

REPORT ON THE MINERAL DISTRICTS
OF ZEEHAN AND NEIGHBOURHOOD.

Government Geologist's Office,
Launceston, 27th October, 1900.

SIR,

I HAVE the honour to present my Report of the visit, which, in accordance with your instructions, I paid to the mineral fields of Zeehan and its vicinity in April and May this year. During a part of those months I was absent from that district on a journey to the new mineral ground on Mts. Jukes and Darwin, which will form the subject of a separate report; I was occupied, also, for some time, on departmental business.

The Zeehan and Dundas districts have, within the past ten years, grown from small beginnings to be important and stable contributors to the mineral production of the Colony. This expansion has taken place in the face of great difficulties, some of which are unavoidable, while the others are expected to be remedied or removed as time goes on. It has also proceeded in spite of the continual gloomy forecasts of croakers, who, forgetful of the time needful for underground prospecting and development, the maturing of plans affecting the metallurgical treatment and sale of the ores, investment of capital, improvement of the means of communication, and other considerations involved in the maintenance of a thriving mining field, could only see disaster ahead.

I found the race of croakers not quite extinct, only they had transferred their shattered predictions from the permanent, productive mines of the centre of the Zeehan field to the undeveloped mineral sections of the outlying districts; and when these, too, with the march of events, will, as is certain to happen, be drawn into the zone of productive mines, no other course will remain for croakers than to flee the West Coast, or for ever hereafter hold their peace.

When we see the flat country and low hills close to Zeehan, and consider that the opening up of every mine involves a tremendous outlay for sinking operations, expensive winding shafts, and pumps, &c., and further recollect that only the first class ore can be realised straight away, the seconds, which are the foundation of the health (the bread and butter) of every mine, having to be concentrated in costly dressing mills, it is impossible to stand in Zeehan to-day and look round on the habitations of a population of upwards of 8,000 without recognising in this young and prosperous centre a striking tribute to the solidity of the field.

This imperious necessity for sinking was one of the factors of the mining work at Zeehan which specially attracted my attention. At Dundas and the other fields on the West Coast range the difficulty does not present itself. There the lofty precipitous hills allow mines to be worked cheaply by adits or horizontal tunnels; but at Zeehan such tunnels only give access to the lodes at very shallow depths, and the exploitation of the mines at any reasonable distance from the surface can only be effected by means of shafts. This condition of work is a great tax on young mines unprovided with adequate capital, and it shows the No Liability system at its worst, confronted, as it so often is, by the hopelessness of getting in calls easily evaded by forfeiture. To lay the foundations of complete success in the Zeehan field, first of all ample capital must be assured, and then continuous sinking persevered with. It is of no use to observe false economy and suspend sinking till the shoot of payable ore is exhausted. Sinking should be continued all the time that ore is being raised, and when the time comes, as come it must, that the vein pinches and a blank is met with, the shaft will have either sunk by that time into a productive zone again, or will have rendered search for it a much easier task than if sinking had been discontinued directly the upper ore gave out. Some of the mines on the field (too well known for me to mention names) have had a disastrous experience from this very cause. One or two, the Zeehan-Montana and the Western, are setting an example to the others in resolutely determining to go down below what is called the shallow zone.

The shafts on the Zeehan mines, as far as I could learn are now at the following depths:—

Western...	...	...	...	600 feet
Oonah ...	...	...	...	425 feet
Zeehan-Montana	...	...	...	400 feet
Col. North	...	...	...	275 feet
Queen (with winze)	...	...	...	270 feet
King ...	...	...	..	246 feet
Silver Bell	...	...	...	180 feet
New Mt. Zeehan	...	...	...	140 feet
Fahey's Tribute	...	...	...	100 feet
British Zeehan ...	...	...	...	93 feet

None of these depths are anything extraordinary, and they are all too insignificant to warrant abandonment in any single case. As a matter of fact, Zeehan has been extremely fortunate in having so much ore concentrated in the lodes of shallow depths, or, to put it more plainly, in having its surface rock worn down by the agents of denudation to a metalliferous horizon in the lodes. The upper edges of the silurian strata have had a good deal removed from them since they were folded by tangential pressure and fissured under great piles of superincumbent rock. The upper parts of the Zeehan lodes have disappeared. These may have been either ore-bearing or barren, and the proximity of the present ore shoots to the surface is purely fortuitous. It is not as if surface agencies were responsible for the shallow zone concentrations. It is true there are secondary ore deposits in some of the mines, but the galena which we see in the lodes close to the surface is the same primary sulphide which will be found a thousand feet below. No known physical cause exists to bar the recurrence of similar ore deposits at greater depths. If I am asked to what depth the deposition of ore extends, I would say that is a question which no geologist or miner can answer. In any case we can imagine a depth beyond the reach of practical mining where fissures could not remain open; that is, they could not even be formed at all in molten and plastic rocks, such as may be supposed to exist at immense depths. Physicists have endeavoured to determine such a depth by means of the data at their command, and have variously estimated it at from

16,000 to 33,000 feet. This means that a fissure or lode is not debarred by any physical impossibility from descending to 16,000 feet. I need hardly say that this is a limit which need not be taken into account in mining. Of course, all lodes need not have ascended from these depths. The popular idea is that no lode is good unless it is a true fissure one, and that such lodes extend downwards to the barysphere or central zone of heavy metals. The latter notion belongs to the domain of theory, and deals with a state of things outside the range of observed facts. What has been observed is that lodes followed to great depths have been traceable for long distances on the line of outcrop. We may, therefore, argue the converse. I have not noticed any purely igneous veins in the Zeehan field proper, that is to say, veins in which heavy metals have been deposited by differentiation or concentration in a molten magma. The Zeehan vein fissures, wherever quartz is associated with the ore, must have received their ore by precipitation from solutions. This may have taken place at great depths, though not below the limit mentioned above, for beneath that, water cannot exist as water, and no circulation, consequently no precipitation, can take place. Hence, all ore deposition in quartz must take place above that horizon. It is not too much to assume, further, that some of the waters which had first descended, deposited during their re-ascent the minerals which they carried in solution; other waters, perhaps, have never seen the surface, but have been expelled direct from the solidifying magma. The derivation of the dissolved minerals is still much debated. The lateral secretion theory has of late years received less support than formerly. The idea is gaining ground that they are derived either from concentrations at extreme depths or from the magma at the base of the more or less consolidated rock. But our knowledge of physical conditions at this depth is elementary.

Most of the Zeehan lodes are true fissure veins, crossing the stratification of the Silurian country; in other parts of their course they become bedded veins, running between the bedding planes of the sandstones or slates. Sometimes they are contact lodes, having "white country" (melaphyre) on one side and sandstone or slate



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on the other. A very frequent feature is the absence of walls or any parting between vein and country. The absence of a defined wall is commented on unfavourably by many mining men, and it used to be considered a more detrimental sign than it is now-a-day. More extended observation has shown the fallacy of the reasoning which underlies the old opinion. If the rock is at all fractured, as is mostly the case, the presence of walls means simply that the dislocation has been considerable. An insignificant degree of displacement may not result in the formation of walls, but may still be accompanied by the formation of veins.

The sets of lodes at Zeehan form a complex series, branching and anastomosing in a network fashion, so that any particular lode cannot be followed far along a course having any definite bearing. Still, in the apparent confusion caused by the different branches and junctions, it is possible to roughly determine the bearings and trend of the main systems as east of north, west of north, and north and south. Thus, the King line of lode on the east of the field is a north and south line. It may be taken as represented by the main lode on the Silver King section and four west lodes on the same property. The continuation of the main lode south passes through Fahey's tribute, and further south to the main shaft on the Zeehan Bell, and extends still further south to the shafts on the Sunrise section. The four west lodes bear slightly east of north and west of south, and, if prolonged, would come into the Tasmanian Smelting Company's section, some of them in the immediate vicinity of the works. All this line of lode south of Zeehan requires prospecting, as there is every reason to believe that the lode-fissures extend a good way into this country. The country rock appears favourable, and I should not be surprised if future exploratory work at this end of the town resulted in an important extension of the Zeehan mining field in this direction. A drawback belonging to the southern end of the line is an impoverishment of the silver contents of the ore, compared with the northern and central mines of the field. Whether this is dependent upon the proximity of the limestone is not easy to say, and, as long as exploratory work is so incomplete, it would not be safe to say that the limestone has

anything to do with it. All we know about the influence of limestone on galena deposits is that it is rather favourable than otherwise, and the rock is usually esteemed as a precipitating agent. The silver contents of galena are often so variable in one and the same mine, that the low grade observed in the few places opened upon ought not to act as a deterrent from work. The Zeehan-Montana Despatch lode appears to belong to the western set of the King system.

There is another set of lodes which bears S.E. from the Oonah, through the Silver Queen, east of Balstrup's, through Montagu, Watts, and M'Auliffe and Austral, down to the smelters, where it would unite with the King system.

The general run of the lodes from the Western, Zeehan-Montana, and Oonah properties, through the Mount Zeehan (Tasmania), is, on the whole, N.E. and S.W. towards the mangause hill; and the Western blocks also show a set of lodes running in a south-easterly direction, but I cannot satisfactorily identify the prolongation of these. In this part of the field there is such a network of minor veins that the general bearing can only be given vaguely. Some of the westerly veins on the Silver Queen would bear S.W. into the Mount Zeehan (Tas.) property, into the east part of Colonel North, and into the Nubeena, further south.

The outside lodes to the west of Zeehan, in the Comstock district, have no uniform bearing. The Comstock and Boss W. lodes bear west of north, the Comstock west lode east of N., Montgomery's lode due N., while the two lodes on the Tasmanian Land Exploration Company's property run north-east. The two lodes on the Britannia bear N.W.; the lode on Stonehenge has a similar bearing: on Britannia Extended, west of N. The Silver Stream lodes have a bearing east of N. It will readily be seen that the lodes in this district cannot be classed according to bearing, as there appears to be no system or regularity in their directions.

The lodes in the whole Zeehan area traverse sandstones, quartzites, slates, limestones, and the so-called "white rock," = melaphyre, an ancient basalt, often vesicular in character, sometimes hard and solid, sometimes soft and tuffaceous. This series of rocks, from

their lithological features, were long ago recognised as Silurian, and, on the evidence of fossils found in the limestone and determined by Mr. R. Etheridge, jun., are referred by him to the upper portion of the middle division of that system. The melaphyre, which at one time excited considerable curiosity, is, undoubtedly, of the same geological age. It is seen, especially in the Oonah and Montana mines, interbedded with the sedimentary strata in contemporaneous sheets, and has, evidently, been emitted in more than one flow. I have been told that it has been also noticed as decidedly intrusive, but I was not able to verify this. There is, however, nothing improbable in dyke-like masses being thrust into adjoining strata at the same time that the lavas and tuffs were projected from the volcanic vents, only I have not seen any proof of it. The rock strikes N.W. with the stratified rocks across the British Zeehan, Silver Queen, Silver Queen Extended, Oonah, Zeehan-Montana, and Western. It is seen while ascending to the saddle of hill on road to the Sylvester mine, six or seven chains E. of the old Sylvester workings. Here the rock is white and vesicular, but decomposes to a yellow clay. It is clearly bedded, and dips N.E., the same as the sedimentary rocks of the field. The prevalent idea, till recently, was that when the lodes are in this rock their silver contents are augmented, but beyond that it is favourable country for ore; I cannot find adequate evidence to establish this. Certainly, I found the No. 4 lode in the Montana wholly in this melaphyre in one place, and thinning out just before coming to the black slate; and the melaphyre is not intrusive there, for it underlies the slate conformably. But this is not the kind of evidence which would specifically prove enrichment. At the same time an enrichment may really take place, and it would be interesting to collect the facts bearing on the point thoroughly and systematically, and settle the question once for all. I commend this to students at Zeehan.

One of the most interesting problems connected with the mining geology of Zeehan is the source of the lode contents. Have they proceeded from the serpentine (gabbro) or the granite magma? Zeehan is bounded on the west by a belt of serpentine and gabbro, about a

mile broad, from east to west. It crosses the road to Trial Harbour about a quarter of a mile west of the South Comstock, and continues west as far as the Agnew huts, where the bare granite country comes in. The margin of the timber is the margin of the basic area. The serpentine is nowhere very pure. West of M'Ivor's cottage the rock does not appear to be serpentinised at all. A little past the cottage the road passes over fresh coarse gabbro, and thence the rock has apparently been influenced by the intrusion of the great granite mass of the Heemskirk range. The serpentine country a few miles east of Zeehan is that in the Dundas district. Some of the rock between the Comstock and M'Ivor's is serpentinised gabbro; and a specimen which I took from the contact near the South Comstock (unfortunately mislaid) appeared to me also to have been gabbro. I was unable, on this visit, to find any rock on that side of Zeehan which could be identified as purely pyroxenic. The serpentine of the Dundas district is a purer form; and some of it might be utilised for small ornaments. There is no demand in the Colony for serpentine rock, and it is, consequently, valueless, at present; but a limited demand might be created by making and exhibiting a few ornaments. In selecting blocks for cutting and polishing care should be taken to avoid varieties which contain grains of the chromic iron, which is a natural and frequent ingredient of serpentine.

From the above we may assume that since the Silurian strata of Zeehan were laid down, the consolidation and intrusion of an immense mass of basic rock, now serpentine, took place on each side of the field; and the question is, whether it is not continuous in depth below the township. The serpentine on the west creeps a little nearer to the town, on the Colonel North property; and I have seen talcose or serpentinous matter in the planes of the slates on the New Mount Zeehan ground, quite close to the centre of the town. The comparatively small proportion of quartz and the correspondingly abundant carbonate of iron, which form the gangue of the lodes, seem to point to some influence being exerted by the serpentine; but this is still compatible with a reference of the lodes to the later formation of granite

beneath the field. The nearest granite is that of Mount Agnew, four or five miles to the west, which is demonstrably later than the serpentine, the latter being hardened at its contact. This is seen quite plainly, where the flinty serpentine occurs on H. D. Marsh's section, E. of Mount Agnew, and near Trial Harbour, where the granite abuts on the hardened hackly serpentine rock. That the granite has influenced the Zeehan country is evident from the stannite found in the No. 1 tribute Silver Queen and the lode of that mineral now being worked in the Oonah mine. This mineral can only have come from a granitic source, and the same source is the parent of the dyke or intrusion of spherulitic felsite uncovered in the swamp between the Montana and Western mines. This latter rock has for some years furnished specimens to collectors and was thought to be an isolated boulder, but while I was in Zeehan this time Mr. George Waller, of the Zeehan School of Mines, put a pick into the ground and exposed the bedrock, which, for a few feet in width, was found to consist of the same spherulitic rock in a rather decomposed state. As far as uncovered it appeared in the trench to be bounded on the north side by quartzite and decayed clayey sandstone, and on the south side by decomposed melaphyre. The work done on it was not sufficient to establish its bearing with certainty, but it seemed to be trending a little to the north of west. We tried to trace it into the hills to the west, but failed to pick it up again. It seems to pass a good way north of the Oonah mine. This felsite is as unmistakable a sign of the proximity of granite as the Oonah stannite lode is, and as far as these two occurrences are concerned, a granitic source is unquestionable. The further question arises, whether the stannite lode, apart from its stannite, presents any features distinguishable from other lodes on the field, or anything, in fact, to indicate that it belongs to a different lode system from the ordinary silver-lead lodes. If the galena lodes are connected with a serpentine or, rather, basic source, then the stannite lode, of granitic birth, is a later stranger in the field, and this might account for its unique occurrence. The alternative is to suppose that when the consolidation of the granite magma took place in a serpentine area, the Zeehan lodes, as a whole, were

formed in connection with this intrusion. This is, perhaps, the most probable, but there is room here for a series of careful observations which would throw light upon a doubtful point. Although both serpentine and granite were probably Post-silurian (Devonian?), it must be remembered that there is a chronological difference, the granite being the later of the two, as far as can be judged from observations made hitherto.

The general trend of the Silurian sedimentary strata is west of north and east of south, and the dip N.E., though in the southern part of the field the latter is westerly. Those lodes which are running west of north often happen to coincide with the bedding planes of the sandstones and slates, but this is merely accidental, for they soon pass across these divisional lines as they descend. The angles at which these strata are inclined from the horizon are from 60° to 70° . This inclination must not be looked upon as due to local tilting by adjacent eruptive rock. The high angles of dip of Silurian strata is nearly universal throughout the Colony; this alone forbids our attributing it to any purely local cause. It may be explained by rock folding on an immense scale. The peculiar flat valley bottoms round Zeehan margined by abruptly rising hills are no doubt the products of marine erosion. They are not filled with river deposits, but have been well sluiced by the sea in Tertiary times, as we see the bed-rock everywhere. Around Zeehan itself I did not see any remnants of Permo-carboniferous or Mesozoic strata, and it would therefore seem probable that these Zeehan country rocks have been exposed to the agencies of sub-aërial denudation from the Devonian period to the present day: a little further south on the Zeehan-Strahan line Permo-carboniferous sandstones and mudstones rest upon the Silurian rocks, which there have been protected from waste and destruction. The nearest Mesozoic rock is that on the summit of Mount Dundas, occupied by the familiar dolerite (diabase) of the Tiers. The upper parts of the lodes at Zeehan, consequently, have been within the range of surface waters for a very long time, sufficient to account for the gossan outcrops and for some of the rich concentrations of secondary silver ores occasionally met with, but I cannot admit that the general productiveness of the shallow zone is

in any way due to re-precipitation. The sulphides mined in the upper levels of the mines are primary ores, and the shallow zone has only a specious appearance of being the richer because productive lodes alone have been worked in that zone.

On this visit time did not permit of my doing more than visit the principal mines on the field. I did not examine the mines for the purposes of detailed description, but for observing their general state of development, and noting any facts in mining geology which might have a bearing upon the nature and prospects of the field at large. At the north end I visited the

Western Mine,

Mr. C. F. Heathcote, Manager :—This important company leases 420 acres, and is working vigorously. The prospects of the mine, thanks to its careful administration, are generally better than they were some time ago. During its career, which dates from 1888, it has raised 34,108 tons of silver-lead ore, of a net value at the mine of £427,550. For the half-year ending 31st March last 1303 tons ore were sold, as against 1939 tons the preceding six months. A good deal of the falling-off was owing to insufficient pumping power, the three bottom levels, Nos. 7, 8, and 9, being under water. A new pumping engine was started just before I left Zeehan. The levels opened from main shaft are—No. 1, at 45 feet; No. 2, 110 feet; No. 3, 170 feet; No. 4, 230 feet; No. 5, 290 feet; No. 6, 360 feet; No. 7, 430 feet; No. 8, 500 feet; No. 9, 600 feet. It has been decided to carry the shaft down a further 200 feet, and it is to be hoped that this sinking policy will be continued. The mine has seven miles of drives and crosscuts.

In the No. 6 level at the rise from No. 7, at a depth of 360 feet, I saw a good bunch of ore, banded with carbonate of iron, lode dipping E. The stope over the back was poor in the north end, 20 feet above level, but ore is known to be overhead as well as ahead. The lode improves going south and overhead. No real walls are visible, but spurs of galena run out into the slate at an angle of 45°. The end of level is 40 feet from the south boundary, and the drive has been barren for the last 15

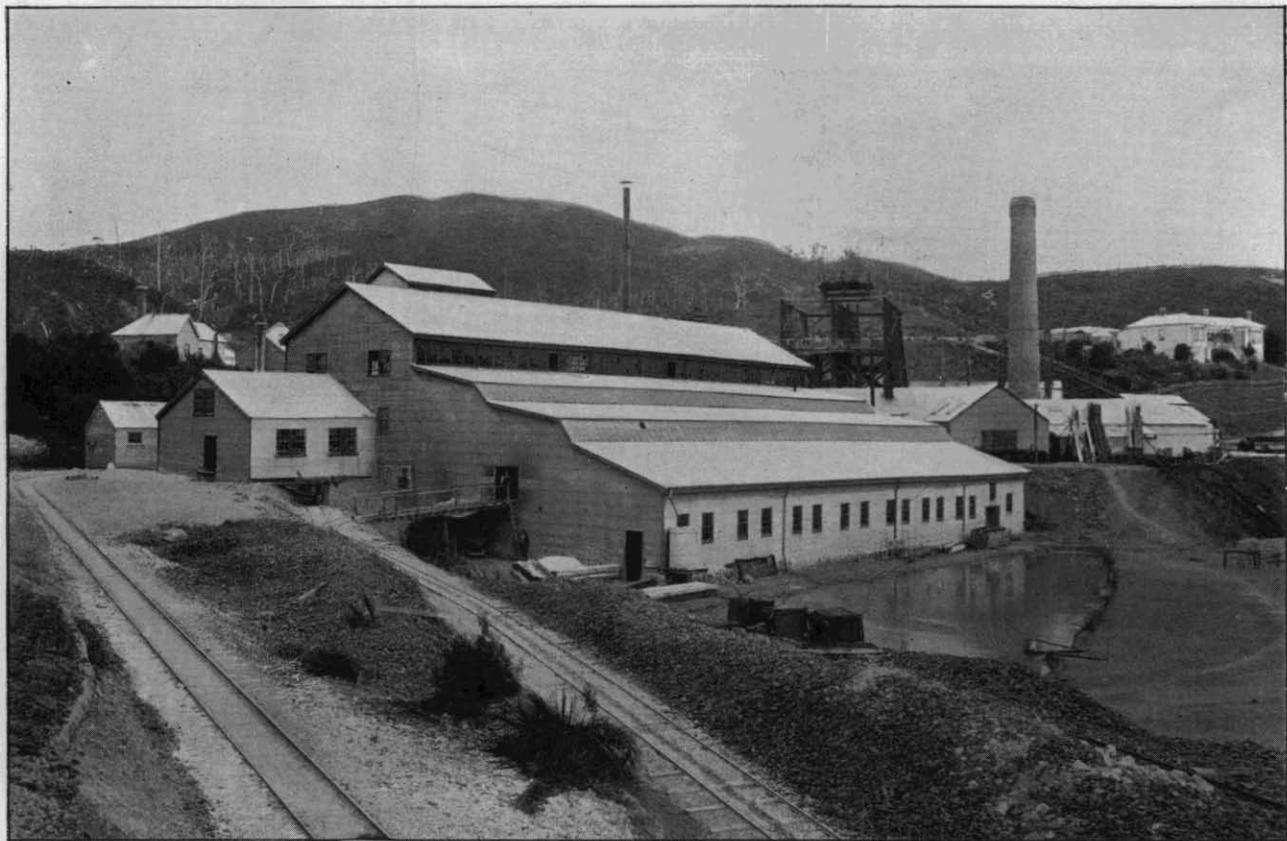
feet. The stope overhead will be pushed up to this, and then stopped.

In the N. drive from No. 5 level E. crosscut the end shows dressing ore. It is intended to rise on the boundary up to No. 2, 180 feet, where there is good ore underfoot. The melaphyre goes a good stretch in this crosscut and junctions with the slate on each side. In this mine the best stopes are associated with melaphyre, but, on the other hand, there are stopes where there is no white rock anywhere near. The south end is poor; the lode here is in slate, with a little filling—a very flat lode, with no good walls, but carrying a little ore. The crosscourse slide seems to come in here. The drive N. 30° W., on slide from No. 5, 4 E. north (Jackson's drive), and the slide here, contain ore. It was driven through a short distance, and holed through to another drive, but the ore-bunch gave out. The average width of the slide is the same as that of the lode, viz., 2 ft. 6 ins. This main slide runs through the mine right down to No. 5, with a bearing of N. 25° W., while the main lode (No. 1 E. lode) bears N.E. In the crosscut E. for Simson's lode, the end looks as if ore were not far away.

