in want of a thorough geological examination. The singular occurrences of richly auriferous patches which I have attempted to explain in this Report may occasion, from time to time, an influx of alluvial miners, and the prospecting work to which such rushes inevitably give rise may lead to results at present impossible to forecast.

There is yet another field on this route, the value of which, in its still undeveloped state, it is quite impossible to estimate, *viz.*:—the zone of the auriferous and cupriferous magnetite on the Rocky River and Rio Tinto line. The

work done so far points to low grade copper ore, but the trials have been insufficient, and it is quite possible that future prospecting may open up more favourable portions of the deposit, which, so far as I am able to judge, belongs to the same series of ancient crystalline rocks as are worked all over the world for their ores of copper and iron.

The alluvial gravels near Corinna, which have been sluiced for gold with unsatisfactory results, do not offer any very hopeful prospects. The only chance is that virgin prospecting down to the bed-rock may strike some richer accumulation than the average. The Whyte River Gold Dredging Company is putting its plant together at the suspension bridge at the Rocky River mine, and the result of its enterprise will be seen shortly.

On the whole, then, these considerations lead me to look upon this part of the Colony as an undeveloped mineral field of considerable promise. The mineral deposits, however, do not simply invite investors to do nothing more than to come and remove them. Mining will have to be undertaken exactly like any other business, with due regard to all the factors of success; the details of working cost and market values carefully worked out: the mining and management must be skilful and well flavoured with business common sense, if disaster does not tread upon the heels of enterprise. Under these conditions, and with a reasonable degree of patience, the field ought to repay exploration, and will, I believe, eventually constitute a by no means inconsiderable addition to the mineral assets of the Colony. Its geological structure decidedly supports such a hope.

I have to tender my hearty thanks to the various mine managers on the fields, and others interested in the resources of this part of the Colony for their readiness and kindness in accompanying me and affording me information: also to the directorate of the Emu Bay Railway Company for facilities and courtesies extended.

I have the honour to be,

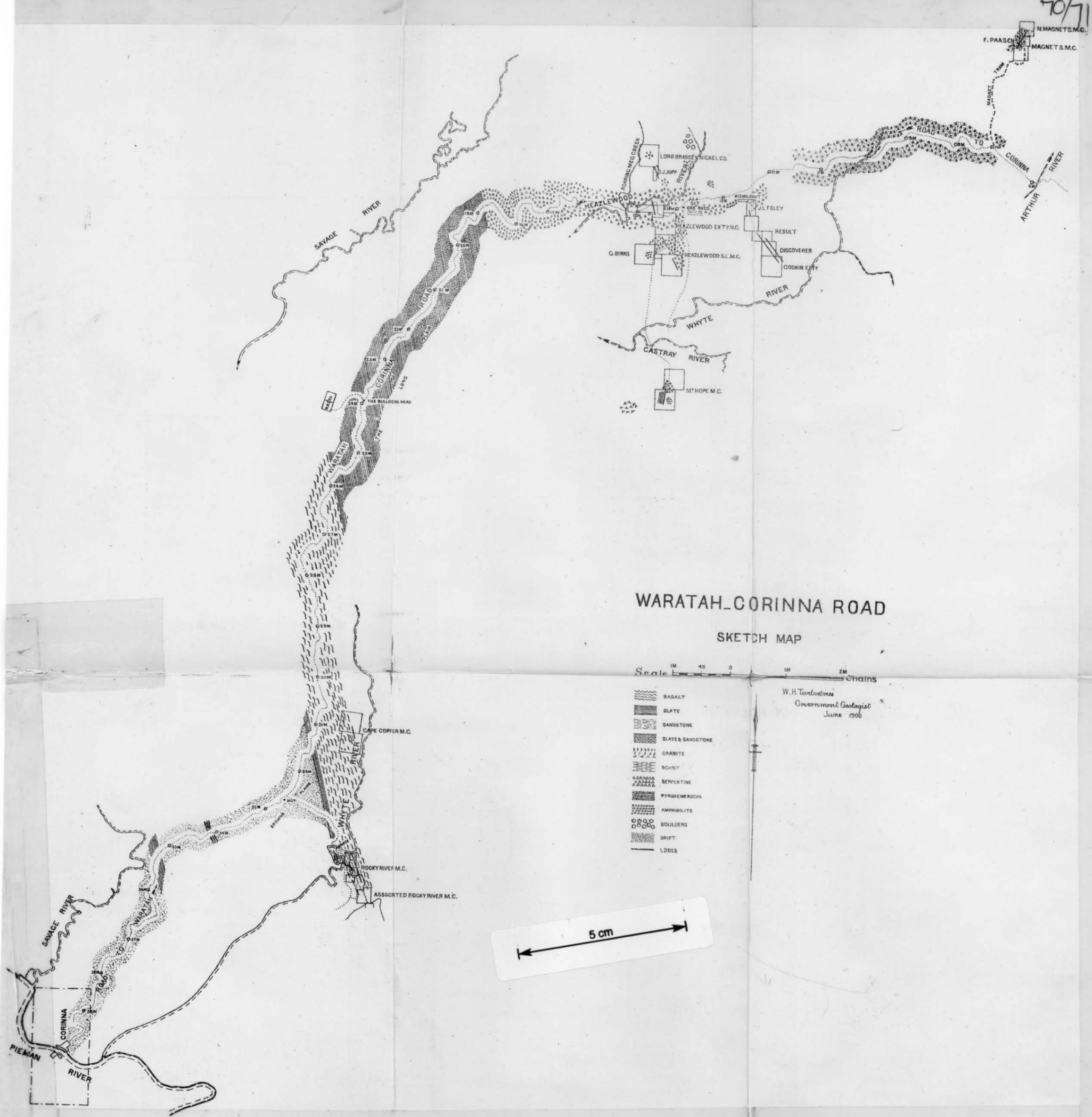
Sir,

Your obedient Servant,

W. H. TWELVETREES,  
*Government Geologist.*

W. H. WALLACE, *Esq., Secretary for Mines, Hobart.*

70/71



WARATAH-CORINNA ROAD  
SKETCH MAP

Scale 1M 40 0 1M 2M Chains

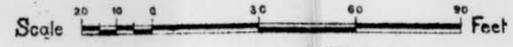
- BASALT
- SLATE
- SANDSTONE
- SLATE & SANDSTONE
- GRANITE
- SCHIST
- SERPENTINE
- PYROXENE ROCKS
- AMPHIBOLITE
- BOULDERS
- DRIFT
- LODES

W.H. Tuxworth  
Government Geologist  
June 1906

5 cm

# SECTION OF DYKE AND LODGE AT THE MAGNET MINE

LOOKING NORTH



W.H. Twilvetrees

Govt. Geologist  
June 1900