Besides the main lode, there is a set of lodges bearing N.W., and another N. and S.; and, as all these sets intersect one another, the result is a complex system of veins, giving rise to a mine which requires very judicious management to yield satisfactory results.

During the past half-year 15,179 tons of stuff have been broken in the gross from this part of the mine, and over 4000 square yards of lode stoped away. The half-year's work has proved the following:—

- No. 2 Level.*—5 W. lode found, so far, to be of no value, but payable ore 40 feet long in the S. extension of a W. lode, and E. branch of 1 E.S. payable for a length of 100 feet.
- No. 3 Level.*—3 W. and 4 W. proved to exist at this level.
- No. 4 Level.*—Discovery of 2 W.N. lode, and 40 feet length of good ore proved.
- No. 5 Level.*—7 E. lode proved within boundary, 4 E.N., 35 feet of payable ground found.
- No. 6 Level.*—Stoping towards boundary, as mentioned above.



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No. 7 Level.—6 1.E.S. and 7 E.S. proved to be different branches of main lode at 360 feet depth south of shaft, and both contain payable ore at this depth.

A good deal of important work is contemplated the next half-year. In a mine with so many miles of underground drives I could not visit every place, but Mr. Heathcote was good enough to explain to me some of the items of the programme. Among others, these were :—

- (1.) 2 *crosscut W.* to be extended into virgin country to the west.
- (2.) *Level 3.*—To explore round 1 W.N., 3 W.S., and 4 W.S., to get ore going down from No. 2.
- (3.) *Level 4 E.S.*—To find E. branch, and get ore below No. 3.
- (4.) *Level 5.*—*Crosscut E.*—Boundary rise to No. 2 level, to explore No. 7 E. lode.
- (5.) *Level 5.*—4 E N. Exploration below Simson's workings.
- (6.) *Level 5.*—1 W.N. *crosscut*: to get under 4. 2. W.N.
- (7.) *Level 7.*—Exploration of parallel lode 1.E.S.
- (8.) *Level 9.*—*Crosscut W.* Below No. 4 there has been no *crosscut W.*
- (9.) *Levels 7, 8, and 9.*—1.E.S. will be carried on.

Exploration and development may still be said to be in arrear, but prospects have considerably improved of late. It is true that at the main shaft no large body of ore is being worked, with the exception of 6. 1.E.S., but there is every probability of good bodies being available shortly in 7. 1.E.S. and 8. 1.E.S. 9. 1.E.S. will also be carried on.

Simson's shaft is situate 820 feet a little W. of N. from the main shaft, and the workings in connection with it have added considerably to the value of the mine. These workings were started in April, 1895, and have disclosed a mass of interlacing and branching veins of galena, forming a kind of magnified open-meshed stock-work. This part of the mine shows the importance of not allowing exploration work to fall behind. It is not so very long ago that the workings were viewed rather

doubtfully. The ore has been principally obtained by starting some very unpromising places, and now Mr. Heathcote tells me he estimates he has 7000 tons in sight, and, altogether, a probability of 20,000 tons of ore existing above No. 2 level. No. 1 level has been opened at 70 feet, and No. 2 at 170 feet, and the continuation of No. 5 level from the main part of the mine will come in under Simson's shaft at 260 feet. In the network of veins it is difficult to recognise any main lodes: there are lode lines bearing N.W., N.E., and N., all connected by meshed veins, generally without walls, being simply fractures of the country filled with ore. The ore is highly argentiferous, having a ratio of 2 ozs. silver to the unit of lead, and this value is maintained from top to bottom. In fact, through the whole mine there is very little variation in the above ratio, nor is the primary ore richer or poorer in the upper levels than in the lower ones.

Some 273 hands were employed at the time of my visit. As is well known, the mill is equipped with the Lührig concentrating plant. A very complete statistical analysis of the Western Company's accounts up to September, 1897, by Mr. Aug. Simson, is published in the Transactions of the Australian Inst. Mining Engineers for 1898, vol. v. The published accounts of the company state that during the past half year 1 ton of concentrates were obtained from 11.964 tons ore, an improvement on the previous six months, when 1 ton was returned from 12.91 tons ore.

The management of the mine is not free from difficulty, owing to the extensive workings and the irregular and branching nature of the ore-shoots. Exploration work must absolutely be kept up. Even an additional 200 feet of sinking will not mean the attainment of any great depth, and there is little doubt but that this important company will persevere in a policy of testing the lodes down to a serious depth. The new pumping engine will take a shaft down to 1500 feet, and with its present careful management the mine will do fairly well. Its future is dependent upon the result of work at a greater depth than has been attained hitherto. The numerous fractures, which are now being worked for their ore fillings, may be expected to improve into more important

fissures in depth in the zone below where they began to split.

Zeehan-Montana Mine.

Manager: Mr. T. Craze. This company is an English one, and started work in 1893 on property S.E. and adjoining the Western Mine blocks, and has since taken additional ground from the Silver Crown and the Silver Queen, bringing its holding up to upwards of 300 acres. It is working on nine lodes, mostly running N.W.-S.E. and N.-S. The No. 8 lode would seem to be the same as the No. 2 main lode of the Western Mine. The No. 6 N. and S. lode breaks up into junctioning veins—it junctions with No. 8, at both the north and south boundaries, but has been struck again further north in the long crosscut of the Crown.

The main shaft is down 400 feet, and 4 levels opened, viz.—No. 1 at 112 feet; No. 2 at 194 feet; No. 3 at 294 feet; and when I was there the shaft had just got down to the 400 feet, but the bottom level was not then opened.

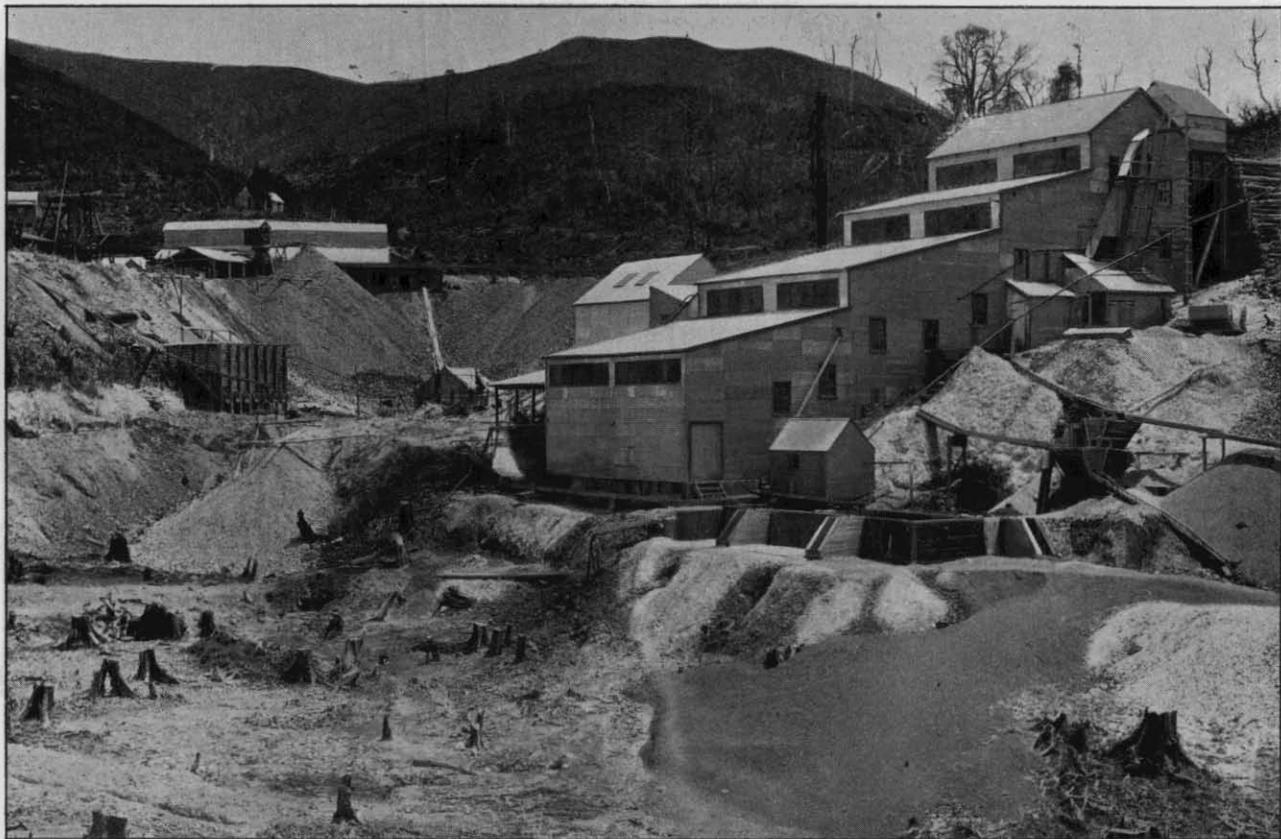
No. 6 is the chief lode of the mine, and is the principal contributor to the output. It runs right through the section N. and S., and underlies E. The central part of its length is unproductive, but the richest end is the north end: however, south of the cross-course the lode becomes payable, and opens out, then, to six feet in width. The central country is slate, but in the north part of the lode the hanging-wall is quartzite, and the footwall black slate. In the N. end of stopes, over back of No. 2 level, the lode thins, and seems to die out in the melaphyre just before coming to the black slate. I may mention the stopes get shorter going towards surface. I noticed the melaphyre underlying the slates, and dipping E. No. 4 lode in No. 3 level N. is wholly in melaphyre, and is carrying excellent ore. This band of melaphyre runs N. and S., and is 350 feet wide. It goes back to the main shaft, the north side of which is slate country. The south drive has been driven up to the slate. The crosscut W. from this level (No. 3) is wholly in slate, dipping E., with bands of hard metamorphic slate or sandstone. The N. drive on No. 6 lode from above crosscut has a slate hanging-wall, and

foot-wall of metamorphic slate or sandstone. I saw 5 feet of first-class ore with soft carbonate of iron in the end. There has now been a fine shoot of payable ore for 450 feet in length.

The mine has a fine hoisting and pumping plant for sinking to 1000 feet, and is equipped with rock-drills and electric-lighting appliances. There is a good concentrating mill, with Bartsch and Wilfley tables. About 65 tons of ore are sent away weekly, averaging about $1\frac{1}{2}$ ozs. silver per unit of lead. From Mr. Craze's statement, it appears that the main workings measure about four miles, that 61,600 tons of lode-stuff have been raised during seven years working, and, as £60,000 have been paid in dividends, the shareholders have received nearly £1 per ton of stuff raised. I will add, that not only has this mine been working at a profit, but it has set a brilliant example to the whole field, for the owners have committed themselves to a policy of deep sinking, which others would do well to follow. Mr. acting-manager Mayne courteously showed me over the mine.

Oonah Mine.

Con. Hy. Curtain, Manager. Work was begun in 1888, and the present company formed in 1890. The property comprises 255 acres, adjacent to and S.W. of the Western mine sections. It is an important mine on the field, and has been a good producer of silver-lead ore in the past, at one time producing up to 1800 tons in the year, though of late the output has sadly fallen off. The mine still employs 50 hands and 36 tributors. The last half-year 297 tons silver-lead ore were sold by company and tributors, worth between £15 and £16 per ton, besides 72 tons stannite, at £21 per ton. The main lode has a bearing W. of north, and underlies E. The deepest level is No. 6, 424 ft. from surface; above this are No. 5, at 322 ft.; No. 4, at 250 ft.; No. 3, at 163 ft.; No. 2, at 137 ft. Most of the galena ground has been stoped away right up to surface, and the bottom workings, it must be conceded, are poor. It is possible, however, that parallel lodes may add to the output, and, in any case, the No. 6 level ought not to be stopped. There is a new lode under the magazine parallel to the



OONAH MINE.

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main lode, 212 ft. to the S.W., and carrying from one inch to three inches of galena. This is now being driven upon, and the programme is to cut it also from No. 6. In the south workings on the main lode there is some rich gossan, with silver chloride and native silver. This is being stoped. Some of it has assayed up to 420 ozs. silver. The crosscut here is in slate and melaphyre, the latter plainly conformable with the slate, which is not perceptibly indurated by it, either above or below. Mr. Curtain told me he had also seen places where the melaphyre is intrusive. This is not impossible, for modern basalts behave in the same way. The Oonah shaft is the second deepest on the field, but, after all, is really no depth at all. Though a vast amount of driving can still be done on the company's leases, no permanence can be assured to the mine without further sinking, and the mistake made is not to have kept that work going continuously. A crosscut (No. 6) 160 ft., has been driven E. in white country, but the lode track, where cut, was insignificant: driving south on it was just started, but the downward extension of the ore-shoot is not expected just yet. The payable lode-stuff over the back of No. 5 level seems to have been stoped away. Between Nos. 3 and 5 levels the main lode has split, and encloses a horse of country which attains its widest diameter at the horizon of No. 4. Between Nos. 4 and 3 stoping is still going on. No. 3 level W. was being driven, the face in pyrites and slate being of an encouraging nature for ore; besides which, it was just about where it ought to cut the stannite lode at a depth of 163 feet from surface. The lode in the crosscut behind the end has since shown some very clean and fairly argentiferous galena, with nearly 2 ozs. silver to each unit of lead. In June this year the stannite was cut in the eastern crosscut, 40 ft. below the old workings. When cut, it assayed 80 ozs. silver per ton. The mine is situated in a central position on the Zeehan lode system, did very well at the beginning of its career, has a lot of maiden ground, possesses a unique lode of stannite, for which they have been getting £21 per ton, but must be carried down to a greater depth if it is to lead to anything beyond a struggling existence upon explorations at present levels.

The stannite lode, which came to the front at the end of 1897, besides being a mineralogical curiosity, is a valuable asset of the mine; in fact, it is not too much to say that it has, practically, saved the company from the ill effects of shallow mining. It was being mined at the time of my visit by two tributes, on the south section on two parallel veins. Allison's tunnel crosscut, called the No. 1 lower stannite tunnel, has its entrance in slate, striking N.W. and dipping N.E., and the drive W. is on a lode 6 feet wide, in slate country. The lode-channel carries a vein of stannite 3 inches to 1 foot, fairly continuous, the best being on the footwall. Behind the end a slide had thrown out the vein from the footwall, and now the vein, a 6-inch one, is on the hanging wall, which is graphitic slate. In the face, dark slate carries streaks of quartz and pyrites. This drive is 115 feet long. Returning to the tunnel, a few feet further in, is a broad drive S., in pyrites and stannite. At first the stannite is 18 inches wide, but then goes off west in 2-inch veins. In the N. drive, about 70 feet, there are two inches of good stannite on the hanging wall, and at 36 feet above the end exceptional assays of 305 ozs. silver per ton have been obtained. The tunnel has been extended 60 feet beyond this, and cut a small pyritic vein.

A surface drive 89 feet, has opened stoping ground N. and S. of the winze. Across the creek, to the N., is the north surface adit, the end of which is about 46 feet above the north end of drive below. A quartz and stannite vein is on the W. side inside entrance, and a small rich vein crosses the level at Curtain's winze, 36 feet ahead of the lower drive N. The uppermost surface adit shows stannite, copper, and galena.

The No. 3 level is about to come below the stannite workings, and there is every reason to believe that the veins of this mineral are persistent in depth. The metal has already been struck in the No. 3 workings, and, if the development turns out to be satisfactory, the Oonah Mine will get a substantial lift. The lower levels of the mine will enable the stannite lode to be attacked in depth, and it will infallibly be met with at those levels. This is a very encouraging feature of the mine. There seems to be a good deal of variability in the contents of the ore, but up to the date of my visit the average value

realised had been £21 per ton. The tin is not paid for : according to assays, the ore contains about 14 per cent. tin, 29 per cent. copper, and from 107 to 140 ozs. silver. When I was there, the ore obtained was bulking 14 per cent. tin, and a maximum of 264 ozs. silver, but the silver contents have not been maintained. The per cent. copper is the same as that of European stannites, but the tin per cent. is only half that of normal stannite ; the silver, too, is a decided novelty. The ore contains, also, bismuth, antimony, and is mixed with galena and iron pyrites. In Cornwall, stannite occurs in granite, associated with cassiterite. It is stated to be lost in dressing*. In his elements of metallurgy (p. 470), Phillips says—"This mineral does not occur in sufficient quantities to admit of being metallurgically treated, and must be regarded as essentially a mixture of various isomorphous sulphides." A notice of stannite as found on the Silver Queen in Clarke's tribute lode, associated with pyrites and galena, assayed by Mr. J. G. S. Stitt, and containing 90 ozs. silver per ton, appears in Proc. Royal Society Tasmania, 1895, p xx. (W. F. Petterd). The following are assays of stannite published by Dana and Phillips :—

	S.	Sn.	Cu.	Fe.	Zn.
Wheal Rock	29·64	25·55	29·39	12·44	1·77
St Michael's Mt.	29·46	26·85	29·18	6·73	7·26
Cornwall	27·94	22·04	27·77	12·75	3·62
Cornwall	29·68	23·42	29·50	13·55	3·85
Zinnwald	29·05	25·65	29·38	6·24	9·68
Klaproth	30·50	26·50	30·00	12·00	—
Kudernatsch	29·64	25·55	29·39	12·44	—
Oonah Mine	?	14·00	29·00	?	—

I went over various workings on cupriferous and galena lodes on the Oonah properties, but I need not particularise. Nothing is being done at Bradshaw's copper workings, but there is room for exploration. All that appears requisite is a slight increase in the copper percentage. Though the work, on the whole, has had somewhat disappointing results, and the outlook, as things are going on now, is none too encouraging, it was quite evident to me that the Oonah has the makings of a good mine : but it requires adequate capital and a more enterprising policy.

* Phillips. Ore Deposits. 1896 ed., page 218.

The dressing floors are fitted with a Lührig plant. It is a pity it cannot be kept running continuously. Fifty hands were employed at this mine and 36 tributors.

I am indebted to Mr. Con. Curtain for accompanying me to the several surface shows and other features of the property in bad weather.

Mount Zeehan (Tasmania) Mine.

This company, better known as the British Zeehan, is working on the Silver Queen Extended, Balstrup, and Silver Spray sections. I had no time to go through the mine this time, but I know the property. The Argent is one of its sections, and at one time returned a good deal of ore, but water grew difficult. The principal work has been carried on lately on the Queen Extended block, but a fine discovery of rich antimonial silver-lead ore, some of it assaying over 2000 ozs. per ton, and the bulk of it worth £30, has been recently made on one of the two 80-acre Silver Spray sections. This rich ore is Jamesonite, a sulphide of antimony and lead, as shown by the following analysis made by Mr. W. F. Ward, Government Analyst:—

Lead.....	40 per cent.
Antimony	29 per cent.
Sulphur	18 per cent.

After several years' perseverance the company seems to be on the eve of prosperity: its output is on the increase, and the increased values also are not wholly due to the present higher market rates. In 1898 the output was between 500 and 600 tons silver-lead ore, worth about £16 per ton; in 1899 between 1100 and 1200 tons, worth about £19 per ton; and this year the new rich ore will make itself felt in the Returns. It is disappointing to notice that work has been carried on mainly by tribute, a very unsatisfactory plan. Although it has kept the concern alive, these large properties have not been developed to anything like the extent they should have been. There has been far too much shallow mining indulged in, and it is only within the last year that preparations have been made for deeper sinking. It is to be hoped that the better times which appear to be coming will induce the owners to embark on a more

vigorous policy. They have an excellent manager in Mr. Vincent. On theoretical grounds I have formed a high opinion of the value of the Balstrup section south of and adjoining the Argent block, and I believe that that ground will eventually be proved to be valuable, for it seems to contain the junction of two separate converging sets of mineral-filled fractures coming in from N.E. and N.W. respectively.

Colonel North Mine.

J. H. Houghton, Manager. This company, besides its mines, has four miles of tramway connecting with Zeehan. Its property is a large one, over 600 acres, at the S.W. end of the lode systems coming through from the Montana, Queen, and British Zeehan sections. It is near the edge of the Zeehan Basin, and on the margin of the serpentine area. The ratio of silver to lead in the ore is fair, though not high, averaging from 1 to 1½ ozs. silver to the unit of lead. From the Grubb's Mine £32,000 worth of ore is stated to have been raised in the past, and that lode is not the only one on the property. The main shaft is down to 275 feet, 4 levels having been driven on the lode, viz.—Intermediate, at a depth of 80 feet; No. 1, at 130 feet; No. 2, at 200 feet; No. 3, at 273 feet. The old stopes go right up to surface, representing a block of lode about 270 feet high × 200 feet in length. The ore-shoot, or body, which, above No. 2, seemed to be vertical, lengthens out between Nos. 2 and 3 in a southerly direction, and from this fact the ore is considered to pitch south as it goes down. At the northern end of the mine there was very good ore in the upper levels, but as the lode descended it grew poorer, and split down to the 130-foot level. No. 2 level, I found, was not being driven N., as the ore stopped with the stope in that direction. It ought to be driven S., however, for there is a probability of it coming into another shoot of ore, which has been struck in the bottom level; and if No. 2 becomes ore-bearing, it will be necessary to resume driving the south end of No. 1. The bottom level was being driven S. on a 6-foot lode carrying a foot of solid milling ore, when I was underground. The ore is rather finer-grained than the produce of the old

stopes, and its assay value is lower. Its appearance, though it is fairly well mixed with blende, is very encouraging. The lode is a fissure one, bearing N. 47° E. In the upper levels its underlay is westerly (contrary to the general rule at Zeehan, except at the King), but there are indications of the E. dip being recovered in depth. The N. drive at the bottom level is on a lode containing much blende. The gangue is carbonate of iron, and the country-rock, melaphyre. It is intended to rise and crosscut behind this end—a very good plan.

It is interesting to notice that Mr. Stitt has determined rutile in a vein on the Colonel North old ground. This would seem to indicate some connection with granite.

The concentrating works are equipped with May's plant, 3 jigs, 3 Frue-vanners, concentrators, and a few Frue-vanners for slimes. Outside some 300 tons second-class ore were stacked as reserve. Fourteen men were working underground. Less blende and more galena would be a desideratum in the ore, and some of the galena is rather poor in silver; but the mine is in ground well worth prospecting, and offering good chances of success. There is every reason to believe that judicious progressive work will bring this property into a prosperous condition.

The four miles of railway from Zeehan offer, along a line through Kenney's, Omant's, Anderson's, and Quiggan's sections, the means of extension into the Comstock district. Access could also be given to the Comstock, especially to the southern portion of the field, by running an extension from the Colonel North tram to the end of the old Tasmanian tram on Carson's section. The Colonel North Company has advantages in the possession of its tramway which it would do well not to sleep upon.

New Mount Zeehan.

This company has 120 acres at Zeehan, and has, unfortunately, spent nearly £14,000 on its mine, with no result worth speaking of. The deepest level is only 124 feet from surface, the main shaft being 140 feet deep. The mine could never be expected to live at this trifling depth. Another factor in its failure is the small

amount of driving upon the lodes. Crosscutting has been carried on to a large extent, but crosscutting is not of much use if the lodes, when intersected, are not followed up by drives. These two causes have combined to bring the mine to its present deplorable state. Work has now been suspended and the mine let on tribute. Eleven parties of tributors are working on different parts of the property, but they do not seem to be very successful so far, and I do not anticipate that they will do the company any real good. There are enough surface shows on the property to tempt them, as there appears to be a network of lodes all over the flat, but of very variable size and quality.

From the main shaft, at a depth of 60 feet, a level has been driven 700 feet on the lode, and another at 124 feet, the lode running a little E. of N., and the ore-shoots pitching S., as they do in all lodes on the property. The 124-foot level, S. on main lode, goes towards Smith's tribute, has been driven 1040 feet, and is within 500 feet of the boundary. A little ore was found in an underlay winze to 40 feet, but nothing payable in the main level. At the surface good ore occurs in Murphy's lode, down to 40 feet behind the end of main level south. A few crosscuts are wanted in this drive. I understand shortness of funds has prevented these being driven.

On Nos. 3 and 4 lodes W. there are short drives, which had some high-grade ore 10 inches to 1 foot, much faulted. The lode here requires developing.

A 100-foot extension of crosscut would connect Nos. 2 and 3 shafts, and drain the latter to 70 feet. This shaft is, however, small, and of no use for deep work.

No. 1 lode, W. level from main crosscut, has been driven without results, though the lode is good enough at surface. A west arm, probably the same as the No. 1 lode coming S. W from N. E., crosses with a short shoot of ore from surface down to 60 feet.

There are nine lodes crossing Main-street, bearing W. of N., with angle diminishing going N. These lodes are nearly vertical, with a slight easterly underlay. When Main-street was constructed, and sundry excavations made for buildings, I believe galena was found in all these lodes. All the land in Main-street has been

resumed by the Government, and this resumption has, doubtless, been injurious to the company.

I had a look at some of the tribute works. On Section 559 No. 2 tunnel was being driven E. to cross-cut supposed lodes in the hill, below where galena was found while digging posts for houses. The tunnel was 123 feet in, and the end 70 or 80 feet from surface. A wide formation of black pyritic pug had been met with, but no galena, except a little near the entrance, and 18 inches of ore which came up in the sole. It is clear that this drive is not deep enough. The country passed through was soft and clayey. Some chocolate-coloured slate or grit, with serpentinous veins, was intersected: in the end a white, lumpy, crystalline sandstone. The main E. crosscut end is 100 feet N. of the pug formation in the tunnel, and will cut it, if continued. There is every sign of the pug being the upper part of a lode, and I look upon the tunnel as being below the mere surface-shoots of ore, and not low enough for a second shoot.

No. 1 tunnel, near Smith's section, is 200 feet from the boundary, and passes through the same black pug formation as in No. 2. A lode 2 feet wide has been cut in it, and a second drive has the same lode on the footwall. It was followed a little distance, but was only a small vein. The black pug, probably, represents Currie's lode in Smith's section. The length of this tunnel is 206 feet, and the end is 100 feet below surface. It is being driven towards the crown of the hill, below which it will be 150 feet. It ought shortly to intersect another lode seen at surface. There are some rather interesting soft carbonaceous seams in the slates in the tunnel end.

If the company begins serious work again there are three aims which it ought to keep in view, viz. :—

1. To continue crosscut from the 70-foot level and connect No. 2 shaft with No. 3 at the Gaiety. Only a hundred feet of crosscutting are required to connect; of course, the lodes intersected in the crosscut would have to be driven upon. If the main crosscut were then continued beyond No. 3 shaft up to the boundary, it would cut four more lodes in the eastern part of the property. Another shaft would,

- however, have to be sunk for continued work ;
the Gaiety one is only suitable for an air shaft.
2. To resume sinking the main shaft, which is only down to a trifling depth.
 3. To arrange an amalgamation with Smith's, which ought not to be difficult, as that section is rather small to float by itself.

To No. 1 I may add that if permanent developments occur in the eastern part of the property another main shaft will be absolutely necessary, as the distance from the present engine shaft will be too great.

The disappointing results, so far, tend to discourage continuance of the work at present depths. Despite the money which has been spent, the mine has not been opened up with a view to the future, and, from all appearances, resumption of work here practically means the starting of a new mine. There is nothing, however, in the nature of the country or lodes to forbid the hope that ore may make again in depth.

South King (Fahey's Tribute).

This thriving tribute is on the south section of the Silver King property, and has been lately an important contributor to the production of the field. Between Fahey's and the railway there is a western line of gossan outcropping across the mine tram track. A crosscut from Fahey's ought to cut it. It is a soft gossan, originating yellow ferruginous water, and no work has been done on it yet. The country is a light fissile sandstone, and the outcrop ought to be tried, for it has a promising look.

The main shaft is now down to nearly 200 feet, and a No. 3 level will be driven from the bottom. At 100 feet a crosscut was driven E., cutting the main lode at a short distance in. The crosscut was then extended to cut a rich little lode known as the Sunrise, but the water proved too heavy, and driving had to be discontinued till sinking is resumed. The lode in this mine averages from 3 to 4 feet wide, and, unlike the lodes in the other parts of the field, underlies W. The country-rock is sandstone. An underlay winze had just been started on

4 feet of solid ore, but had to be stopped at 8 feet on account of water. When the main shaft is sunk further this winze will be drained and work resumed. Going south, the lode widens to 6 feet, and attains a maximum width in stope of 18 feet. In the gossan, in the upper parts of the mine, patches of copper ore are found. Further on there is blank ground for nearly 60 feet; two exploratory crosscuts have been driven, but without success. For 30 feet behind the end of level there are stopes overhead. The N. level has been driven 293 feet, the last 30 feet of which have been blank. The remainder has been on a lode from 2 feet 6 inches to 4 feet 6 inches wide, bearing slightly W. of N., dipping 1 in 5, and carrying dressing ore with carbonate of iron gangue. When the lode is flattest, it has been found best for ore. The ratio of silver to lead has varied from a little under to a little over 1 oz. silver to each unit of lead. The last stope was 90 feet from the crosscut. The lode does not seem to have any proper walls; they are walls behind walls; but such as they are, they are exceptionally good, showing graphitic slate and pug. In the end there is no hanging-wall visible, but the lode track hugs the footwall on which pug and soft carbonate of iron are lying. The rest of the face is lode-slate streaked with carbonate of iron and galena. A crosscut E. has been driven behind the end for 22 feet, but without intersecting anything. The lode in this mine is widest at 30 feet from surface, but the best body of ore is at 50 feet. The stopes are 130 feet in length. Second class ore was being treated in handjigs, but the intention is to erect a concentrating plant. 170 hands were employed. For some time the tributors were unfortunate with this mine, but it is pleasing to see that their perseverance has been rewarded. Their success will not be without effect on neighbouring ventures.

On the boundary between the South King and Zeehan-Bell there is a shaft which goes down to the 116-foot level of the Bell, and some 30 feet lower still. It was formerly worked by tributors, and I understand that a sub-tribute from the King did pretty well here. Both the South King and Bell mines are connected with this shaft, and now the Bell Company ought to sink to strike ore at a deeper level, as the ore pitches south, though

close to the shaft it would appear to narrow out funnel-shaped in depth.

North of Fahey's, just south and E. of the railway line, a small shaft was being started by Mr. Fahey on a gossan outcrop on the main line of lode. This gossan carries galena, and it is quite likely that there may be a shoot of ore here.

Zeehan-Bell Mine.

From the old tribute shaft, in the northern part of this property, some argentiferous gossan and low-grade galena were obtained, not very high in silver. This was on the main lode, which was picked up further south, and stoped out to surface for a long distance. The zinc contents are said to increase going south. Two levels have been opened out in this mine: an upper one at 116 feet, a lower one at 180 feet, besides the upper adit. The bottom level is being driven, but nothing done in main faces until both levels are connected. The lode in bottom level carries 2 feet mixed ore in short erratic shoots. No ore in the face and no stopes in back of level. This level is 270 feet long from crosscut. A little stoping has been done over back of adit. A winze is going down from the 116-foot level to connect with rise from the 180-feet. The face of the 116-foot has holed to the level from the South King workings. The work in the winze and rise was all that was going on at the time of my visit. 13 hands were employed. The lode has been traced and worked at surface for 300 feet south and as far north as the South King boundary. The claim has been idle a couple of years, but seven months ago was re-started.

There are no concentrating works attached to the mine, as the company intends first to sell its ore as raised, and wishes to assure itself of a better grade before committing itself to that expenditure. The ratio of silver in the ore from this mine is low, being $\frac{1}{2}$ oz. to a unit of lead, and this is the return from ore in the bottom drive. There is a good deal of low-grade ore in the upper part of the mine awaiting concentration; in fact, most of the ore requires to be dressed. If a small dressing plant had been put up here, Fahey's ore would have been secured, but it is now almost too late.

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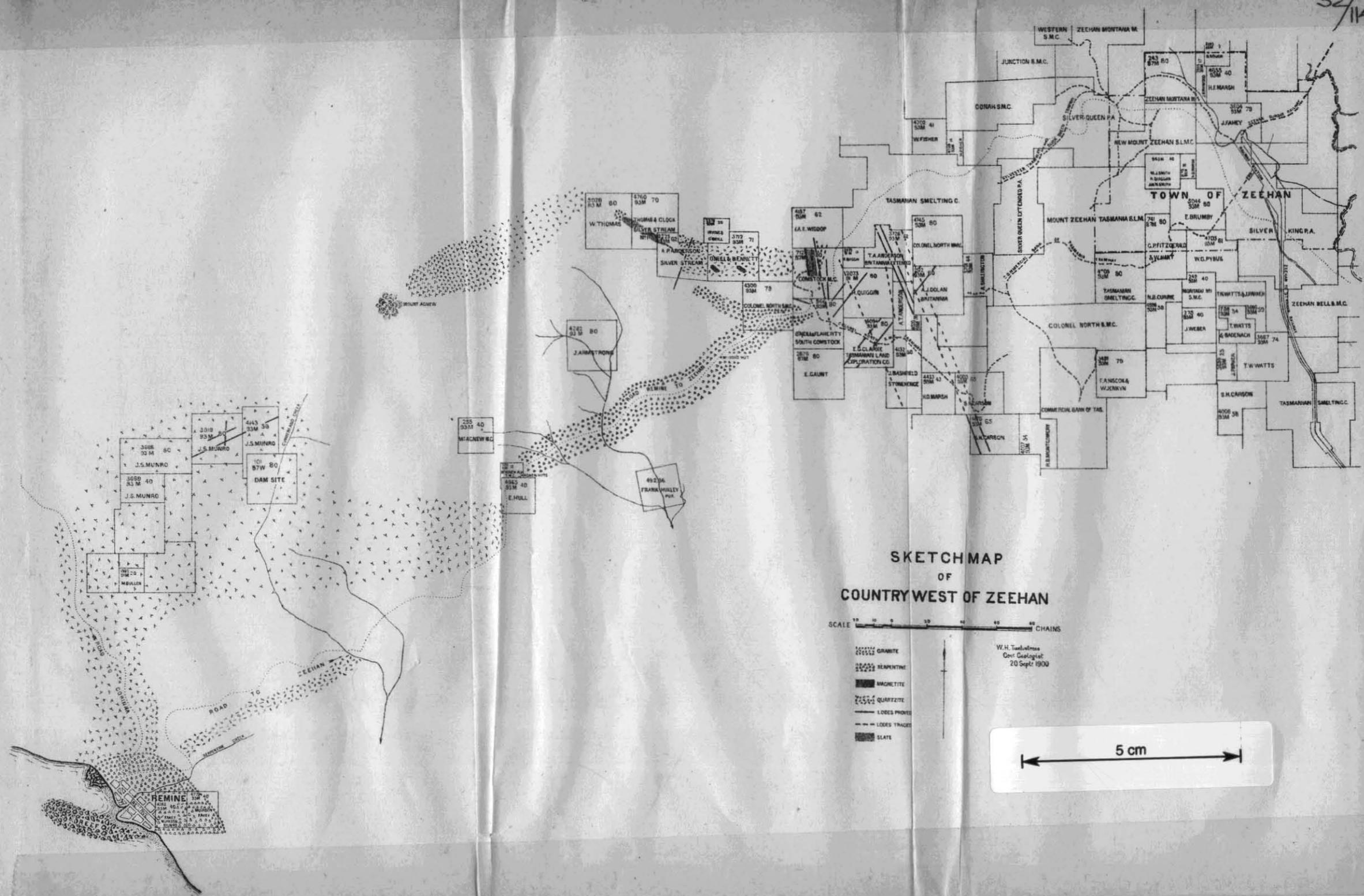
I noticed the ore is associated with a fair amount of zinc blende. The ore close to the King boundary has been stoped away to surface, and the prospects of the mine, as a whole, are not encouraging between the 115 and 180 feet levels. A fair trial would be to carry exploration to a greater depth. A long crosscut from the shaft would cut the western gossan lode, and that would be a legitimate piece of work; but the present company does not seem to be very energetic in its venture.

Western Consolidated Mine.

This was formerly the Western Extended, in part. It comprises 350 acres, adjoining the Western Mine property on the N. and N.W. The old Western Extended did work on some lodes running E. and W. of N., and sank a main shaft 160 feet. The new company is being formed to take over these blocks as well as those formerly held by the May Queen and others. A lode has been found running E. of south, which is claimed to be identical with the main lode of the Western Mine. Whether it is so, will have to be ascertained by following it to the boundary, for the lodes of the Western are so irregular in bearing and behaviour, that the mere correspondence in strike of a lode on an adjacent section is insufficient for identification. The published assays of the ore are very variable, the lowest silver ratio being about $\frac{1}{10}$ oz. to the unit of lead, and the highest, over 3 ozs. to the unit, but, I should think, the latter must be secondary ores. The country is slate and sandstone, outside the favourable melaphyre country, and deserves prospecting. It will be gratifying if the owners can show that the Western is not the termination of the field, but that the Zeehan lodes extend further north. As an effort to prospect and extend the length of the ore-bearing belt beyond its present known limit, the venture is worthy of encouragement.

THE COMSTOCK DISTRICT.

About four miles west of Zeehan the country, consisting of Silurian slates, sandstone, and limestone, with an extension of the melaphyre lava, is seamed with a series of zincy silver-lead lodes, which, though unconnected



SKETCHMAP
OF
COUNTRY WEST OF ZEEHAN

SCALE 0 10 20 30 40 50 60 CHAINS

- GRANITE
- AMPHIBOLITE
- MAGNETITE
- QUARTZITE
- LODES PROVE
- LODES TRACE
- SLATE

W.H. Tuckwell
Geologist
20 Sept 1900

5 cm

with the Zeehan lodes, are probably of the same age, and originate from the same source. They have no constant bearing, but cross each other in sets in different directions. Perhaps, however, the most frequent bearings are west of north and east of north; but it is altogether premature to say which of these sets are the most important. I am inclined, however, to believe that, like the lodes on the Zeehan field, those running W. of north will be found the principal ones. The country rocks mostly bear N.E., and the lodes intersect them after the nature of fissure-veins. On only one property (North Tasmania) has a shaft been sunk as deep as 190 feet; all the other shafts are 100 feet and under, so that we really do not know what the lodes are like at any reasonable depth. Some of them have gossan outcrops, the poverty of which may be attributed to the leaching out of the primary minerals, to be found again in a secondary form at the ground-water level. Most, however, show unchanged sulphide in their outcrop, and from this we may infer that no great leaching has taken place. From the favourable appearance of the outcrops, and the solid, defined character of the lodes as seen not far below surface, it may be assumed that their behaviour in depth will be found satisfactory. Certainly, there is nothing in their aspect to warrant the absurd notions that they are only surface phenomena. As channels for ore deposition they are as well defined as any on the Zeehan field proper, and from this point of view I should judge them to be even superior, for their is no symptom yet of the vein branching and interlacing, which is characteristic of so many of the Zeehan lodes. They are a good deal nearer to the Heemskirk granite range than the Zeehan veins are, and many of them are close to the contact of the serpentine with the Silurian country. The serpentine contact crosses the Trial Harbour road a little W. of the South Comstock, and runs N.W. through the Colonel North West and Silver Stream to H. D. Marsh's west section, where it has been raised by the great granite mass which is now developed as Mount Agnew. It continues in a S.E. direction to the west of the old Tasmanian tramway; but I found serpentine also further E., on the Britannia section. This contact country is in the highest degree favourable for the deposition of ore in

leds, and the district may be considered favoured in that respect. I should think it very likely that the serpentine intrusions shattered, or at least shook, the country-rock, inducing the formation of lines of weakness, which were taken advantage of by the succeeding granite magma acting as the mineralisator.

The Comstock district has been practically abandoned for several years, desultory and tribute work only being now proceeded with at a few of the old mines. Numerous sections were taken up about 12 years ago, and great expectations formed of the field. Its failure to fulfil the hopes entertained may be ascribed to a combination of causes, which I enumerate as follow :—

1. The preponderance of zinc blende in the vein stuff.
2. The comparatively low silver contents of the galena.
3. The insufficiency of subscribed capital for working the mines.
4. The difficulty and cost of transport.

These drawbacks discouraged adventurers, and, finally, led to the stoppage of work. The attention of the public was then drawn away to the newly-discovered silverfields at Dundas, and the Comstock area fell into a state of neglect, from which it has never recovered.

If we examine the causes of disappointment we shall find that some are remediable, while the others may, under the altered state of things now prevailing, operate far less prejudicially than they did in the eighties.

Though zinc is an unwelcome companion of galena, it is by no means such a drawback as it used to be. The rise in its market value and improvements in separation methods have increased the chances of the Comstock mines. The clean blende ore can be sold at a profit direct, either to the smelting works at Zeehan or to local buyers for European smelters : and where the blende is associated with galena not too intimately (*i.e.* not chemically) and without too much iron pyrites, there is no insuperable difficulty in separating it by dressing. Some of the zinc blende occurs very clean, scarcely needing hand-picking, and yielding 50 per cent. zinc.

A sample of dense zinc blende which I took from the South Comstock Mine has been assayed by Mr. W. F. Ward, Government Analyst, and contained—

Zinc.....	48·70 per cent.
Lead	1·12 "
Iron.....	9·80 "
Manganese...	1·60 "
Silica	6·48 "
Gold	trace.
Silver	16 dwts. 8 grs.

An analysis of solid zinc ore from the same mine by Mr. J. G. A. Stitt yielded the following results:—

Zinc.....	52·47 per cent.
Iron.....	10·50 "
Manganese...	3·62 "
Sulphur	32·95 "
Silica, &c.	·46 "
	<hr/>
	100·00 "

Gold	4 dwts. 14 grs.
Silver	1 oz. 15 dwts. 22 grs.

Assays of South Comstock zinc ore by Mr. Hill, the assayer at the Hercules Mine, have given the following:—

	Per cent.	Per cent.
Zinc	50·80	51·80
Iron	10·40	18·20
Manganese.....	0·50	—
Lead	0·54	—
Silver	3·20	1·90
Insoluble	9·15	2·80

The iron is evidently approaching a quantity which may prove troublesome. For a zinc ore assaying 43 per cent. Zn. miners can obtain about 20s. a ton at the mine, and 4s. for every excess unit. Bulk parcels of 48 per cent. have been sold at 35s. a ton; other consignments down to 32s. Consequently, there is an important difference between now and a dozen years ago, in that there is a market now at Zeehan for the blende ores, while then there was none, and the zinc was an absolutely

useless commodity. It need not be anticipated, however, that the blende will remain the sole or dominant mineral in the lodes. Blende and galena are natural associates, and when one dies out the other often appears. This change is not dependent upon depth, but may take place at any time. I think, however, it is likely, seeing the great development of blende there is in the lodes of the district, that the galena will always be found to be accompanied by blende more or less, even when the former predominates. There is, however, nothing in this to discourage exploitation. On the contrary, the presence of zinc in such quantity is satisfactory in the meantime, as furnishing some return for capital pending the discovery of galena zones in the lodes.

The silver contents of the ore constituted a second factor in the cessation of work, but these are not intrinsically low. The average contents of 287 tons of ore from the Comstock Mine I find to be 63 ozs. silver to 52 per cent. lead per ton. This is a little below the average of the Zeehan ore, and, with former conditions of work, may have tended to discourage early investors. In some mines on this field the silver contents fall below 1 oz. to the unit of lead, but at the present time they do not offer an invincible difficulty. Thus the two drawbacks abovementioned are no longer so formidable as they appeared at one time. As for the remaining ones, they may be remedied absolutely.

The great mistake was made of supposing that a small outlay would bring quick and important returns; and there is danger of this mistake being repeated. Most of these mines require shafts, pumping and hoisting appliances, &c., and to attempt to begin work at them again without being prepared with ample capital will only lead to disaster and bring the field into bad repute. Small prospecting companies cannot hope to achieve anything worth doing, and it would be well if only such companies resume operations here as are ready with a well-considered programme and have the funds for carrying it out.

Comstock Mine.

This mine is close to the main road to Trial Harbour, about 5 miles from Zeehan railway station. From Zeehan the track along the Silver Queen swamp is taken

over decayed melaphyre and slate country. The hills appear to be sandstone. At the junction of the Oonah and town trams we see melaphyre, and again going up the hill at Queen No. 2, where it is vesicular. The melaphyre here has yielded rich kaolin and carbonate ores. It decomposes to a characteristic yellow clay, which clothes the spur up to the Sylvester saddle, 360 feet above the Queen bridge. On the saddle, in the roadside cutting, the white rock is well bedded, striking N. 20° W., and dipping N.E. at a chain south of the north boundary of the Sylvester 33-acre section. The country along the road S.W. of the saddle is obscured by surface soil, but the melaphyre possibly extends to the old Sylvester Mine, where the ore is very pyritous. The upper zone in this mine yielded fair secondary ores, chlorides, and phosphates, and the galena obtained was equal in silver contents to that of the Zeehan mines.

The Comstock Mine itself is on Section 712-87M, and was opened in the early part of 1888, on a strong lode, bearing N. 15° W., and dipping N.E. Following the lode up from the south, a surface trench exposes it in limestone as 5 feet wide, with seams of galena, pyrites, and dark, ferriferous zinc blende. This dark blende tarnishes an indigo blue, and the iron pyrites, on exposure, assume a coppery hue. Going north, the lode appears to split. North of the small reservoir it continues strong, with good ore underfoot. Up to here it has been stoped down to 19 feet: there is a nice seam of metal in the N. end of this cut. A small shaft which is between the dam and poppet-head yielded two or three tons of blende last year. In the part of the section north of the central 10-acre block there is a 30 or 40 feet shaft, just S. of the main shaft, which latter has been sunk to 100 feet. From this shaft, 8 chains N. of the open stope, two levels have been driven N. and S., one at 45 feet, and a bottom one at 100 feet. The lode, when struck in a 43-foot E. crosscut, was found to be a blende ore, 4 feet in width. A good shoot of galena and blende ore, 100 feet in length, has been stoped away from the shallow level to surface, going south. The mullock-heap has been picked over since, and, it is said, has yielded some good blende, assaying over 50 per cent. zinc. The Comstock lode throughout its length contains galena and

blende in varying proportions, the latter often very abundantly. From the open stopes to the northern boundary, the lode, with blende, can be traced through the section. Ten chains east of this another strong lode, of similar character, though poorer in lead and silver, has been traced for a length of five chains, and will most likely be found to traverse the property. From the company's records, I notice that 300 tons of silver-lead ore realised £4000, or £13 per ton, which, for the ore of this field, and in those days, was a satisfactory return. As far as I can learn, about 600 tons of ore was the total output. This should encourage perseverance in further developing the property, which has several good points, and the proprietors should not rest satisfied until they have explored the lode at serious depths. This lode, which goes strong into the South Comstock section, is a powerful and continuous one along its strike, and has every indication of persistence in depth. To more fully prospect it, a long crosscut tunnel has been driven nearly 700 feet on an easement from the South Comstock, and is about to be extended as far as the lode.

South Comstock Mine.

This is on the 80-acre section, situate immediately to the south of the Comstock. The lessees, Messrs. G. O'Neill and W. Flaherty, have let the mine on tribute, and it is at present the only mine on the field forwarding regular parcels of ore to Zeehan. The main workings are just inside the north boundary, where there is an open cut with a face 58 feet high, exposing a lode at least 13 feet wide, which consists, at this point, of zinc blende and other lode-matter. The full width of lode is not laid bare. In the floor of the face a shaft has been sunk, first for 40 feet vertical from surface, then on the underlie to a depth equivalent to a further 40 feet vertical. A short drive, 20 feet, has been put in south from the bottom of shaft, and from this drive a little good galena ore has been won. The drive, however, resembles a burrow more than anything else. This is the deepest part of the mine, and the zinc blende here is, perhaps, the purest. The underlay (E.) is becoming much flatter in descending. Both galena and blende

co-existing at this depth is rather favourable for galena prospects as mining works go down. O'Neill's tunnel has been driven at 18 feet below the shaft collar for 114 feet along the lode, which consists mainly of nodular blende and pyrites. At the end of the tunnel a crosscut has been driven diagonally S.E. across the lode for 66 feet without absolutely reaching the hanging-wall. The ore exposed is chiefly zinc blende, in irregular lumps and patches, the poor lodestuff between the solid patches of ore being soft iron oxide and pyrites. At the end of the crosscut a winze has been sunk 15 feet, and in the bottom of this the zinc ore seems more solid. The long tunnel from the S. side of the hill is 97 feet vertical below the level of these works, and will provide a useful test of this lode at some depth. A little galena is won from time to time, and hand-picked at the mine, and realises from £6 to £10 per ton at the mine. Sales have been made at £6 13s., £8, and £10. A sample from the N. drive, assayed by the Government Analyst, returned 84 per cent. lead (by wet method), and 114 ozs. 6 dwts. 16 grs. silver. I have very little doubt that the proportion of galena will sooner or later increase. If the mine, in the meantime, can be kept going with the proceeds of the zinc blende, of which it has a large quantity easily available, it will inevitably, in the course of time, come into the galena-bearing zone of the lode. The lode has not yet been blocked out sufficiently to allow of any safe calculation of the quantity of zinc ore in sight or readily accessible. The quantity of soft, worthless lode-matter is considerable, I should say at least 50 per cent., and any unforeseen increase in this will upset the estimate, but I think it would be safe to say that there are from 6,000 to 8,000 tons zinc blende above the level of the deepest works. This blende ore averages from 40 per cent. to 48 per cent. zinc.

A small drive is being put in N. on the lode from the crosscut behind the end, and the soft gossan of the crosscut has given place to solid blende ore the last six feet. Some galena has also been won from this drive; good clean ore alternating with blende, and apparently going underfoot. With the present means of transport, I do not think that the ore can be mined and delivered in Zeehan under 30s. per ton, but

improved communication ought to reduce this cost by 5s. per ton, which, in such a low-grade ore, means a great deal. It has been claimed that the blende averages 4 dwts. in gold contents, but my sample, assayed by the Government Analyst, contained only a trace of the precious metal, and 16 dwts. 8 grs. silver. I am told that continental buyers offer £4 per ton in Antwerp, with an extra allowance for any gold contents, but as the ore would cost nearly that sum by the time it was placed on the European market, there seems to be no particular advantage in disposing of the output in this way.

If the blende ore could be sent to Zeehan for 3s. or 4s. per ton this mine would be a legitimate venture, especially if amalgamated with its neighbour, the Comstock; and I think a fair proportion of silver-lead ore could also be got out without much difficulty or delay. The silver contents of the galena being a little higher than in some of the other mines of the Comstock district, is an advantage. But the proprietors, to ensure success and make a good mine of it, ought to amalgamate with the Comstock and provide ample capital for systematic work. Small associations with insufficient means will neither benefit the adventurers nor do justice to the mines.

Besides the main lode which traverses both the Comstock and South Comstock properties, the latter section carries a nearly parallel east lode bearing N. 45° W., a N. and S. lode (Montgomery's) and two lodges running N.E., viz., the Stockyard lode N. 30° E., and the Boss lode N. 32° E. The Stockyard lode has an old collapsed shaft, and carries the usual zincy galena ore. Some nine tons which were sent away are reported to have had good silver contents. In order to test the nature of the gossanous material from some of these lodges I took samples from the South Comstock upper tunnel and the Stockyard lode, which have been assayed by Mr. W. F. Ward (the Government Analyst) as under:—

S. Comstock : soft gossan. Gold trace, Silver, 1oz. 17dwts. 13grs.
 Stockyard lode : gossan. Gold, 1dwt. 15grs., Silver, 2ozs. 9 dwts.

The lower adit referred to above, if pushed far enough, would drain all these lodges, and give access to them at a moderate depth. The South Comstock main

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lode is concealed southwards by the overburden on the hill; but what is supposed to be its continuation has been driven on N. below the old Tasmanian tramway. Some blende and galena were found in a small seam in similar slate country to that on the N. side of the hill. A little native copper, too, is present in the ore.

Macdonald's Tribute.

I should have mentioned above that, on the Comstock property, E. of the main road, an open cast excavation is being worked on tribute, on a large galena lode bearing N. 20° W. and dipping N.E. An old shaft is situated just E. of the workings, and has cut the lode at 35 feet. The ore is poor in silver, but rich in blende. The lode has been trenched along its course northwards, and several tons of blende ore sold from it, carrying 45 per cent. to 47 per cent. zinc. This is parallel with the Boss lode on the adjoining section. A little concentrating ore can be picked out of the waste heaps which I saw, but the galena is associated with a good deal of pyrites and blende, and I do not think mining will pay unless there is easy tram communication with Zeehan. But, even with rich ore, this tribute would never pay with the present unsystematic way of working. The tributor intends sinking, and cutting the lode lower down, but at no great depth, and shallow mining will neither prove nor sustain the mine. A few yards south of this, just before coming to the *Comstock Hotel*, an outcrop of iron pyrites, blende with a little galena, courses N. 20° W. through slate country.

North Comstock.

Section 1546-93M, 62 acres. This was taken up in 1888, and about £1200 spent in shallow and surface prospecting, which was continued without results, as far as silver-lead ore was concerned; and work was abandoned in 1892. I walked over the property, and examined the work which had been carried on, with a view of picking up the main lode coming into the section from the Comstock.

Half a chain north of the south boundary, a small adit has been driven N. 80° W., but it is altogether too far to

the west of the main lode, though, if continued, it would intersect one of the lodes coming from the south. It has been driven 45 feet in dark slate country, containing a little pyrites. The upper, or third adit, about 550 feet above the South Comstock, has been driven N. 80° W., across slate, and has intersected a small vein carrying galena. This vein runs with the stratification of the country, and was the object aimed at in starting the adit, but, seeing its unsatisfactory nature, the tunnel was pushed on to cut any lode which might possibly be ahead, as loose pieces of galena have been found in the creek, higher up. An intermediate tunnel has been driven N.E. for a couple of chains (including the approach) to cut the Comstock lode. After this, it forks; the westerly drive following a soft gossanous lode, which crosses the tunnel W. of north. The lode carries a 1-inch seam of galena. The gangue is quartzose, and the ore is not associated with so much blende as usual. The end is not more than 18 feet below the surface, and no additional backs can be got by continuing the drive. The only possible policy is to sink, but the country is wet, and it would be advisable to wait till it is drained by the companies on the Comstock sections, lower down. By extending the eastern fork a zinciferous lode, which crops out in the creek, would be met with, but no great increase of backs could be got. The outcrop does not expose the lode sufficiently to see its width, but, from all appearances, this is most likely the Comstock lode, or a branch of it, for I am rather inclined to think that the main Comstock lode splits up into branches as it goes north. The wet country and the rather heavy scrub make prospecting on this section difficult. What ought to be done first of all is to expose the lodes coming in from the south all along their course from the boundary, and see exactly what there is to aim at. At present, some uncertainty exists as to what the lodes which have been cut really are, and whether the exploratory works are in the best positions.

Out on the button-grass country, within two chains of the N. boundary, a N. and S. lode, with a westerly dip, goes into the hill N. Its width is 14 inches to 16 inches, and it runs in sandstone and quartzite country, apparently, conformably in direction with the stratification. It is

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seamed with quartz sprinkled with a little galena, and impregnated with iron pyrites. Good backs are available, and can be increased to the extent of about 40 feet by going lower down into the button-grass swamp. The hill is a high grassy ridge running across the northern part of the section. The direction of the lode bears down the hill into the plain a little E. of a shaft which has been sunk in the swamp at the base of the hill. This shaft, 20 feet deep, is in gossany matter, sprinkled with pyrites and a little galena, but in different country, viz., slaty. The lode here can only be explored by sinking. From what I have said, it is evident that none of these lodes have been sufficiently tested.

Boss Section.

This comprises 80 acres (2073-87M), in the name of R. Quiggin, east of and adjoining the Comstock and South Comstock sections. A good deal of prospecting has been carried on, but no depth has been attained. The main lode enters the section from the N.E. angle of the South Comstock property, and bears N. 32 E., across the Boss section, with an outcrop about 20 chains in length. Just inside the boundary, from the Comstock, a trench exposes the strong pyritic lode, which, about 50 feet further N.E., is shown again in a long trench and a short crosscut drive, where it consists of dense iron pyrites, and crosses fissile black sandstone country. Still further N.E. are some open workings on the same lode, where the iron pyrites carry blende and some nice-looking galena. Some of the latter is reported to have assayed 105 ozs. silver, and to have been sold at £15 per ton. The lode contains a good deal of blende, which looks well enough where it is not mixed with the iron pyrites. Very little backs are obtainable, and this necessitates sinking. Further N.E. the lode was driven on, and 30 tons of ore were sent to the Argent mill. Five tons of ore were won in simply cutting through the lode 16 feet, which crosses the level diagonally, and was composed of pyrites and blende, with bars of galena. After driving 70 feet a sink was begun, but discontinued at only three feet below the level, owing to water. A shaft from surface has gone down to a depth of 28 feet. The

lode is in yellow clay, and, together with the country strata, dips W. It is a strong lode, with a solid outcrop, 19 feet wide, of iron pyrites, and work has been abandoned without giving it fair play. To leave off at this trifling depth from grass is only playing at mining. No backs are to be had, and further adit-driving is, in my opinion, useless.

There is another lode on the section, the west lode, which is shown in a strong iron gossan outcrop, bearing N. 30° W., dipping N.E., and, in direction, passes out of the block at the N.W. corner. Some iron pyrites is visible in this outcrop, and the gangue is quartz. It is seen on a small hill on the rather flat button-grass plain, 100 feet above the *Comstock Hotel*. The country falls away on the east of this to the plain at the base of Mt. Zeehan. A crosscut tunnel into the hill from the W. would test the lode not far from surface; but, as not more than 30 feet of backs are obtainable, the result of the crosscut would be indecisive. The great drawback of the lodes on this section is, that sinking is an imperative necessity, and this will involve heavy preliminary and standing expenditure. Down the hill, near the east boundary, is the eastern lode, bearing west of north and running through slates with a westerly dip. This lode is two feet wide, and carries blende and iron pyrites, with some galena. It has been surface-trenched some six or seven feet deep, and lower down the hill an adit is being driven just inside the E. boundary, to come under the surface outcrop of blende ore at a depth of about 40 feet. It has been driven about 200 feet, and now seems to be about vertically underneath the outcrop, but will have to go in further still, as the lode underlies west. The men, however, have been taken back from the face 100 feet to drive on a galena vein intersected by the adit. A seam of galena $1\frac{1}{2}$ inches thick, in curly disturbed country, veined with quartz and impregnated with iron pyrites, appears in a south drive just started, and requires following. In the opposite drive, where the ore continued for six feet in, the country is now barren. Further in an inch vein of galena was risen on for six feet over back of tunnel, but died out in very broken country. The stratification all through the adit is irregular, and heads of rock are constant. I do not think the main

lode has been reached yet ; the galena which has been met with so far appears only to be associated with flat seams of quartz, and not to represent any real lode. Further to the north-west on this part of the section there is another lode carrying small veins of galena. And again, towards the south and just inside the east boundary line, is a shaft sunk on a lode or vein running west of north in fissile sandstone and slate. A tunnel is being driven from the boundary to cut this, but has not yet connected with the shaft. I picked over some fair-looking galena on the small pile of stuff at mouth of shaft, but my impression is that this part of the property is seamed with small veins rather than fissured by any definite lode-channels, and, on the whole, the deposits of ore are likely to be irregular.

Clarke's Section.

This is an 80-acre block, No. 4094-93M., in the name of E. G. Clarke, formerly Tasmanian Land Exploration Company, and is situate south of the Boss. The Boss west lode passes into it, and it has, further, two lodes of its own traversing the section from the S.W. corner to the N.E. About 400 feet west of the west boundary the old main shaft is sunk 100 feet, and bottom levels are said to have been driven N. and S. for 275 feet, the south level in ore which has been stoped out to surface. The ore—a high grade galena-blende—is said to be the best on the field. A parallel lode—the Laura lode—has been worked with fair results. Several prospecting shafts have been put down, and trenches cut into these lodes, but I am told that work practically ceased six years ago. The hoisting plant is reported to have been inadequate ; at any rate, after considerable expenditure on shafts, the company suspended operations. I could not get underground, and can form no proper opinion of the mining prospects, but the lodes which traverse the property deserve a better fate than their present neglected state. The country-rock is conglomerate and sandstone.

Stonehenge.

Section No. 4132-93M., 80 acres, is south-east of the preceding. Three lodes bearing west of north, traverse

this property. The westerly lode passes N. into Clarke's, and the two others N. to the Susannite. The principal lode has been sunk on, and 60 or 70 feet driven upon it. The ore is galena blende, but I was unable to learn anything about the results obtained. The section seems to have been completely abandoned, without much work being done on it.

E. Gaunt's Section.

No. 2876-87M., 80 acres. This is situate south of the South Comstock, and is favourably placed for the extension into the section of the lodes from the South Comstock and those from Clarke's section. Nothing has been done to prove these yet, but if work is resumed at this group of mines, the section ought to be thoroughly prospected.

Carson's Sections.

No. 4005-93M, 65 acres, and No. 4476-93M, 65 acres, situate a little to the E. of Stonehenge, have two lodes bearing W. of N., which pass northwards into the North Tasmanian section. The lode in the western part of No. 4005 is tapped by an adit driven N.E. There is fair milling ore, but it would never pay for the cost of transport into Zeehan. If the adit were continued further, it would cut the western lode. The backs here are low, not more than 40 feet. The lode is of a good size, but the work done is only on the top of it. At the south boundary of 4005, the old Tasmanian main shaft and tunnel are situate, near the east end of the Tasmanian tramway. The slates strike N.E. and dip S.E. The lode is a large blende-pyrites one, associated with quartz; and the ore used to be treated in a concentrating mill, which was afterwards sold to the Comet Company. The large 3-compartment shaft has its poppet legs damaged by fire, probably bush fires, as it is in a line with a belt of burnt timber. The low silver ratio of the ore, and the want of communication with Zeehan, are great drawbacks.

North Tasmanian.

These blocks appear now on the chart in the name of A. E. Shillington. They comprise 182 acres, viz., No. 3699-93M, 73 acres; No. 3700-93M, 65 acres:

No. 3701-93M, 44 acres. Two nearly parallel lodes enter the section from Carson's, on the south, and course N.W. through the S.W. corner of the middle section, continuing thence into the Britannia property. A main shaft has been sunk in the south section. The depth attained is said to have been 190 feet, and levels opened out on a good-sized lode, which has been stoped out, I believe, to surface on a good run of galena-blende ore. The underground workings are now inaccessible. The lode bears N. 20° W. and dips N.E. The ore has a solid healthy appearance in the specimens which I picked up at surface, but would have to be dressed. The silver ratio averages a little under 1 ounce to the unit of lead. Mr. J. G. A. Stitt, of Zeehan, reports numerous assays of the ores as sold to the Queensland Smelting Company, viz. :-

	Kaolin and Gossan ore, 328	ozs.	Silver, 39	°	Lead
"	87	"	"	7	"
"	76	"	"	13	"
Galena, first quality	75	"	"	76	"
"	70	"	"	74	"
"	67	"	"	71	"
"	65	"	"	73	"
" second quality	54	"	"	61	"
"	49	"	"	52	"
"	44	"	"	66	"

But a sample of galena picked north of shaft assayed 124 ozs. silver, 79 per cent. lead. On the other hand, a good deal of the ore is stated to contain only a little over half an ounce of silver to the unit of lead.

We have slates and sandstones on this property on the E., while to the W. igneous rock occurs, which I was not able to identify on the spot ; but there is some sort of a contact which has probably influenced the lodes favourably. £5000 or £6000 worth of ore is reported to have been won from the mine during the company's and subsequent tributors' time. I am told that the pumping plant, which was removed when work was stopped, was inadequate for managing the water at the depth reached.

About 200 feet W. of the main lode is another one, coursing N., 10° W. Both lodes dip N.E., but the western one is flatter, and there is hardly any doubt that it will junction with the E. one in depth. The former

ought to be cut in depth by a crosscut W. from the bottom level on the E. lode, and this should be done by any one who takes up this property.

An adit has been driven W. 200 feet on the middle section with the view of cutting these lodes, but I believe it will have to be extended a little further before intersecting. This is a piece of work which requires proceeding with, as the lodes can be easily followed north with moderate backs, though none too good. Deepening the shaft will expose the lode at a more satisfactory depth; and, given better communication with Zeehan and the necessary capital, this property, with the higher price of lead, possesses encouraging prospects. Its position is within a mile S.W. of the Colonel North railway, besides which the old line of the Tasmanian tram passes through the section at the S.W. corner. It is a pity to see a legitimate prospecting property like this lying idle.

Britannia Section.

No. 1512-93M., 80 acres, A. J. Dolan. This is bounded on the S. by the preceding, and on the N.W. and W. by the Susannite property. It can be easily reached by a track about 30 chains long from Grubb's tram (Col. North railway), on the British Mt. Zeehan property. Shillington's tram, branching off from Grubb's, is along the line marked out by the Colonel North Company for tram extension to the Comstock. Several lodes are known to exist on the section, but the most important ones are the two parallel lines of lodes coming in from the south, and traversing the Britannia section in a N.W. direction, and passing out of it near its N.W. corner; and the two T.L.E. parallel lodes, which cross the N.W. corner in a N.E. direction. The latter are the principal ones. The western lode has a strong outcrop traceable for 7 chains, and the eastern lode for 14 chains. On the eastern T.L.E. lode a small prospecting shaft was sunk 12 feet about eleven years ago, upon the discovery of galena in the creek. A bucketfull of blende and iron pyrites was got up, but the water proved too heavy, and nothing further was done, except at surface. A trench a few yards S.W. of this shaft shows a lode about 6 inches wide, said to be

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widening under foot, which consists of blende and pyrites, with a little fine-grained galena. It carries some soft pug on the hanging-wall. The country-rock is slate, striking N.W. and dipping N.E., while the lode cuts through it with a bearing of N., 10° E., and a dip to the S.E. About 700 feet S. of the north boundary line a small shaft has been put down some 20 or 30 feet on a blende and pyrites lode containing a little galena, and a further shaft of about the same depth was sunk on some highly argentiferous galena. The No. 4 adit has been driven N.E. through slate, and cutting the E. lode at about 140 feet in an E. crosscut, in which the lode is about 10 feet wide, 6 feet of which is a solid lode of zinc blende and iron pyrites, carrying galena. The remaining 4 feet are composed of soft pug, pyritous and zincy matter. The ratio of silver obtained is 1½ ozs. to the unit of lead; a little copper is also said to be present in the ore. Altogether, it is an ugly mixture. A little further on in the crosscut is a small seam of galena about 8 feet beyond the lode-wall. The lode has been tested at surface 50 feet ahead of this, but the depth in the crosscut is trifling, only 25 feet below grass. Further south, about 500 feet from south boundary, two adits have been driven at right angles to each other, No. 1 going north, No. 2 going west, or a little north of west. The No. 1 adit has been extended through slate country 102 feet, and under a strong gossan outcrop. At 70 feet a quartz lode was cut, 2 feet wide between walls, carrying 4 inches of galena, clean, and with no blende. This ore assayed a little over 1 oz. silver to the unit of lead. The vein bears N.E., consequently, parallel with the E. lode, which is ahead of the adit. From the indications at surface I think the adit will shortly enter serpentine country. At the contact line, possibly, some ore-channel may be met with. This adit is a low one, and should be continued through the section, for it will cut all lodes belonging to both systems, and enable the ground to be satisfactorily proved. The country between the lodes is veined considerably. Of the two systems the T.L.E. is the more important, and the work has been done principally on those lodes. The Tasmanian lodes are represented by lines which require to be traced by systematic trenching.

The No. 2 adit has also been driven 102 feet at right angles to No. 1; nothing has been cut in it so far, and it has some distance to go before intersecting the E. lode. The line of one of the Tasmanian lodes crosses it at or near the entrance, but though both these lodes, if continuous, would pass through the section, they cannot be identified till the trenching just mentioned has been carried out. In the N.W. corner of the block, No. 3 adit has been driven north-west for about 170 feet, with the object of intersecting the west T.L.E. lode, under a strong outcrop which crosses that corner to the S. boundary of the Britannia Extended. About 30 feet from approach, and 18 feet from surface, a 6-foot band of pyritiferous and iron gossan crosses the tunnel, and has been passed through. The present end of tunnel cannot be far from the lode, which is underlaying to meet it. Close to the face there is a vein of quartz, and water is flowing freely. The tunnel is in pink and yellow clay, the decomposition product of slate, and the face is now about 40 feet vertical below surface.

Besides these main lodes there are other features which deserve attention. In the eastern part of the property there are large and wide gossan outcrops; and E. of the east lode a small seam of galena was cut in a trench, and a shaft sunk 21 feet, with a crosscut extended from the bottom to cut the lode, which, 1-foot wide, dipped out of the shaft at 15 feet. The lode is a galena-pyrites one: the bottom of the shaft is in curly slate, with quartz and a little pyrites; the crosscut has not been driven far enough to reach the lode.

There are other prospecting works on the property, some of which I did not see; others, I need not particularise. The section is conveniently situated with regard to the Grubb (Col. North) railway, via Shillington's line, only one section intervening, and the indications of mineral at so many points warrant an expectation that more vigorous progressive work would result in satisfactory developments. As the E. lode underlies west and the W. lode east, they will probably unite in depth, and one of the aims of those in charge of future work should be to explore them at the junction.

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Britannia Extended.

This block, N.E. of the Boss and N.W. of the Britannia sections, is better known as the Susannite, owing to the occurrence of highly argentiferous mimetite (arsenate and chloride of lead), which at first was conjectured to be susannite, a variety of leadhillite (sulphato-carbonate of lead). The barrel-shaped crystals of this yellowish resinous-looking mineral have been identified as campylite by Mr. W. F. Petterd, and this identification has been confirmed by an analysis made by Mr. W. A. Macleod, B.A., B.Sc. During the investigations a question arose whether the mineral might not be what Dana calls pseudo-campylite, a pyromorphite which assumes rounded forms resembling campylite. It appears that the boundary is vague between mimetite and that variety of pyromorphite in which arsenic takes the place of phosphorus. The increase of arsenic causes pyromorphite to pass into mimetite, and when the barrel form is present there is scarcely a doubt as to it being campylite. In the present instance, we may consider the mineral as true campylite, *i.e.*, an arsenical pyromorphite or mimetite, which crystallises in barrel-shaped crystals. It is associated with other crystals having the mammillary and acicular habits of pyromorphite and mimetite. I notice the lodes marked on local plans of this section are called mimetite lodes. This rich secondary ore is characteristic of the upper part of the lode, and is mixed with soft decomposed pyrites down to the tunnel level, which is not more than 35 feet below surface. The pyritous lode bulks $1\frac{1}{2}$ ozs. silver to the unit of lead, and the other lode in drive 1 oz. to the unit. A tribute party of four are working, but had not effected any sales when I was there. They had a small pile of ore outside tunnel, which they claimed had given assay returns up to 116 ozs. silver and 7 per cent. lead.

This ore will infallibly change to lead sulphide in depth. The west drive on this property has been driven 200 feet. It intersects a strong pyrite-galena lode 16 feet to 18 feet wide, with rather low silver contents, under 1 oz. to the unit. There is no blende with this ore, and on any other field such a lode would not be left unexplored. But nothing much can be done with

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the property by small tribute parties. The lodes invite thorough testing in depth.

SILVER STREAM DISTRICT.

This must be considered with the Comstock field, of which it forms the western part. It comprises the sections lying immediately west of the Comstock and North Comstock. Geologically, it shows more pronounced signs of the proximity of the serpentine than the generality of the Comstock mines. The succession of strata going E. to W. from the Comstock Mine to the base of Mount Agnew would be— 1 limestone, 2 quartzite, 3 sandstone, 4 black slate, 5 quartzite, 6 serpentine, 7 granite: the serpentine intrusive into the sedimentary strata, and the granite subsequent to all others. It would require considerable time to go over all the surrounding country and trace the geological boundary lines, but by walking westwards, I thought I could fix the granite contact somewhere in the swampy flat on W. Thomas's section, No. 5028-93M. The serpentine is seen along the Trial Harbour Road, in contact with the sedimentary rocks a little to the west of the South Comstock Mine, and also on the Colonel North West Section, so that it is evident that the mineral deposits of the Silver Stream district are situate near the serpentine contact lines, and have probably been indirectly influenced by the rock. There is, however, no necessity to refer them directly to anything but the granite period, notwithstanding the presence of minerals commonly found in serpentine country, *e.g.*, brucite (?), magnetite, clinocllore, &c.

Proceeding westward from the Comstock section, we enter a 39-acre block, 970-93M, where the country is quartzite, covered with button-grass. On the top of the hill is a seam of gossan, which transgresses the country strata with a bearing of N. 10° E. It goes down vertically from 2 feet to 12 inches wide, and with a fair wall on the E. side. This is about 230 feet above the Comstock. Passing further west to

O'Neill and Bennett's Section,

71 acres, No. 3712-93M, the quartzite country continues, and on the top of the hill is a deep cut through a

strong iron and quartz outcrop 4 feet wide, and bearing N. 25° W. On the N. side 250 to 300 feet of driving would give a couple of hundred feet of backs. The gossan carries no metal, but where exposed looks a very likely capping for a lode. About 250 feet further west a shallow cutting exposes another iron outcrop, about 3 feet wide. A few hundred feet of backs could be got here from the east. I believe these outcrops cover silver-lead lodes, and an attempt ought to be made to get below them. Since these notes were penned I have heard that one of these lodes has been recently cut at 120 feet below surface, and that a ton of galena has been sold from it, netting £10.

The hill here falls off towards the sea, and an extensive view is obtained of the timbered serpentine country to the S.W. In the southern part of the section there is a bold projecting outcrop of magnetic iron ore, which can be traced for about 7 or 8 chains south down to the blind creek in gully, 60 feet deep; but further west additional backs could be obtained by driving a crosscut tunnel. At the southern end the outcrop is not so dense, but more gossanous. Going N.W. and across gully, about 150 feet further west, is another iron outcrop, where gold prospecting has been carried on. While the quartzite country is bare, the iron outcrop is covered by a narrow belt of timber, evidently denoting a more favourable soil for forest growth. The magnetic iron seems to be surrounded by quartzite country, and thus to partake of the nature of a lode, but I am very doubtful as to its occupying an independent fissure, or to its having any other connection than with the neighbouring serpentine, which may also be beneath it. The question ought to be set at rest by prospecting below it and along its walls, where the deposition of ore is most likely to have taken place.

Silver Stream,

Section 2223-93M, 62 acres, A. P. Anderson, is due west of O'Neill and Bennett's property. Work on a lode, bearing east of north, was started ten or eleven years ago, and has been carried on in a desultory way, the mine falling into the hands of tributors, and meeting

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with the usual fate. A shaft has been sunk 50 feet down to No. 1 level, and thence continued 27 feet by a winze to the lower adit. Payable ore was stoped out above No. 1 level, and No. 2 level has been driven 600 feet, but for a length of 500 feet it was not more than 30 feet from surface, and only an additional 45 feet were gained in the last hundred feet of the drive. The lode is wide in places, but averages three or four feet. From what I learned, upwards of 200 tons ore had been sold, but low in silver contents. The silver ratio is reported not to have exceeded half an ounce to the unit of lead. The ore-band has been as much as five or six feet wide in this lode, and it will doubtless recur in depth, but nothing can be done without the necessary capital for sinking and draining. The Silver Stream lode is the principal one known in this part of the field, and has been left alone far too long. When the district is brought into communication with Zeehan there will be some chance of a vigorous development of the property. A few chains south of the shaft the eastern fringe of the serpentine country is met with, but at the mine itself I saw nothing but quartzite and dark clay-slate.

Three or four chains north of the south boundary, a tunnel about a chain long has been driven S 10° E., in what appeared to be serpentine. It passes through what was described to me as the copper formation, which is a band of decomposed serpentine carrying a little copper pyrites. The trend of the serpentine is N.W. By continuing this crosscut the galena lode would be intersected. The copper pyrites band is none too encouraging; the ore is sparsely disseminated and does not seem to fill a fissure. From what I noticed in this journey, the serpentine in various parts of the field appears to contain disseminations of copper ore, but there are no known copper lodes, and it is very doubtful whether the magnetite outcrops pass into copper pyrites in depth. The margins of the magnetic iron masses are the most likely places for copper ore.

Silver Stream, No. 1.

No. 4760-93M, 70 acres, Thomas and Glock. This is a property N.W. and adjoining the Silver Stream. Its

characteristic feature is a large outcrop of magnetic iron, several chains wide, forming the top of a N.W.—S.E. timbered ridge, which passes through the section. This iron belt passes into the adjoining section on the west, and 3 or 4 chains into the Silver Stream on the south-east. O'Neill's magnetic iron outcrop on the 71-acre section is supposed to be its continuation, and though that blow seems a little north of the line of strike, it undoubtedly has some connection with the occurrence. The big deposit of magnetite is a most interesting geological phenomenon, besides claiming attention from a mining point of view. It is desirable to attack it at a reasonable depth and determine whether it caps a pyritic lode. The surface indications show that in its more solid portions it is a mass of dense magnetic iron ore without any symptoms of a sulphidic lode beneath it. The view which a prospector habitually and naturally takes of oxidised outcrops is that they graduate downwards into unaltered sulphides: and such a view encourages him to aim at getting down into the supposed sulphidic zone. He is fortified by his success in sinking on lode cappings in sedimentary or acid eruptive rocks. But there is grave doubt whether the same thing always holds good in gabbro and serpentine country. In these latter rocks concentrations of iron oxide are assumed to take place during the crystallisation and differentiation of the magma, and are thus distinct phenomena from those connected with the formation of lodes. A cut in the gossany clay and iron towards the north end of the ridge shows an earth which certainly looks like the decomposition product of an igneous rock, which might have been serpentine or a contact rock. It contains small glistening talc-like flakes, somewhat resembling decomposed enstatite, but which are probably clinocllore, a mineral of the chlorite group, often associated with serpentine and its contacts. In this part of the blow the iron is not dense and solid. Still, it would be improper to look upon the iron as a simple cap, for it runs down to creek level. I do not see why it should not continue to descend to any imaginable depth with earthy or stony portions, according to the more or less perfect concentration of the iron in the original magma. This concentration appears to have proceeded in a

N.W.-S.E. line, and, as a whole, to have been connected with the contact either of granite with serpentine, or of the latter with the sedimentary rocks against which it impinges all along this line. It is quite possible that some copper ore concentrations may occur in connection with it, though no decided signs are noticeable. The most likely positions for ore of any kind would not be below it in depth, but on its flanks. I believe a local association is driving from the adjoining section to get well into the iron formation. If this tunnel is continued far enough, we shall know more about the body of ore than we do now. As an ore of iron, this large blow may at some future time impart value to the property.

Wm. Thomas's Section.

No. 5028-93M, 80 acres. This was formerly held by the Tasmanian Silver Prospecting Company, and subsequently by H. D. Marsh. The magnetite on the preceding section runs into this, and is evidently close to the granite contact. A little further W. is quartz-tourmaline rock, and then the granite of Mt. Agnew. The intervening country on this section appears to be sandstone and quartzite, together with a dark metamorphosed rock, which microscopical examination shows to be indurated serpentine. Some blende and pyrites from M'Clochlin's shaft show that a lode of some kind has been struck. The mica-like mineral in large plates, slightly greenish, and with greasy lustre, seen on the heap at mouth of shaft, is clinocllore, and the ore deposit would appear to be a contact one. Clinocllore is a secondary mineral, and this is just the position in which it is likely to occur. The phenomenal silver assays said to have been obtained from here are in accordance with this view. Unless the shaft is unwatered, no opinion can be formed as to the prospects of mining here. No good shoot of galena has been met with: the ground is low and swampy, and all work would have to be done by means of sinking.

I have now passed in review most of the properties on the Comstock field. My remarks will have shown that the district is favoured with several strong blende-galena lodes, serious work on which has been neglected for

several years, owing to circumstances already alluded to. In consequence of the blende ores now being marketable, and with the higher price which has been ruling for lead and silver for some time past, it appears to me quite practicable for some of these abandoned mines to be profitably worked, if only there is the means of cheap transport to Zeehan. The Trial Harbour road does not give this facility, and the Colonel North railway stops a good way short of the south end of the field.

Communication by tram, either by one route or another, seems to be the only remedy for this unfortunate isolation, and the knowledge that it is to be applied will, without a doubt, revive interest in the dormant sections. Of course, a line running out to the field will not have full traffic immediately, but I anticipate it would at once secure a fair quantity of ore from the Comstock and South Comstock mines, besides which it would convey stores to these and other mines re-starting.

The field can be approached in two ways. First, there is the Queen Extended route to the Comstock and South Comstock mines. These mines are five miles from the Zeehan railway station. There is a tram-line for about half the distance, and the extension of this for a further $2\frac{1}{2}$ miles would take it as far as the Comstock. This is the route favoured by those interested in the Comstock group, as being the shortest and most direct one to the mines at their end of the field. The drawback to it is that it will have to climb the hill from the present Queen extended tram. The Trial Harbour road ascends 350 feet from the Queen bridge, and then descends 150 feet to the mine, and the tram-line could not avoid at least 250 feet of this ascent. A survey, however, would show whether a convenient line could not be found. Of course, as the Comstock mines will be the chief immediate customers of the tram, their position has to be kept in view. Another thing to be considered is that if the Comstock is to be on the main line, which will be ultimately extended to Heemskirk, then the most direct route should be taken, and the companies in the other parts of the field left to connect with it by horse-tram. It would be desirable to see whether the Queen Extended route could not be taken up to the Britannia,

Susannite, Boss, and so on, to the Comstock. It would thus serve most of the mines which are now working.

The other way of opening up the field is by making use of the Colonel North railway (Grubb's tram), which could be extended to the Comstock in two ways, viz., (1) by a direct route of $1\frac{1}{2}$ miles from a point on the existing line due west across Shillington's, Britannia, and along the north boundary of the Boss; or (2) by about a mile of new tramway connecting with the old Tasmanian tram, which communicates with the Comstock by a two-mile track. This route is the more circuitous, but each route passes through sections which are likely to be taken in hand again, and work resumed on the lodes which traverse them.

Taking the (1) Colonel North route, that company has already surveyed it from the saddle of its own line on the Spray Hill, on Section 195-87M. It crosses Shillington's section from E. to W. into the Britannia, where prospecting is going on upon lodes which I have described. It then continues westward into the Britannia Extended or Susannite ground, where exploratory work is being conducted; and thence along the north boundary of R. Quiggin's Boss section, the lodes on which require more attention than they are receiving at present. From here it enters the Comstock section, leaving the Sylvester mine close at hand to the N., and would be continued to the South Comstock immediately to the south. The mines along the old Tasmanian tramway would then connect with the new railway at the South Comstock.

The Colonel North Company has an alternative route (2), filling up the existing gap between its line on section 1584-91M., and the end of the Tasmanian line on Carson's section, 4005-93M., whence the tram rails would be laid along the line of the old tram road to the Comstock. It would serve the Tasmanian sections, and ultimately reach the Comstock, but would leave the Britannia blocks to the N.

I think the real choice will be found to lie between what I may call the west branch (1) from the Colonel North and the Queen extended line. In favour of the former, it is alleged that the Colonel North railway has already climbed the hill, while the Queen Extended would have to find a way up, and that it is the shortest

due west route from the Zeehan railway station. In support of the Queen route, it is contended that it is a natural line of extension of the town tram, and would best serve the mines in the northern part of the field. Whichever of the two routes be adopted, it will have the effect of making work possible on sections which have long been condemned to enforced idleness.

It must not be expected that a large traffic will attend on the line all at once. Capital has been unfairly diverted from the district, and it will take some time to secure its return. There will, however, be an immediate return from the South Comstock, and probably from the Comstock Mine; and others certainly will follow. The district will in time supply the Zeehan mines with a fair quantity of timber, and the smelting works with flux, all of which will be carried by the proposed line. Mine-owners will be able to get stores and machinery to the field economically and with ease. I anticipate confidently that the line will be instrumental in assuring a reasonable measure of prosperity to mines which are now either languishing or abandoned. What I chiefly fear, is that sections will be taken in hand by small prospecting associations, who, with insufficient capital, cannot carry out the work systematically and thoroughly, and who, after a short trial, and the exhaustion of their funds, will put their properties again on tribute, and, sooner or later, throw them up, having securely fastened upon them a thoroughly bad name. What is wanted, I repeat, is for companies well provided with capital to begin serious work, with the determination to see it through; and I have no doubt that perseverance on those lines would be rewarded. Hitherto the lodes have been too far from Zeehan to pay for ore transport, and perhaps too near to be floated into important companies. If they had been more distant and less accessible they might have had a better chance of attracting capital. The worst detractors of the field cannot deny that it abounds with mineral. Most of this cannot be realised profitably under present conditions of transport. The zinc blende, which is so prevalent, was worthless in former days, but is now a marketable product, and, with cheap transport and smelters near at hand, can be turned into hard cash. This ore, and the argentiferous galena

found on so many sections, supply good reasons why the field should not be allowed to remain in its present undeveloped state. If treated properly, it may be expected that in the future this district will become an important adjunct to the Zeehan system of mines.

I do not know that the serpentine country to the south-west has been properly explored for lodes, but, geologically, it is quite as favourable a matrix for silver-lead lodes in this Colony as the Silurian strata are, and it would not be at all surprising if prospecting resulted in uncovering some important lodes between the Comstock and Trial Harbour. The most likely zones in that country would be on the contact line between the gabbro and granite, where the granite begins near the Agnew, and again further west near the coast line, where the granite joins the serpentine. These contact boundaries furnish lines of weakness, along which, under the stimulus of intrusive rock magma, deposition of ore is apt to take place.

If eventually the tin ground at Heemskirk is proved to be valuable, and this is quite possible, then the country west of Zeehan will assume additional importance. Be this as it may, Zeehan, surrounded by country which invites the prospector and investor, must remain for generations an attractive mining centre.

Trial Harbour and Mt. Heemskirk.

I combined a visit to Trial Harbour with my journey to Heemskirk. On the main road, about half a mile west from the South Comstock, a small cut has been made into the serpentine, on a 15-inch quartz vein, which carries a little auriferous pyrites. This is 5 or 6 chains north of the south boundary of the Col. North W. sections. It is in a good position for working, if it can be proved to be of any value, having excellent backs above and below road. The rock along the road is imperfectly serpentinised, and fresh gabbro is seen just beyond M'Ivor's cottage in the road cutting on the left. A little iron and copper pyrites can be detected in it, but there are no safe indications of anything payable. The gabbro seems inclined to become amphibolitic along this road, indicating its proximity to granite. About $\frac{3}{4}$ -mile

further on, a large iron gossan outcrop crosses the road, but no trial of it appears to have been made. The Heemskirk granite invades the gabbro country near the Agnew Creek. This latter rock is the bluish granular stone seen on the road, and used as road metal. It merges gradually further E. into a more typical gabbro of coarser texture. The granite of Heemskirk in its fresh and unaltered state is a handsome rock, consisting of pink orthoclase felspar, abundant dark mica, and quartz. Where it is tin-bearing there is a development of white mica, a fact suggestive of the secondary nature of this mineral. In places, the granite is converted into greisen, or a quartz-lithic-mica rock. The tourmaline of the stanniferous granite is very abundant, and ranks among the finest in the Colony. Fine cabinet specimens are freely obtained.

Bourke's Alluvial.

I looked at these tin workings, which are on the Agnew creek, just at the change from the gabbro country to the granite. About 3 feet of wash rests on the coarse bed-rock granite. This drift is full of large stones of granite and quartz-tourmaline rock. Mr. Bourke had been sluicing here for eleven months, and had found the ground very patchy, but had struck a rich spot just before my visit. Here, and at the Big Orient, there were 5 men at work.

The Heemskirk granite country covers the area between the Agnew and Orient creeks, and on the plateau S.W. of the latter creek we have schistose quartzites, bearing N. 30° W., and dipping N.E. At the creek above Trial Harbour these are replaced by somewhat indurated serpentine, which, at the harbour, forms the high bank fringing the ocean shore. About 28 chains N. of the harbour granite comes in, and the serpentine shows signs of contact metamorphism.

Trial Harbour Nickel.

About half a mile south of the harbour, on the hill facing the ocean, a shallow shaft, 180 feet above sea-level, has been sunk in soft serpentine, which contains some impregnations of sulphidic nickel ore and a little zaratite.

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Outside the shaft are five bags of ore and a barrowful of green nickel-stained serpentine, but I could not see any sulphide ore in the stones on the heap. A very good specimen was shown me at Smith's, at the harbour. This shaft seems to be following an iron vein running N.W. Thirty feet below the shaft collar a drive has been extended 26 feet from approach, with the view of intersecting the nickeliferous vein. For the last 12 feet the drive bears N. 80° W., in massive, but somewhat decomposed serpentine, with iron ore seams and white patches of magnesite (the carbonate of magnesia). The drive was suspended when I visited it, but it ought to be continued to the shaft, and the behaviour of the nickel vein ascertained. At present, all that can be said is that there is undoubtedly a concentration of nickel ore in the serpentine here, but whether it will be found to develop into anything payable is problematical. To the east of the shaft is a wide iron gossan, which no doubt covers a ferruginous belt of the serpentine, but it is improbable that it is the capping of any lode. These lodeless gossans are characteristic of serpentine country, and have often led to fruitless work. They do not mark the course of any fissure, but represent a magmatic concentration of iron in the cooling rock-mass. On the north side of the hill a long tunnel has been driven S. into the serpentine, 150 feet above sea-level, towards the surface gossanous outcrop. I followed the adit some 50 or 60 feet as far as the water would allow me. There are no indications of productive lodes in this serpentine, but, theoretically, contact ore-deposits ought to occur along the common boundary of serpentine and granite, and they may possibly yet be found.

The granite country to the north is a plain of marine denudation, rising gently towards the Heemskirk range, furrowed with gullies and strewn with water-worn granite boulders, and exposing round bosses of the same rock. Everywhere solid granite underlies the soil a few feet below the surface.

Montagu Mine.

This abandoned claim is situate at the foot of South Heemskirk and between the Cumberland Mine and the main road from Zeehan. Mr. Matthew Bullen resides

on the property, and showed me round, giving me sundry information. I saw in his house a splendid nugget of tin ore found in the Montagu Creek, and evidently brought down from some lode on Heemskirk. An old main shaft is situate above the creek. This was sunk 120 feet, a well of 120 feet left, and a drive put in at 100 feet for the creek. An E. and W. lode was cut and driven upon for 12 feet. Where cut the lode is said to have been 10 feet wide, but very poor, consisting of hard quartz-tourmaline rock. It was very irregular, cutting out into barren rock, and no further work was done when the funds ran out. I believe a few tons of tin ore were obtained. The main lode is intersected by a N. and S. one in the Montagu Creek, and at the intersection the latter is two feet wide; it is said to open out to 3 feet 6 inches at 40 feet down a prospecting shaft sunk in the creek. Two other prospecting shafts have been sunk between this and the main shaft. About 20 feet to the west, lower down the creek, are two or three small parallel veins, but not stanniferous at outcrop. Altogether there are over a dozen lodges and veins of tourmaline, which cut through the line of the N. and S. lode in this creek. The latter lode is tin-bearing at surface where the others intersect, which is just what might be expected. As usual, the veins do not shift at the junctions.

The Montagu main lode can be traced at surface for quite a quarter of a mile along its course E. In this direction a prospecting shaft sunk on it discloses about a foot of tourmaline quartz rock in decomposed granite. Further up the hill the lode is crossed by another from the north. The most easterly shaft is 20 feet deep, and in this Mr. Bullen cut the lode 2 feet 2 inches wide, carrying fair ore. A peculiar feature in this lode is that in its western part the tin ore is grey and brown, while east of the split it changes to a sharply crystallized black ore.

The present position of the claim is that two or three tons of tin ore per year can be got from the stone at surface single-handed by simply hand-crushing and dolly-ing, and there is evidently a good deal of tin in the surrounding country. Whether a resumption of active work would result in success is difficult to say. The

necessity for sinking is a drawback, and the buncy-nature of the ore is another damaging factor; still, the lode has not had a fair trial.

Federation Tin Mine.

Formerly the New West Cumberland, comprising 256 acres leased to J. S. Munro, viz., No. 3689-93M, 40 acres; No. 4143-93M, 56 acres; Nos. 3688 and 3919-93M, 160 acres. This mine, on the south end of Mount Heemskirk, is 3 miles from Trial Harbour, and 12 miles by road from Zeehan. It has been recently taken over by new owners, who intend testing its value in a systematic way. They have put the battery in order, which is now equipped with 20 head of stamps, a Frey's stone-breaker, 3 classifiers, 8 Frue vanners (4 with corrugated belts, and 4 with plain ones), convex slime-table, 2 Pelton wheels (one to drive the vanners, the other the battery). The water is brought through a 7-inch column at 250 feet of pressure, and with an additional head of 200 feet above that, making altogether 450 feet of pressure available. A race has been cut $1\frac{1}{4}$ miles from the dam to the intake. The supply is abundant—more water, it is said, running away in the height of summer than would be required for 40 head of stamps. The old battery site was lower down the creek, a hundred feet lower than the new mill. The property has been practically idle for five years; and the old proprietors gave it up altogether the year before last. From what I can learn, the association of iron with the tin ore, on Section 3688, baffled the dressers, who were not up to table work. They also had a large percentage loss in dressing the bismuth found with some of their ore. This applies to the old portion of the property, which the present owners have no intention of working. An inclined self-acting tramway for 20 chains, the top of which is 450 feet vertical above the mill, connects with a ground horse tram-line, which comes round the hill from the East Cumberland section.

The old workings at the top of the self-actor consist of two adit levels, one 70 feet above the other. The upper adit has been driven 400 feet, at first on a body of tin ore taken out in an open face at entrance: most of

it is said to have been a bag to the ton of stuff. A few vertical tourmaline veins also gave a little tin. The ore pinched out to a small vein of quartz, and the drive was driven through dry tourmaline granite, containing at one point a shoot of bismuth ore, which was stoped out by the old company. This adit finally cuts through what is called the iron-stone lode, 4 feet wide, from which, I was told, some bismuth had also been taken. It is really a cross-lode of ferruginous tourmaline rock, the iron oxide being derived from the tourmaline: the iron varieties of tourmaline assay, according to Dana, as much as 14 per cent. Fe O. The lower adit does not appear to have met with any success.

On the top of the hill, on the eastern section (No. 3688), are two long outcrops, which merit a more particular description. The one courses N. 50° E., and is the lode now called No. 1, upon which work is about to be principally carried on. The other, No. 2 lode, is a very long outcrop of hard tourmaline-quartz, running N. 62° E. In an easterly direction it courses through the Cumberland section proper, the long section, and has been worked at the east end. On the top of the hill, about 150 feet of granite forms the country between these two nearly parallel lodes.

On the No. 1, or block lode, a small prospecting shaft (Munro's shaft) has been sunk 27 feet, where the lode may be taken as being about a chain wide. The lodematter is dense black stellate tourmaline, containing cavities which probably were once occupied by quartz. From this shaft, in the old times, lodestuff, which was sledged down to the battery, is said to have returned 3 per cent. tin ore. Mr. Stitt's assay of a bulk sample from the bottom of the shaft yielded 5 per cent. tin ore; Mr. Latta's assay of 14 lbs. from this shaft was 1.37 per cent. metallic tin. A sample taken on my visit right across the face averaged 4 per cent. tin ore. The shaft cuts across the lode, which is here of great width and promise. It has a 4-foot band of soft decomposed quartz-tourmaline running down it, and flanked at the east end with reddish micaceous-looking iron oxide. This point is, at present, a very important part of the mine, as it is not only, so far, the deepest accessible place, but the lodematter is more stanniferous than in the drive lower down,

where it is associated with the harder country-rock. The aim of the owners, I conceive, should be to attack the lode wherever it is of a soft ferruginous nature, for that portion will be found to be the richer in tin. Why it should be is not so easy to explain. It may be due to simply mechanical liberation of the tin ore from its associated tourmaline on the decomposition of the latter, together with the rock of which it formed part, and, as the decomposition product occupies a smaller space than the original rock, the tin ore may be regarded as a natural concentrate; or it may be that the rock was really richer in tin at these places, and the oxidation of the iron in the tourmaline is in some way connected with the unstable nature of the rock itself, where saturated with the fluoric solutions or vapours. In either of these two cases, the oxidised iron lode-matter is the indication of tin ore, and its most favourable matrix. A face, therefore, below this shaft, where, according to assays, there appears to be payable tin, and, provided the bulk returns can be kept up to 1 per cent., or even a little under, the venture should, with careful management and the existing facilities for economical extraction and treatment, be fairly satisfactory.

A little lower down the hill a blind drive has been cut some 12 feet into the lode, composed of black decomposed tourmaline quartz-rock. A dish prospect, on my visit, gave 3.47 per cent. tin ore, but an assay by Mr. Latta returned 1.62 per cent. metallic tin. Close by is the upper drive across the same lode, cutting across it for 40 feet. At 40 feet in, the further wall is struck, but for the last few feet the lode carries hardly any tin, so that 30 feet may be put down as the ore-bearing part. But this is scarcely the full width, as the approach is in lode, and the latter extends several feet further down the hill. There are portions of hard, poor rock in the lode exposed by this drive, and to this I attribute the poor return obtained from a bulk sample which I took of the lode and rock all along the drive. The Government Analyst reports a yield of 0.20 per cent. tin. On the other hand, Mr. Stitt took an average sample from along the roof of drive, and obtained from it 1 per cent. tin oxide. The N.E. drive from this adit has been extended 30 feet along the hanging-wall of lode in poor rock. The country here

and there is soft and kaolinised, and seems to be outside the tin-bearing, gossany part of the lode. The S.W. drive, 47 feet, is also in massive country outside the proper tin-bearing part of the lode. Bunches of gossan, kaolin, and tourmaline form a soft, clinkery lode, best seen on the footwall side of the drive. These drives have not served any useful purpose beyond defining the boundary of the lode. Some of the lodestuff from the end of the S.W. drive was assayed by Mr. Stitt, and returned 2 per cent. tin ore. The adit has been continued into the hill for half a chain beyond these drives in a decomposed rock, which can be identified as white mica granite. By continuing it another couple of chains the tourmaline lode of the long section ought to be reached, and with no great difficulty, for the granite country is soft for the most part, the kaolin and iron being easy ground for driving. It is intended to begin a face on this lode a little further down the hill, below Munro's shaft. Mr. Sale, of Zeehan, assayed the concentrate from a dish prospect from the face exposure, which yielded 3.96 ozs. metallic tin per dish. A sample of the lode-rock assayed 2.06 per cent. metallic tin. A lower tunnel has been driven from the horizontal tramway, lower down the hill, on the N. side, for a distance of 210 feet, originally directed straight towards Munro's shaft (150 feet below it), but was afterwards bent round eastwards to come beneath the upper adit. The country is granite all the way in. The horizontal tramway starts from the mouth of this tunnel, and goes right round the hill to the hoppers.

This line of lode going S.W., not many yards from Munro's shaft, crosses another quartz-tourmaline lode, running N. and S., or a little E. of N. The way in which it crosses this at the top of the hill is instructive. It neither displaces it, nor is heaved by it, but crosses without any deviation. This is a frequent feature of tin lodes, and shows that the line of lode is a line of jointing which existed before the introduction of the tin. It is well known that extensive jointing, apart from metalliferous lodes, is a constant characteristic of granite country. A cut or two on the west side of the apex of the hill leaves no doubt but that the lode has really passed through the hill. Two shafts have been sunk

about 30 feet deep on the N. and S. lode, or cross-lode, as it may be called, and on the N. side of the hill a small underlay shaft or adit has been driven on its course a short distance. Here the lode is about 4 feet wide, consisting of black quartz-tourmaline rock, bounded by a greyer variety of the same rock on either side. The shaft just above it to the S. is at the top of the hill, between 800 and 900 feet above the battery, and is sunk on the same lode, which is banded with a hard rib of bluish and greenish tourmaline rock, about 20 inches wide, with about a couple of feet of softer decomposed tourmaline rock. Some assays of the hard rib-rock by the Hamburg Metal Company returned over 25 per cent. metallic tin; and a recent assay by Mr. J. G. A. Stitt yielded 28.5 per cent. tin oxide. A sample from this shaft, according to an assay conducted by the Government Analyst, contained 12.2 per cent. metallic tin. The lode may, consequently, be expected to vary a good deal in its tin contents, but the returns obtained obviously suggest the advisability of further trial, which can be made inexpensively by adit from the north side of the hill. Another shaft has been sunk on the same tourmaline course, some 40 feet further S. The rock here contains some arsenopyrite, which is the origin of a characteristic yellow colour.

No. 2 lode runs right through Sections 3919 and 4143 to the Cumberland Creek, but has not been traced east of the latter section. It has a long, wide outcrop of quartz-tourmaline rock traversing the granite, and forming the backbone of the hill. The tourmaline on the Cumberland section proper (the long section) becomes greenish in tint going east, and at the eastern end of the outcrop is quite pea-green, like the similar rock at Mt. Bischoff, which used to be called chlorite. At that end is an old inclined shaft descending to the adit below on a lode composed of quartz-tourmaline, with white mica, the quartz being stained with some fluorine. The quartz-tourmaline-felspar pug yielded a little tin in the old times. Some work has been done in an open face above No. 1 adit, and ground stoped below that adit from a pass going down to No. 2, but tin has not been found in payable quantities. On Section 3919 a long tunnel was driven by the old company from the south,

but was suspended before it was far enough in to come under the outcrop aimed at.

In the alluvial of creek to the E. of the upper hopper, on Section 3688, half a ton of black tin ore has been won. The ore is not waterworn, but sharply crystalline, and the wash or soil containing it bends away from the creek northwards. The creek itself runs up from the valley N. 60° E., and has about 2 feet of alluvial, decreasing to 18 inches, soil up the hill. The mineral is evidently lode tin from a vein not far away. It is a fine-quality ore, and the hillside should be prospected to ascertain which lode it came from.

Near the top of the inclined tramway, I saw a few old trenches and shafts exposing tourmaline lodes, some of which had yielded a little tin ore in the old days. Not very much systematic work has been done on the property, and outside the No. 1 lode nothing really good has resulted from prospecting. After my examination, the opinion which I have formed is that the ground is eminently favourable for tin ore, but the lodes are likely to be rich only locally. If parts of the lodes in which ore-concentrations exist can be picked up by prospecting, they will help the production, but these zones are very irregular, and of small extent, as far as disclosed by past work. The mainstay of the mine will be found in the No. 1 lode, and there is a fair chance of a payable output being derived from it. The venture upon which this enterprising syndicate is now embarked will be watched with interest by all who wish well to Heemskirk tin-mining.

About 18 men are employed at this mine, and perhaps 40 or 50 altogether on the Heemskirk range. Alluvial has been worked on Packer's Creek, below the Cumberland, and about 15 tons of tin ore were won. The alluvial consisted of 2 feet of wash under 7 feet of stripping. The reason why much alluvial is not found between here and the coast-line is that the sea at no distant date covered the country up to the range and well-slucied the bedrock. Though tin-bearing alluvium will continue to be worked here and there, and will perhaps give fair returns to small parties of men, yet Heemskirk must depend for its permanence upon the lodes which certainly exist, and which in places contain good deposits of ore.

Heemskirk, as a tin field, has for a long time altogether lost favour, owing to its abandonment after a little underground work, and the consequent collapse of possibly extravagant hopes. The lodes have been condemned as capricious, but in doing this the nature of tin deposits, which are often only impregnations from joints, is not sufficiently taken into account. As far as I could see, the Heemskirk lodes have nothing unusual about them, and I have no doubt that their richer portions, when discovered, will answer expectations. The present price of tin has led to a revival of interest in the field, and if any measure of success attends the efforts now being inaugurated, it will lead to a more thorough trial of the lodes than they have yet received.

Renison Bell Tin Mine.

This property comprises five sections—181 acres in the North Dundas district, viz., Sections No. 165-93M, 40 acres; No. 166-93M, 16 acres; No. 2534-87M, 40 acres; No. 2606-87M, 40 acres; No. 2536-87M, 45 acres. It is reached by taking the train from Zeehan to the 5-mile station, whence a four-mile walk along either the Emu Bay line or the Owen Meredith tram leads to the mine. The mine is 2 miles 56 chains along the railway line from the centre of Tunnel Hill. From the 5-mile the Emu Bay line first passes N.E. through the old M'Kimmie Silver and Nickel Mining Company's sections, and further north through the Madame Melba flat, where a few men are still washing gold. The country-rock is a decomposed serpentine, which a little further north graduates into its parent rock, gabbro or bronzitite. On the track over the tunnel is the junction between the serpentine country and the Silurian slates. The railway thence runs along the strike of the slates, and the contact with the serpentine is exposed at intervals to within about three-quarters of a mile of the Renison Bell Mine, when it is replaced by sandstones and slates. On entering the S.W. angle of the 45-acre section, we first become aware of the proximity of tin country, for the railway track has just uncovered a band of tourmaline-

quartz-porphry, a white granular porphyry with needles of black tourmaline scattered sparingly through its groundmass. The rock is, however, without tin. Another outcrop of similar rock occurs nearly 1000 feet higher up to the S.E., on both sides of the boundary between Renison Bell section (165) and Sligo's section (1146). It is there a few chains wide, and is bounded by slate on the east side. The two exposures are parallel, and as one is only 10 chains east of the other, they may be parts of one and the same intrusion, though they cannot be connected, so far.

The Renison Bell Mine is in a very undeveloped state, and this renders any useful expression of opinion at present very difficult. Some work has been carried out down at the Argent River, on the northern section of the property, No. 2536, and the lodes have been trenched up the hill on that section: driving is proceeding at the Big Blow on Section 2534, but merely on a scale sufficient to avoid forfeiture.

The main, or No. 1, lode courses S.E. through the hill from the Argent River, on Section 2536. On the S. bank of the river it is exposed in an open face, about 20 feet wide, where it is of a soft gossanous and pyritic nature. A tunnel has been driven in slate S.E. along the western side of the lode for 100 feet. A crosscut N.E. from this tunnel only cut a soft pyritic vein, which, when followed a few feet, died out into flinty country. As this crosscut was a failure, a second one was put in at end of tunnel, and 200 feet from entrance. This has been driven 60 feet, and has cut into the lode, which is here dolomite and arsenical and iron pyrites, but has not yielded any tin. After cutting into the dolomite, the crosscut makes a useless bend, being driven too much to the south. It has passed through about 30 feet of dolomitic stone. Several assays have been made of the pyritic lodestuff in this crosscut. The indications show that we have a true tin lode, although in this part of it the tin ore is absent.

Government Analyst's Assay:—

Gold	Minute trace.
Silver.....	4 dwts. 21 grs.

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Queensland Smelting Company's Assays:—

Gold	1 dwt. 12 grs.
Silver	11 dwts. 2 grs.
Copper	0.75 per cent.
Lead	0.20 per cent.
Gold	15 grs.
Silver	11 oz. 5 dwts. 9 grs.
Lead	0.75 per cent.
Bismuth	Present

And the Government Analyst's assay of soft lode-matter 40 feet in from mouth of tunnel returned:—

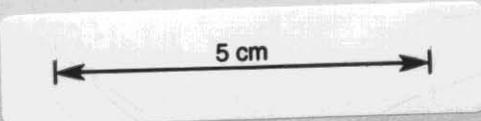
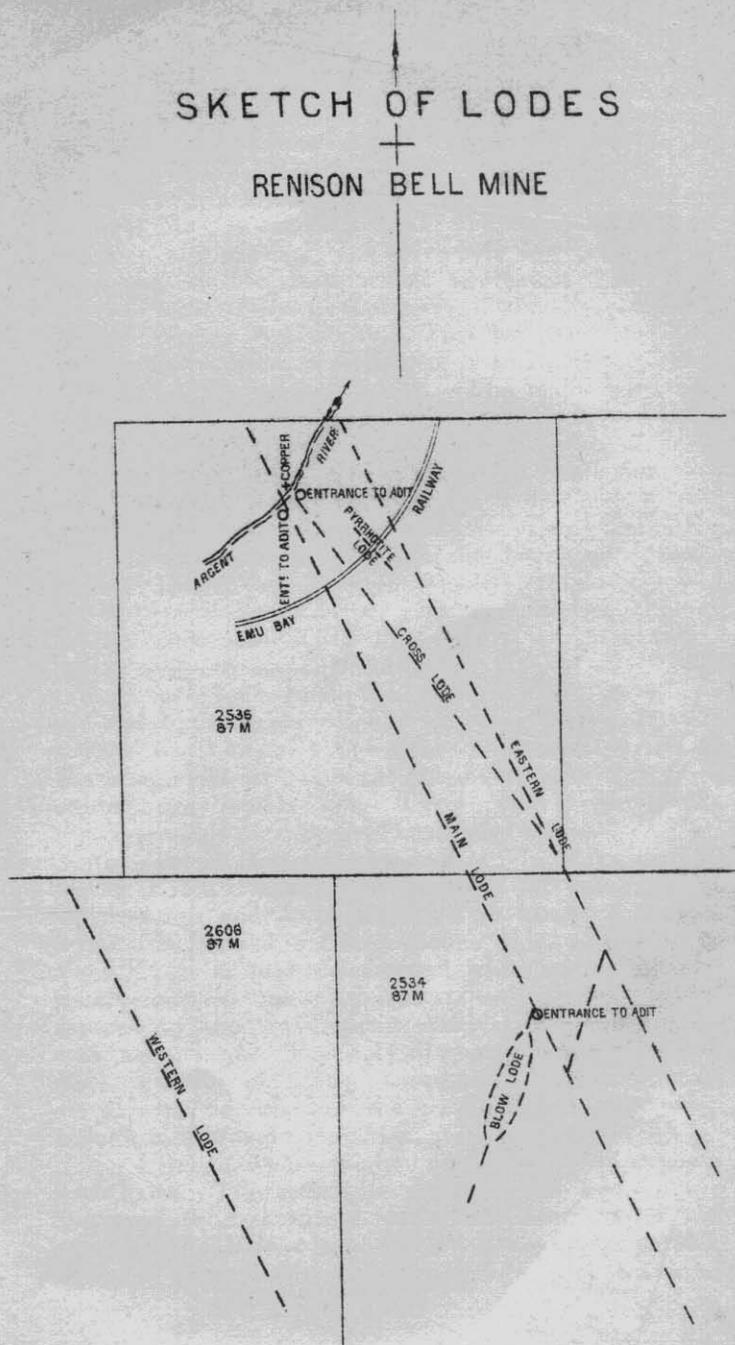
Gold	20 grs.
Silver	2 ozs. 4 dwts. 2 grs.

The open gossan face on this lode, at the river, is evidently rich in tin, as may readily be seen by dish prospects. The Government Analyst's published assays of what are stated as bulk samples taken from this face give 9 per cent. metallic tin. As we have just seen, however, the lode does not maintain this richness when cut within the hill. It is a pity the drive was not carried along part of the lode, instead of outside it in the slate country, as it would have proved it more thoroughly. I have been told that bulk assays of even 10 per cent. tin have been made from the open face, and I can well credit it; but such contents seem confined to the soft gossanous material, and are, I believe, due to the oxidation of the pyrites releasing the tin ore, and permitting the natural, mechanical concentration of the latter, which, in this way, enriches patches of the gossan far above the average of the lode as a whole. If this is correct, we need not always look for a rich lode below a rich gossan. Still, there is rich solid tinstone distributed irregularly in the lodes on this property, and it can only be got at by systematic development work. The open face cannot be worked purely hydraulically, as too much of it will require crushing. The site for machinery will have to be lower down the river, E. of mine. The river drops about 100 feet in a mile, and about that length of race and fluming would give a good fall to the battery. It is, however, quite premature to consider the machinery question yet. The present tunnel is not high enough above the river

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SKETCH OF LODES

RENISON BELL MINE



for a good tip, and too low for a future battery. Some connection with surface further east will have to be aimed at, so as to give the needful height above river.

What is called the cross-lode joins the main lode at the open face, on the river bank, and has a direction S. 42° E., with a dip N.E. A drive S.E. has been put in for about 69 feet, from which a crosscut goes N.E. 14 feet to intersect a tin-bearing lode exposed in a costean pit 52 feet above. This has not been cut. Where the crosscut was driven, a small vein yielded some large zinc blende crystals. The main drive was first on a lode 2 feet wide, but this was thrown, by a fault, just inside the entrance. The assays at mouth of drive were, as usual, high, 7 per cent. tin. A small sink was put down a few feet at the approach to drive on a lode which, Mr. Gaunt tells me, was 6 feet wide at first. He says he took out all the ore, 35 bags, which only realised £8 per ton, although selected samples assayed 34 per cent. and even 54 per cent. metallic tin. This is another illustration of the exceedingly irregular distribution of the tin ore in these lodes.

Both these lodes (main lode and cross-lode) have been exposed by several trenches on their course further south. No. 1 trench exposes the main lode, pyritic in character, and with quartz gangue, stained with iron oxide in grey hackly slate. Twelve feet further east is the costean pit on cross-lode mentioned above.

No. 3 trench is on the cross-lode only. It is about 30 feet S. of No. 2 trench, and uncovers the lode-capping, which is soft and decomposed. Two bands of pyrites, 2 feet 6 inches and 4 feet 6 inches wide, separated by about 8 feet of broken laminated white sugary quartz-rock, represent the lode. A piece of this quartz, assayed by the Government Analyst, contained 2 per cent. metallic tin. The footwall country is hard, silicified slate, or sandstone. The disintegrated pyrites is associated with tin ore, but the trench is not quite deep enough to thoroughly test the nature of the lode.

No. 4 trench, 50 feet higher up the hill, has exposed both lodes. The cross-lode shows at the end, in the bottom of the trench, as 5 feet 6 inches of pyrites and quartz, with a second band 4 feet 8 inches of soft pyrites, separated from the first by flinty slate, with seams of

waterworn pebbles, descending six and ten feet from the surface. Loose wash goes down to the floor of the trench, which requires carrying deeper to prove the lode properly. With so much wash in this trench, assays are not safe, unless the samples are taken very carefully. Further W. down the trench the main lode is also shown, 20 feet wide, with the usual soft gossanous capping.

All trenches have been bulked, and assay returns published at 1.2 per cent. metallic tin, but the mixing of samples from distant points on the lode cannot be looked upon as serving any really useful purpose.

At 140 feet above the river the Emu Bay railway cutting, which runs S.W.—N.E., intersects the lodes already known, and has also recently cut through a large pyrrhotite lode 50 feet wide, bearing N. 20° W. in slate country. Mr. Stevens, the mine manager, reports bulk samples as averaging 1.9 per cent. tin. This lode is another example of variable metallic contents. I took samples from a width of 15 feet in the middle of the lode, where it seemed to be purest and most solid. These have been assayed by Mr. W. F. Ward, Government Analyst, who reports the contents at 15.5 per cent. metallic tin. Two other samples from the same spot yielded 54 per cent. and 0.3 per cent. respectively. Another sample, assayed by Mr. W. A. Macleod, B.Sc., yielded no tin at all. The pyrrhotite is associated with ordinary iron pyrites and vivianite, and is abundantly veined with quartz. On the footwall there is a 1-inch veinlet of galena, poor in silver, assaying only 26 ozs. silver to 65 per cent. lead. Since my visit, Mr. N. H. Propsting tells me that 40 or 50 lbs. weight of stone have been taken from this lode, over a width of 25 feet and a height of 7 feet 6 inches from the floor of the cutting, and that an average sample from this was assayed by the Government Analyst, and returned 10.8 per cent. metallic tin. The lode here evidently demands serious attention, for these returns are encouraging. This large lode has not been seen either N. or S. of the railway cutting. Further W. in the cutting the cross-lode, 7 to 8 feet wide, is intersected, the footwall of which is formed by a layer of white quartz conglomerate and grit, 48 feet thick (described in the mine reports as the white lode). I was told that this conglomerate contained

tin. I felt very dubious about it, but a sample assayed by the Government Analyst yielded 0.03 per cent. tin, so that it may be assumed that the stanniferous vapours from the adjoining lode penetrated the conglomerate to some extent. Still further W. are broken sandstone and black slate for about 30 feet, underlying which is the gossan outcrop of the main lode, which was being cut through while I was at the mine. A point of geological interest is the horizontal bedding of the white grit, as shown by the lines of pebbles in it, while the rock itself is fissile in laminae, dipping at a high angle to the E., conformable with the adjacent slates.

The pyrrhotite and cross-lodes converge going south, and must unite before reaching the boundary of the section. If the former could be shown to bulk payable tin contents, which ought not to be very difficult to ascertain, an open face on it could be easily worked, with a succession of benches up the hill as far as a vertical height of 200 feet.

About 140 feet above the railway is No. 6 trench, which exposes about 80 feet of black pyritous lode-matter, supposed to be the cross-lode: on its western wall is an exposure of dolomite, with specks of galena and pyrrhotite. Bulk assays here are reported as yielding 1.2 per cent. tin; but a sample which I took, on being assayed by the Government Analyst, only returned 0.03 per cent. tin. The pyrrhotite and cross-lodes may have junctioned here, and originated this broad belt of lodestuff. The overburden consists of a few feet of hill detritus, also said to be tin-bearing. I have seen samples of such detrital lode-matter extremely rich in tin, and a few pieces of it included in the bulk-sampling of a trench, would easily raise the average tin contents to an abnormal figure. The greatest care is requisite in sampling the lodestuff in the trenches, so as to rigorously exclude all loose detritus. To have sampled these trenches properly would have taken me more than a week. I had to content myself with taking promiscuous samples from the most important exposures.

Notwithstanding the local rich concentrations of tin ore, these lodes present an essentially low-grade proposition, and the success of the enterprise will depend upon--(1.) whether the ground between the railway cutting and No. 6 trench will pay to work; (2.) whether the lode below the Great

Blow is payable. I do not attach the greatest importance at present to the lodes lower down the hill. They will have to be explored by underground mining, and will also have to be rich in tin to pay costs.

The small galena vein in the pyrrhotite lode does not look promising enough to spend any money on. It could be intersected, if desired, by a crosscut E. from west side of the mine hut, and then driven on S. under the railway cutting, but the silver contents are too low for it to be payable.

The sledge-track lode, E. of No. 5 trench, was shown to me; and a further one, the Eastern lode, was pointed out, but I had no time available for its examination.

Following the main lode further S.E. up the hill, on Section 2534-87M, it is joined by the Big Blow lode, an apparently faulted lode coming in from the S.W. This is at 500 feet above the Argent. The Big Blow is a large quartzo-ferro-manganese outcrop projecting, by measurement, 30 feet above the surface on its lower side, bearing S. 20° W., and having a surface width of 20 feet, but narrowing towards N.E. Light yellow, rusty, quartzose slates dip E. under the footwall of the gossan. This wall is exposed to sight for 3 chains, and the outcrop continues 3 chains further all along the hillside, and then goes out of sight long before reaching the western lode. Some rich lumps of gossan, assaying as much as 60 per cent. tin, have been found, but these are exceptional. One of my rich samples, assayed by the Government Analyst, returned 56 per cent. tin. Mr. Ward has also assayed other specimens of this gossan, returning 52.2 per cent., 28 per cent., 36 per cent., and 67 per cent. tin.

A drive S. has been put in 82 feet on the footwall of the main lode, at its junction with the Blow lode, 60 feet below the latter on the underlay, and the E. side of the drive follows the footwall. A rich flat vein of cellular quartz and greenish-black pug crosses the drive at entrance, and dips rapidly down to the sole. This vein bulged to 3 feet thick, and thinned down to 3 inches. The level takes a bend west in its course, and behind the end short crosscuts have been put out E. and W. The crosscut W. is in the light-coloured slate, which is seen beneath the footwall of the Blow lode at surface. Some oxidised lode-stuff is in the end of drive, and since my visit the cutting of

a stanniferous pyrrhotite lode in the E. crosscut has been announced. Mr. W. F. Ward's assay of a sample of this returned 30.7 per cent. metallic tin. The ore contains much iron pyrites, and the tin is present as oxide. It would seem, therefore, that the Big Blow is the capping of a pyrrhotite lode carrying tin oxide. The tin is confined to the darker grey parts of the veinstuff, but, from its association with pyrrhotite and iron and arsenical pyrites, will be troublesome to treat, involving calcining and dressing operations. I understand the quality of the lodestuff is far from being uniform. It is this patchy character which tinges the prospects here with uncertainty. The latest news from this drive is that it has been extended to 156 feet, and that a second crosscut E. (No. 2) has been driven at 122 feet in, with about 75 feet backs, cutting the same lode, with good stanniferous pyrrhotite ore further in the hill. The main drive, also, is reported as continuing in good tin-bearing lodestuff. This development is full of promise, and ought to stimulate prompt and vigorous work. In conjunction with the lode in the railway cutting, it has improved the prospects of the property, and no time should be lost in developing the discoveries.

About 70 feet S. of the tunnel entrance on main lode another lode branches off to the W. of S. The strike of this suggests that it is the other part of the faulted Big Blow lode, but this point requires clearing up, and will be settled by continuing the present end on the main lode south. I may mention that on the east side of entrance to tunnel a crosscut has been driven S.E. into the main lode, without reaching its hanging-wall.

Just sufficient prospecting has been done on the property to establish the occurrence of rich concentrations of tin ore in the upper parts of the lodes, but not enough to enable any satisfactory estimate of the value of the lodes to be formed. The lodes, which have been pricked into, require to be proved systematically, and the work which I would suggest as of primary importance is—

1. Drive on the Big Blow lode where it has been struck in the upper crosscut, eventually also crosscutting lower down. It is essential that the lode below the huge outcrop should be properly explored. There is every inducement to do this, and it is surprising that the work has not been

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attended to before. The outcrop itself, too, should be carefully examined, with a view to determine the parts which carry the rich concentrations. The main lode should also be driven further on in this adit, as far, at least, as the supposed heave of the Big Blow lode.

2. Well establish the bulk value of the large pyrrhotite lode in and above the railway cutting. To do this, some bulk parcels will have to be sent away. Until that is done, there will be nothing but uncertainty, as the tin percentage in different parts of the lode is excessively variable. Not only the tin contents, but the cost of treatment must be ascertained, for the association of the tin ore with pyrites will necessitate calcining and increased milling expense. If an average of 3 per cent. could be relied upon, I believe the lode would pay to develop.
3. Drive on the main lode at the river, and follow it into the hill, establishing connection with cross lode by a crosscut E. Another 200 feet ought to be driven on it to ascertain its character as a tin-bearing lode.

I may add that there is a possibility of the big blow lode uniting with the main lode in depth below the present upper drive, as its underlay is flatter than that of the latter lode.

The property has been allowed to slumber far too long. Assays of rich specimens may be very encouraging, but are not sufficient to bring a mine to the front, if no serious work is carried out. It is freely admitted that stanniferous lodes exist: what is now necessary is to be assured that the tin is in payable quantity, and the way to ascertain this is to adopt some working programme identical with, or similar to, the one I have sketched out above.

All the tin lodes on the property will probably be found in depth to be composed of stanniferous pyrrhotite, iron and arsenical pyrites, and still lower down the pyrrhotite may give place to the bi-sulphide, iron pyrites, the magnetic iron pyrites (pyrrhotite) having lost the original second atom of sulphur. The tin does not occur as tin pyrites, but as the oxide. The solid pyritic veinstuff, which is met with just below the surface, increases the

difficulty of treatment. All said and done, however, exploration should not be abandoned. It is possible, especially with present prices of tin, that the pyrrhotite lode may develop into a payable proposition. In the eastern part of the Renison Bell property, the North Renison Bell people began a crosscut tunnel, which they extended 600 feet N. 20° E., through Silurian slates lying at a low angle. The last 20 feet are in dolomitic limestone. No lode has been cut in this tunnel.

The occurrence of tin lodes and tourmaline quartz porphyry in this district, of axinite in the Colebrook field, and the tin minerals, tourmaline, fluorite, bismuth, wolfram, &c., at Mt. Black, indicates the underlying basement rock of this part of Tasmania to be stanniferous granite.

Copper Lode at Renison Bell.

The main tin lode at the Argent River passes across to the N. bank, opposite the low tunnel, and shows as a quartz pyrrhotite lode. It is bounded on the E. by slate, which, opposite the tunnel on the cross-lode, is seamed with quartz and impregnated with iron pyrites. What has drawn attention to this exposure is a little native copper and green carbonate found encrusting the pebbles in the wash which clings to an exposed face of the slate. Where the copper has come from is uncertain; probably, from copper pyrites, though I could see none anywhere, nor any native copper in the solid slate. To make a trial it will be necessary to get into the solid bedrock below the old creek wash. At present, it is impossible to say whether the quartzose vein will open out into a true lode, or is only one of the numerous small veins which intersect this hill.

Tunnel Mine.

Returning to Zeehan through the Emu Bay tunnel, at the south end of the latter, I saw an E. and W. lode crossing the approach. It had been driven upon a few feet east, and was shown to be a quartz-galena lode, running in serpentine, and dipping south. It is about 2 feet wide, and some galena has been bagged from it. This ore is associated with chromate of lead and pyromorphite: the drive was about to be let on tribute when I saw it.

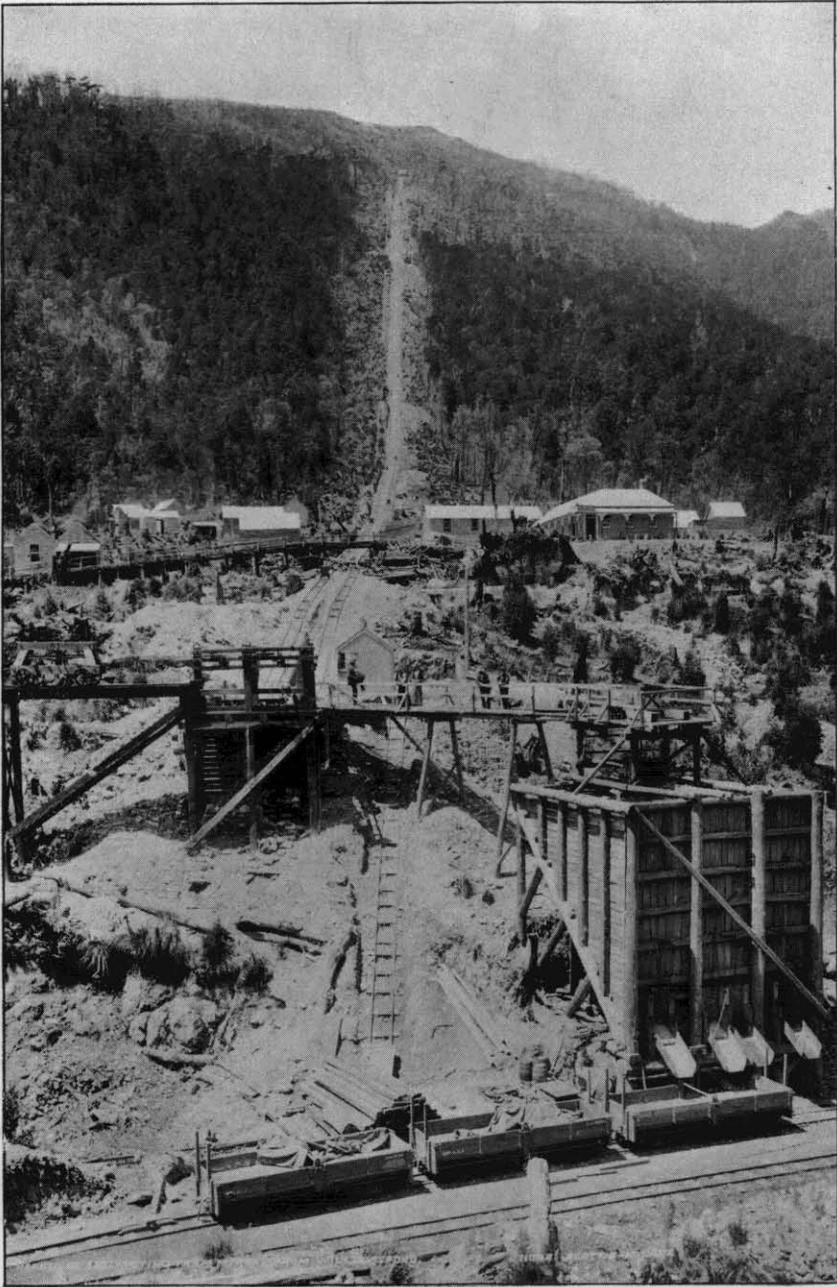
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Evenden Mine.

This mine is on Section 299-93M, at Moore's Pimple. A low tunnel has been driven E. about 330 feet, for the first 270 feet in slate and quartzite, coursing N. 10° W., and dipping N.E. At 270 feet a 3-inch gossan vein was intersected, containing a little galena, and a drive south was carried along it for 40 feet; the vein widens a little going S., but nothing payable has been met with. In the end, the hanging-wall carries 6 inches of gossan, said to contain slugs of galena now and then. The line of gossan is the real vein, and the rest of the drive is bedded quartzite. Some zinc blende was met with in the floor of the drive. The end of the main tunnel is in magnesian rock, seamed with dolomite, and stained green with nickel or chrome. It is very probable that the vein is a contact one between serpentine and the stratified rocks. In the tunnel are a few vughs, which contained slugs of galena: this is No. 4, the galena lode. Some surface excavation has been made above the drive in soft gossan, which has yielded galena. At surface, about 100 feet south of the end of the south drive aforesaid, there is a large ferro-manganese gossan outcrop, containing, besides iron and copper pyrites, some galena and crystals of lead chromate. This outcrop measures 80 feet in width on the slope of the hill, and can be traced through the bush for 7 or 8 chains. By continuing the drive another 100 feet, it would come under this gossan, and a rise could then be put up to surface about 130 feet. If this work justified further outlay, a lower tunnel could be got in 200 feet lower down.

Although the work, so far, has not resulted in anything really good, it ought not to be finally abandoned before testing the lode under the great gossan outcrop, which can be accomplished, as said above, with a comparatively trifling outlay. It may be as well to say, however, that I do not anticipate that the lode below the gossan will correspond at all in size with the surface exposure. The iron in the adjacent serpentine has contributed largely to the formation of the gossan, and its segregation has most likely taken place in minute infiltration channels. But the occurrence of lead minerals in the outcrop denotes the existence of lead ore below it; whether in payable quantities, or not, can only be ascertained by actual work.

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HERCULES SELF-ACTING TRAM.

Geologically, the contact position of the lode is a favourable sign. If the gossan is found to descend to the level of the drive, a winze must then be sunk, with a view of following the oxidised mineral down to the sulphidic ore. The silver ratio to the unit of lead in this mine is 1.3 ozs. to 1 per cent.

S. of this, on the track to Dundas, I saw what is known as the copper lode, which is a band of quartzite, impregnated with copper and iron pyrites, and a little native copper in the bedding planes. I could not satisfy myself that this occurrence was a real lode. On one side of the quartzite are slates or schists; on the other, conglomerate; and the copper ore exists in oxidised and indurated bands of country-rock. A few trenches have been cut across these bands, but the indications do not encourage more than a trifling expenditure in prospecting.

Hercules Mine.

This well-known mine is the property of the Hercules Gold and Silver Mining Company, which holds 15 sections (154 acres) on the west slope of Mt. Hamilton, a spur of Mt. Read. The mine offices are about 2900 feet above sea-level, and 1800 feet above the Williamsford terminus of the N.E. Dundas tram, with which communication is effected by an inclined self-acting tram-line, upwards of a mile long. The present work of this incline is to bring up the mine stores and run down the ore, which the neighbouring (British) Mount Reid Mining Company, Limited, is consigning to the Zeehan smelters, for the Hercules Company has not yet begun to send away its own produce.

This company has now been at work for five years, exploring its ore deposits and endeavouring to obtain satisfactory evidence of their permanence. Five crosscut tunnels have been driven into the hill across the schists, the lowest, No. 5, being extended nearly 900 feet, with its face ascertained by survey to be 433 feet below the surface; No. 4 is 140 feet above No. 5, and No. 3 is 53 feet above No. 4. These tunnels have intersected bodies of zincy silver-lead ore as well as copper sulphide ore occurring in the argillitic schists or phyllites conformably with the dip and strike of the laminations of the latter, and, so far as

has been observed, of lenticular form. These occur at intervals in the schists, in more or less parallel bands, or, more frequently, *en echelon*, and several levels have been driven upon them, establishing their nature and behaviour in a fairly reliable way.

The schists are aluminous and have undergone hardly enough reconstruction to be called true schists. They might more properly be termed argillites, or, at the most, argillaceous schists. Sometimes a step further in the process of metamorphism may be noticed, when they become phyllites, or clay-slates, with a surface made glossy by the development of mica. The occurrence of patches of unmistakable slate shows the real nature of these quasi-schists. At the same time the talc schist occasionally found has probably originated from different rocks, and would seem to indicate originally eruptive members of the series. The strike of these schists is a little west of north, approximately 10° to 15° , with the dip always east of north. The angle of dip varies from 45° to 75° . The dip of the strata shows that Mt. Read does not form an anticlinal arch, for the easterly dip continues east right across the mountain, until within a mile of Red Hills, where a western dip first comes in. Consequently, Mt. Read owes its form and existence as a mountain entirely to denudation. I do not mean, however, to say that the schists have necessarily been exposed to surface denuding agents during excessively long periods, for there are signs of a former capping of conglomerate, which has been removed subsequently to the elevation of the schist. This conglomerate may be seen lying horizontally on schist on the White Spur track, a few hundred yards S.W. of the shaft on Dunne's Blocks. I am doubtful as to its age; it is, however, either Devonian, or Permo-carboniferous. The schist, which underlies it, strikes N. 20° W., and dips, as usual, N.E.

There is nothing available for the determination of the geological age of the schists. No fossils have been found in them, and their stratigraphical relations with the middle Silurian strata at Zeehan have not been investigated. Their physical aspect does not count for much in solving the question: they are, doubtless, of the same age as the associated slates, yet how different in appearance. The nearest approach to a fair guess is, that they belong

to the lower Silurian slate series; but this interpretation must be considered subject to correction, in the light of later researches.

The ore deposits, besides possessing economic importance, are also geologically interesting. They do not occupy fissures or cavities produced by violent fracture of the country-rock, but have been formed along lines and planes of weakness which have originated from the foliation of the rocks. Along these lines mineral-bearing solutions may be conceived as travelling, attacking the rock on either side, removing its constituents in solution, and depositing in exchange their own mineral contents. The deposits thus fall into the category of bedded veins. This class of deposit is often looked upon as inferior to a fissure vein in point of permanence, but this fear is unfounded. Continuity may not be so absolute as that of the gangue of a true lode, but it may reasonably be doubted whether it is not equal to that of the ore-shoots in a lode. It has, moreover, the additional advantage of indicating, as a rule, the existence of parallel deposits along parallel laminations of the schist.

This theory of replacement pre-supposes the country-rock to have been already laminated or foliated before the mineralising solutions found their way between the laminae; and the way in which the ore follows the lamination, even when the latter is minutely arched, without breaking or otherwise suffering a solution of continuity, strongly supports this. If we accept this view, the alternative theory of the ore having been precipitated on a lake bottom is quite untenable. Even at the stronghold of the latter theory, Mount Lyell, I saw reason to doubt its applicability. The tongues of schist extending at right angles into the pyritic ore, or *vice versa*, seemed to me strong evidence against the deposition of the mineral on the floor of a lake. I believe the facts warrant us in taking a wider view of the important ore deposits of the West Coast range, and compel us to look for an explanation which will cover the mineral occurrences, not only in sedimentary strata or crystalline schists, but in igneous rocks as well. The theory of metasomasis harmonises with the facts observed at Mount Read, and distinct evidence of it has been found in the eruptive quartz-porphry or quartz-felsite at Red Hills, where the rock

passes into hematite, and iron pyrites occurs in patches in the country, unconnected with fissure veins. Clearly, no lake theory could apply here. Further confirmation is afforded by the consideration that, as the eruptive rocks are not so liable to deformation as the softer slates, the latter would naturally furnish the easiest channels for ore deposition.

The primary ores met with in the Hercules Mine are zincy silver-lead ores, copper pyrites, and a little fahl ore. Near the surface these have oxidised, and produced gossan ores with enriched gold and silver contents.

The longest run of zinc silver-lead ore driven upon is 270 feet. Several drives from Nos. 1, 2, 3, and 4 tunnels have been put in on the course of various ellipses and other masses of sulphidic ore, though, for the past half-year little or no work has been done on this class of ore, owing to the unsettled state of the question of the treatment of complex zincy sulphides. The owners believe that the work actually done shows that there are 90,000 tons of sulphide lead ore above the level of No. 4 workings; this does not mean that that quantity has been actually disclosed by blocking-out, but that by drives, rises, and winzes, &c., its existence has been rendered fairly certain. The assay values vary from 9 per cent. lead and 11 ozs. silver to 10 per cent. lead and 12 ozs. silver for the bulk of the ore, with an average of 0.140 ozs. gold. 52,000 tons are estimated to contain 29 per cent. zinc, and 25,000 tons, 25 per cent.; 5000 tons, 30 per cent.; 5400 tons, 31 per cent. zinc; so that, probably, 29 per cent. to 30 per cent. zinc contents is a fair estimate. Full values of gold, silver, and lead contents of sulphide ore, without cost of treatment on furnace deductions for zinc, would be about £3 10s. per ton; consequently, if this ore is to be turned to account, it must be either by recovering the value of the zinc, or by assisting the infinitesimal margin of profit by realising at the same time the oxidised ores, of which the company estimates it has 15,000 tons in sight. According to the published assays, the value of most of these oxidised ores at 0.6 ozs. gold, 25 ozs. silver, 3 per cent. lead, may be taken as £5 13s. per ton, without smelting charges and deductions. The total value at the mine of lead sulphide and gossan ores on the above basis would be nearly £400,000, subject to the deductions

aforesaid, and subject to the ground defined by the exploratory work done proving to correspond with the estimates made.

Unfortunately, the silver-lead ores are associated with zinc blende, and zinc blende is the smelter's bane. It bridges over the difference in specific gravity of slag and matte, which require to be separated. Matte and slag become pasty, and the difficulty of separation is increased, resulting in foul slag, which requires smelting over again. In thus decreasing the fluidity of slag and matte, the zinc causes wall accretions or hangings to form in the furnace, composed of zinc oxide, lead, iron, sulphur, and silica. These are remains of imperfectly smelted charges, which have to be barred down and smelted out. With ores containing an excessive proportion of zinc, these hangings are constantly forming, and interfere with the regular settling down of the furnace charges, and if they are not removed in time, the furnace has to be blown out. In the ordinary smelting process the zinc is not recovered, but drowned out by working it off with a larger proportion of non-zinciferous ores. For this service to their customers, smelters make a fixed charge for each unit of Zn. in excess of 10 per cent. They can manage pretty well with 10 per cent. or 12 per cent., but if this is exceeded, they experience difficulties. The zinc contents, of course, are not recovered. Though zinc is not quite so volatile as lead, it carries off silver in the excessive fumes which it creates. Some silver enters the slag; some remains in the infusible sulphide. The Hercules ore would probably sustain a loss of a few ounces per ton.

Seeing that the recovery of the greater part of the zinc from such ores as these, poor in silver and lead, is practically indispensable to profitable mining, metallurgists and chemists all over the world have for several years been at work upon the problem—the zinc problem, as we call it here. Certain advances have been made in laboratory manipulation. Some of the experiments have answered very well from a laboratory or technical point of view, but when we inquire whether they can be utilised commercially for these Mt. Read ores, we find we are still condemned to an expectant attitude. These processes are, as a rule, not so satisfactory on a large scale as in the laboratory. The conditions surrounding the trials which have been

made have also to be taken into account. It does not follow that successful tests under the favourable circumstances prevailing in Europe will determine commercial results on the West Coast of Tasmania.

The enumeration of various processes which claim some measure of success will suffice to illustrate the close attention which has been paid to the subject. We have—(1.) Bartlett's system, (2.) Burnham and Fry-Everitt process, (3.) Greenway's dry process, (4.) Ellershausen's process, (5.) Wetherill magnetic process, (6.) Angel process, (7.) Ashcroft process, (8.) Marsh-Storer process, (9.) Gentle's process, (10.) Gitsham's process, (11.) Carmichael's process, (12.) Henrie's process, (13.) Worsey's process, (14.) Phœnix process, (15.) Siemens-Halskø's electrolytic process, and (16.) allied processes devised by Swinburne, Lorenz, and Cowper-Cole.

A few remarks upon some of these will be made here :—

(1.) *The Bartlett system* comprises two stages, in the first of which the ore is treated with an air blast, fumes being condensed which contain sulphide, sulphate, and oxide of lead, and zinc. The fume is roasted, traces of extraneous metals are driven off, and a product is left which consists of about 60 per cent. oxide of zinc and 40 per cent. sulphate of lead, forming a zinc-lead pigment. The second part of the process is the reduction of the remaining half of the zinc and a little lead and copper. A copper matte is produced, but nearly all the lead has been accounted for in the first stage. The remainder of the zinc contents is volatilised. It is stated that the loss of silver is 15 per cent. of the total contents. The principle, therefore, is to expel the lead and zinc in a form which can be refined into a zinc-lead pigment, and this is a disadvantage.

(2.) *Burnham and Fry-Everitt Process.*—The Fry process has, as a matter of fact, treated large quantities of Broken Hill silver-lead ore (20 per cent. to 35 per cent. lead, 25 per cent. to 30 per cent. zinc, and 30 ozs. silver). The ore is calcined, mixed with salt-cake, and then smelted in a blast furnace with a small proportion of iron oxide. 90 per cent. of the zinc passes into the slag, from which it is driven off as oxide in a Siemens' gas furnace. The lead is reduced, and the iron and sulphur form the

matte. About 70 per cent. of the zinc contents of the ore are stated as recoverable.

The Burnham Syndicate experimented with this system in 1897, and gave up their patent and works at Swansea to the Smelting Corporation in 1898. The process was examined by the metallurgist, A. Raht, who estimated the cost of treatment at £2 4s. 8d. per ton of ore, and that it was reasonable to look for a recovery of 70 per cent. of the zinc contents, 87 per cent. of the lead, and 90 per cent. of the silver. The drawbacks here are the cost and the inferior form, from a marketable standpoint, in which the zinc product is recovered.

(3.) *Greenway's Process.*—In this process the mineral is roasted with salt, and volatile chlorides, easy of condensation, are produced. Sodium sulphate is leached from the remainder, which is raised to 35-50 per cent. zinc, when distillation can be effected.

(4.) *Ellershausen's Process.*—This, the Sulphides Reduction (new) process, has been in operation on a commercial scale at the corporation's works at Llanelly, in Wales. Broken Hill sulphide ores (20 per cent. lead, 25 per cent. zinc, 10 ozs. silver) are smelted there in ordinary blast furnaces, the zinc (90 per cent. of it) being volatilised, together with a large proportion of the lead. The fumes are afterwards condensed and treated. The zinc product is, therefore, in the form of flue dust and deposit. The lead is recovered in the form of bullion; any copper present, as a low-grade matte. All these products have to be re-treated, which handicaps the process, if we wish to apply it to the Hercules ores. As the lead settles out of the zinc solution, a sodium sulphide solution is admitted to the latter, and zinc sulphide is produced. The sodium sulphate flows away, leaving the zinc sulphide, which is then converted to an oxide by roasting in a reverberatory furnace. The marketable product is, accordingly, in the undesirable form of oxide.

It is claimed that the cost of treatment is not more than 20s. per ton, but, while this may be the case in countries where sulphide of sodium can be produced cheaply, it is evident that it would be much higher in Tasmania.

The trials made with this process last year on Tasmanian ores at Angoulême, in France, were not altogether satisfactory, owing, it is alleged, to defective plant, and to the

final details of the method not being definitely settled. The experiment resulted in only a partial recovery of the metals, viz., 50 per cent. zinc, 60 per cent. lead, 60 per cent. silver, and 65 per cent. gold. I understand further improvements have been effected since then, and it may possibly be brought within the range of practical metallurgy. The progress of experiments will be watched with interest, for this is one of the processes which have been subjected to trial on a commercial scale.

(5.) *Wetherill Magnetic Process*.—This process aims at separating weakly magnetic minerals from non-magnetic ores, and in this way improving the residue as a zinc ore of marketable value. Zinc, iron, and manganese minerals can be separated, spathic iron ore and zinc blende. Rhodonite can be separated from blende. The process is especially suited for working in conjunction with concentration by ore-dressing machinery, and subsequent smelting. On the one hand, the blende can be raised to 40-45 per cent. zinc; on the other, the concentrates can be reduced from 10 per cent. to 15 per cent. zinc. It is obviously unsuitable for the Hercules ores.

(6.) *Angel Process*.—The principle of this system is to calcine the ore with sulphate of soda, and then to condense the volatilised zinc. The precious metals are concentrated in the reduced lead.

(7.) *Ashcroft Process*.—At one time this promised to be a success, but the Sulphide Corporation had finally to close down the leaching department in their works at Cockle Creek. The ore used to be roasted in reverberatory furnaces and leached with ferric chloride (and sulphate). It was then passed into electrolysing vats, but the liquor proved corrosive, attacking the pumps, and, consequently, a zinc sulphate solution had to be adopted. So many difficulties were found in roasting and leaching, and the preservation of the electrolyte, and the cost so great, that the process proved a commercial failure. The whole process is complex, and involves no fewer than 13 different operations. Precipitates and residues go to blast furnaces and refinery. Originally, the ore, after roasting, was leached out with sulphuric acid, and zinc sulphate produced, to which Zn O was added, afterwards decomposed by heat and Zn O resulting, two-thirds of which had to be returned for re-treatment.

(8.) *Marsh-Storer Process.*—By this system the ore is roasted, the zinc sulphate leached out with acid, and the zinc precipitated as a hydrate, which is afterwards calcined to oxide. The cost of magnesia as a precipitant is a drawback.

(9.) *Gentles' Patent—(Metals Extraction System).*—The inventor has died, but the system is not defunct. It is primarily a process for treating complex low-grade auriferous and argentiferous zinc or copper ores (or both). The copper pyrites is desulphurised, and soluble sulphate produced. Sulphuric acid is made, and used for treatment of the burnt ore in lixiviating vats. The resultant solution is then treated with chloride of lime, and the dissolved metals converted into chlorides, which are decomposed, the copper and iron being precipitated as an oxy-carbonate, and afterwards sintered and smelted. With zinc ores, the separation of copper and zinc in solution is effected by the addition of zinc oxy-carbonate, and the product can be brought up to a value of £14 to £17 per ton in England as oxy-carbonate, and if converted to oxide, up to £30. The copper, zinc, and sulphur thus being removed, auriferous and argentiferous lead remains. Cyaniding may be resorted to, or the gold and silver can be left in the copper for parting.

This process is not so well adapted for the zincy-silver-lead ores of the Hercules by themselves, but if these are mixed with the cupreous ore which occurs in the mine, the two classes form a description of ore which the method has in view. Sulphuric acid enters into the process, and this would be manufactured from the copper and iron pyrites.

(10.) *Gitsham's Process.*—The Australian Zinc Recovery Company, at Footscray, is working this with small parcels. It is understood to be a roasting and lixiviation process. Results on a larger scale are looked forward to.

(11.) *Carmichael's Process.*—This has a novel element in it in the form of sulphate of ammonia. It is understood to consist of (1) a preliminary sulphating roast, (2) calcination of the roasted ore with sulphate of ammonia, (3) the solution of the zinc and filtration from the smelting product, (4) precipitation of the zinc as oxide, and recovery of the sulphate of ammonia.

The roasting is conducted so as to produce as large a percentage of neutral sulphate of zinc as can be conveniently done. The roast is then mixed with sulphate of ammonia in the proportion required to furnish sufficient SO_3 to satisfy the zinc oxide and basic zinc sulphate in the ore. When the mixture is heated, it agglomerates at a temperature far below the dull red, and as the heat is raised, the anhydrous ZnSO_4 tends to consolidate the ore into a hard mass, which is the chief practical difficulty to be contended with. The calcined mass, when wetted, slakes readily. The residue, after the solution of the zinc, is filtered and washed free from ZnSO_4 with a filter press. This can be done, owing to the absence of gelatinous silica, which is such an obstacle in processes depending upon sulphuric acid for the solution of the zinc.

The solution filtered from the ore contains the zinc, with copper, iron, manganese. The copper is readily acted upon by sulphate of ammonia. If the ammonia gas evolved during calcination be passed through the liquor, the zinc is precipitated as a granular white oxide. The dilute sulphate of ammonia liquor is evaporated for the recovery of the sulphate crystals, and the residue of the ore briquetted and smelted as usual. 90 to 95 per cent. recovery of the sulphate of ammonia is said to be obtainable.

The price of sulphate of ammonia is higher now than it used to be, and would form a drawback in the case of the Hercules ores.

(12.) *Henrie's Process.*—This is a leaching process worked out by Mr. Henrie, the resident metallurgist at the Tasmanian Copper Company's mine at Rosebery. His experiments are reported to have effected a satisfactory recovery of gold, silver, lead, and zinc. The zinc is marketable in the form of oxide. Sulphuric acid has to be used. The process may be said to be still in its experimental stage.

(13.) *Worsey's Process.*—The Hercules directors have had some of their ore treated by this process, which is a humid one, but the result was not satisfactory commercially.

(14.) *Phœnix Process.*—This process has the great advantage of recovering the zinc in a metallic form. It

secures the decomposition of zinc sulphide "in an electrolyte of fused zinc chloride, sulphur vapour coming off at the anode, and metallic zinc at the cathode, lead sulphide being capable of decomposition in a similar manner. In the treatment of lead-zinc sulphide ores, as described in the patent specification, it is proposed to mix the pulverised ore with molten zinc chloride in a pot, and electrolyse, first, for the deposition of lead, and then, in a separate pot, for the deposition of zinc." From this description, the method appears to be a direct one, and not too costly, but there will no doubt be the usual difficulty of maintaining the electrolyte in a proper condition, and the antecedent difficulty in purifying the solution before it passes into the electrolysing vats.

(15.) *Siemens-Halske Process*.—This agrees in principle with the Ashcroft process, but is not so complicated. The ore is roasted and leached with sulphuric acid, or an acid zinc-sulphate solution, and the resulting sulphate of zinc solution electrolysed. Iron pyrites are almost a necessity. Difficulties are present in the condition of the electrolyte.

(16.) *Swinburne's, Lorenz, and Cowper-Cole's Methods*.—These are all electrical processes for dealing with these ores, worked out with considerable ingenuity. They are subject to practical separation difficulties, and are too costly for installation on the Hercules Mine.

Other processes have been devised, but the above are such as have attained any degree of importance. The principle which underlies most of the humid methods is roasting to form sulphate of zinc, and leaching it out in solution. The next step is to precipitate the zinc by either lime, soda, or magnesia. In practice, enormous difficulties are encountered: all the zinc is not changed into sulphate; the iron is not kept entirely out of the sulphate solution; gelatinous silica forms; etc.

I could not undertake here to discriminate closely between these different processes. Some of them are quite out of court when considering the Hercules ores. Others which are less disadvantageous would have to be tried on a fairly large scale, and the owners of this mine are not in a position to afford expensive and uncertain experiments, which might involve the company in irretrievable disaster. On reviewing the history of the several methods, it is apparent that though certain

difficulties have been, I will not say entirely, overcome, but minimised in the laboratory, a commercial process is still a desideratum. After all the experiments, I fear we are as far off as ever from the solution of the difficulty of recovering the zinc successfully from this ore. I do not refer to technical success, but to commercial results.

During the last twelve years the production of spelter has increased by 50 per cent. Additional uses have been found for it in electrical science, and the cyanide treatment of gold ores is also partly responsible for an increased demand. According to Merton's list, the world's production of spelter in

1890 was	.....	342,616 tons
1893	..	371,059 ..
1896	..	417,460 ..
1898	..	436,202 ..
1899	..	460,895 ..

A sudden solution of the zinc problem would undoubtedly depress market prices, and seriously upset present estimates of costs and returns.

It seems to me that in pursuing a waiting policy, which was justifiable while experiments appeared to be on the eve of success, the Hercules Company is locking up a large portion of its resources for an indefinite period, and that it would be preferable to make some arrangement with the Zeehan smelters for the conversion of the lead sulphide ore into cash. As said above, this ore can be smelted by diluting it with less rebellious ores, and it would be a pity if the mine-owners and the Smelting Company could not arrange matters on a workable basis, even if the profit be less than mutually anticipated. If such an arrangement is not practicable, the only alternative is to leave this ore intact, and wait till the solution of the zinc difficulty has advanced to a stage permitting its exploitation to be resumed. But it is only right to warn the owners that no immediate practical solution is in sight.

Last year, ore consisting of copper and iron pyrites was met with, in a course 40 feet long, in the south drive from No. 3 tunnel, of an average assay value of 6 per cent. copper, mixed with a small proportion of zinc blende. The north drive from No. 4 tunnel came subsequently

below this occurrence, and the body of ore was found to widen out to 20 feet and extend for about 80 feet in length. The No. 5 tunnel at 550 feet entered schist with impregnations of copper pyrites; from 670 to 700 feet it passed through cupriferous schist, carrying bands of iron and copper pyrites, some of it payable (up to 5½ per cent. copper). At 700 feet this formation was explored by N. and S. drives, which showed copper ore to exist in payable quantity for 60 feet in length.

This ore is sometimes very clean. A rich sample, assayed by the Government Analyst, returned 14 per cent. copper, 0.5 per cent. zinc. The average contents seem to be about 6 per cent. copper for fair quality ore. The assays stated by Mr. Sydney Thow are:—

From	Silver.	Gold.	Lead.	Copp'r	Zinc	Iron	Insol.
				%	%	%	%
No. 4 tunnel	1 oz. 13 dwts. 5 grs.	8 grs.	—	6.2	3.7	34.4	12.0
No. 5 tunnel	1 oz. 0 dwt. 15 grs.	11 grs.	—	6.3	—	22.1	36.2

Altogether, a belt of country exists, 140 or 150 feet wide, more or less cupriferous, payable at intervals; in one instance, from 10 to 20 feet being of this nature.

The task of the company will now be to develop this discovery, of so much importance for the welfare of the mine, and to assure itself of the existence of this kind of ore in sufficient quantity to justify the erection of smelters. Drives N. and S. on the best part of the ore-course will prove its longitudinal extension, and rises and sinks will test its vertical behaviour, though not quite sufficiently without a lower tunnel.

The occurrence of the copper ore is in every way similar to that of the zinc silver-lead ore, of which such a large quantity has been exposed. Looking at the usual mineral character of the schists on this range, the zincy silver-lead ores seem exceptional, while copper is the more staple metal. From indications elsewhere on Mt. Reid (Ring River), I think it very likely, though I can furnish no explanation, that the zinc-lead sulphide will generally be replaced at lower levels by copper ores; and, if this is found to be the case with the Hercules Mine, the prospects of ultimate success will be much better.

The gossan ore can be worked off slowly in smelting the pyritic ore by adding it in quantities moderate enough to avoid too rapid reduction and consequent enrichment of slag, or it can be disposed of to the local smelters, as the company may find more advantageous; in any case, the quantity of it estimated to be in sight is a sound asset, and can be turned to account in one way or the other.

Sullivan's Reward.

Between 500 and 600 feet above the No. 5 tunnel, and on the crest of the hill to the east of the mine, is a large ferro-manganese quartz blow, which has been taken to be the outcrop of a lode. On examining it, I found it to be country schist of a very quartzose nature, gnarled and rough, which, with its iron gossan, may be pardonably mistaken for lode capping. Traces of gold are said to have been found in it, but no other valuable mineral. The outcrop is conformable in strike and dip to the enclosing strata, viz., strike N. 20° W.; dip, N.E. 70°.

East Hercules.

The mine is in the valley E. of Mt. Hamilton, just E. of the small creek at the foot of the hill. A shaft has been sunk about 40 feet in green chloritic schist; the pile of schist at surface obtained from the shaft and drive shows the rock to be faced and impregnated with copper pyrites. A heap of three or four tons of ore at shaft-mouth looks as if it would yield fully 4 per cent. copper. The change in the country-rock which has occurred at the creek is favourable for this metal. Unlike the Hercules schists, this chlorite schist has been originally an eruptive rock, probably a quartz felsite.

The small creek is a tributary of the Ring River. The mine is in a very awkward place for getting working supplies. It could best be worked from the No. 2 tunnel of the Hercules by extending that through the hill. Its geological position is favourable for ore, and I anticipate that some day it will be taken in hand again.

Mount Reid Mine.

Section 3302-87M, 80 acres. The British Mt. Reid Co. (Mr. Luke Williams, General Manager), is carrying on work

here, both quarrying and mining, on a large body of zinc lead-copper sulphide ore. The workings have been described so often that I need not repeat uselessly. I was taken over the mine by Mr. Luke Williams, who afforded me every opportunity of investigating it geologically. By this means I was shown that the ore-body is a huge, lenticular mass of sulphides, between 800 and 900 feet in length, tapering out towards north and south. The greatest width of the lens at the surface is 83 feet. At the open cut at shaft the width is 50 feet, but 27 feet below, it has widened to 74 feet. It is here interstratified with quartzite right across, and is occasionally a very dense sulphide. The fahl ore in the quartzite is considered rich. It is worth noting that the hanging-wall of this body always carries the richest ore.

The deepest level has a present depth of 150 feet from surface, but is called the 300-foot level, because at the south boundary it will give that quantity of backs. The drive is just about half-way through the block now, and will be driven 1,800 feet further to the south boundary-line. There is a run of 140 feet very dense sulphide ore, which has been crosscutted 26 feet, with no sign of a foot-wall yet. A 50-foot winze has been sunk on the underlay, with good ore down to 35 feet, after which lower-grade sulphides prevailed. A rise has been put up to the next level, 27 feet above, for stoping back on good smelting ore. There is a good deal of quartz along this level.

The face in the south end of main drive, not being worked, is in a mixture of solid sulphide and mineralised schist, not so good as seen further back: schist on each side of the drive. The surface width of the ore-body some 150 feet further south of this is 25 feet. The schist inside the apparent walls is still mineralised. Work has been discontinued till the arrival of air-compressors. Crosscuts are required here to prove the width of the ore lens, which I take to be narrowing rapidly, and will probably pinch out completely within another 150 feet.

No. O bench was being worked in red gossan, containing up to 33 ozs. silver and $\frac{1}{2}$ oz. gold per ton. The darkest red is the best matrix. Manganese is present, and cerussite crystals, with sulphate of copper, occur. The N. end of cutting is about 12 feet wide, the formation widening to 80 feet. 634 tons sent to the Zeehan smelters.

98/14

contained $\frac{1}{2}$ oz. gold, 18 ozs. silver, and 2 per cent. up to 5 per cent. and 6 per cent. lead per ton. No. 1 bench was not working. The schist here has some galena, but is poor. No. 2 bench was going to start. It is in siliceous schist, containing good grade ore. No. 2 prospecting shaft is about 14 feet down, in quartzite and schist, carrying some good dense ore, assaying 7 dwts. 20 grs. gold. No. 3 prospecting shaft (also called No. 14) is down 20 feet. A bulk assay from the pile returned 13 dwts. 1 gr. gold, 9 ozs. silver. No. 4 shaft (also called No. 15) is down 29 feet, and its ore, obtained by chipping the wall, returned 12 dwts. gold, 17 ozs. silver. At 20 feet down, the ore-body proved to be 25 feet wide. This is ahead of the end of tunnel. 25 feet further south Williams' shaft, No. 18, has proved the ore 10 feet in width, which has been driven on for 40 feet to within 10 chains of the south boundary. The ore is banded. Beyond this to the S. no work has been done.

About 40 hands were employed on the mine, and Mr. Williams kindly informs me that the total tonnage of sulphide ore sent to the Tasmanian smelters up to the 31st March was 2457 tons, of an average assay value of 5 dwts. 4 grs. gold, 20 ozs. 15 dwts. 4 grs. silver, 6.8 per cent. lead, 25 per cent. zinc. Gossan ore for same period, 632 tons, assaying 9 dwts. 21 grs. gold, 18 ozs. 17 grs. silver, $4\frac{1}{2}$ per cent. lead. Mr. Williams further furnished me with the following return of ore sold to the smelters for the quarter ending June 30th, viz.—1019 tons, containing 7 dwts. 16 grs. gold, 16 ozs. 12 dwts. 19 grs. silver, 10.8 per cent. lead, 0.78 per cent. copper, 23.9 per cent. zinc.

Over 500 tons of ore-bulking, 40 per cent. zinc, have been stacked on the mine. It is intended to develop the mine vigorously with rock-drills (worked by an air-compressor), to break down large quantities of ore, to send the suitable descriptions to the smelters, and to decide upon some treatment for the bulk of the stuff.

The New Palace Blocks, 121 acres, are those on which air-compressors and a large concentrating plant are to be fixed. The ore from this plant will be run direct to the Williamsford Railway, and so to the smelters. I feel doubtful as to the advantage of submitting these ores to concentration. Some of the ore exists as a double



MT. READ MINE AND TOWNSHIP.

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sulphide of lead and zinc (huascalite), which cannot be separated by dressing. Much of it has its constituent minerals too intimately blended to suffer perfect separation, and imperfect separation means loss of the precious metals. Concentration tests have been carried out in the Silver Queen, Oonah, and Montana mills, at Zeehan, on upwards of 200 tons ore. 102 tons dressed at the Silver Queen assayed, before treatment—gold, 2 dwts. 15 ozs.; silver, 5 ozs. 3 dwts. 5 grs.; lead, 7.1 per cent.; zinc, 19.4 per cent.; copper, 0.37 per cent.; iron, 14.1 per cent. The jig tailings, which comprised ore sized up to $\frac{1}{2}$ -inch diameter, assayed—gold, 1 dwt. 23 grs.; silver, 5 ozs. 9 dwts. 2 grs.; lead, 5.9 per cent.; and this, as Mr. Luke Williams remarks, proves that practically no concentration takes place with this coarse crushing, but that finer crushing does result in a certain release of the minerals is shown by the assays of the Frue Vanner concentrates—gold, 9 dwts. 4 grs.; silver, 20 ozs.; lead, 36.3 per cent.

100 tons ore were put through the Oonah mill, assaying, before treatment—gold, 2 dwts. 15 grs.; silver, 6 ozs. 9 dwts. 7 grs.; lead, 9.2 per cent.; zinc, 19.8 per cent.; copper, 0.40 per cent.; iron, 16.41 per cent. Exhaustive assays of the products were made, proving a concentration of gold contents, heavy concentration of silver and lead, increase of copper contents by 50 per cent., a slight concentration of zinc, and a decrease, *i.e.*, separation of iron. Progressive concentration took place in the slimes. The Silver Queen and Oonah slimes treated on the Montana Wilfley table showed irregular concentration. The results of these elaborate trials show that concentration to a certain extent can be effected, but information is still needed as to the amount of loss which takes place in the operation, as this is the crux of the whole matter.

The same difficulty which confronts the Hercules proprietors in the treatment of zincy ores applies to this mine also. There is no reasonable doubt as to the large quantities of ore available, but a profitable zinc process is still a desideratum. In the meantime, the company is doing the only thing which can be done under the circumstances, *viz.*, sending ore for reduction in the smelting furnaces at Zeehan. The work at the mine is being ably and vigorously carried out.

101/114

Dunne's Mount Read Mine.

Sections Nos. 164-93M, 19 acres, and 218-93M, 44 acres. This property is adjoining and south of the Mount Reid Mine, and the line of the main ore-body on the latter property enters Dunne's Blocks. The rock formations on the two estates are identical, and the sulphidic belt continues through both blocks, as, indeed, it does through the Hercules property also. It must not be assumed, however, that the ore-body is continuous through all these properties. This is not the case, as was specially seen, with unfortunate results, on the South Hercules section. The ore makes in lenticular masses, wedging out within certain distances and making again further along, often not on the same strike, but parallel to it, *en echelon*; so that really nothing further can be said than that the metalliferous schists prevail on all these sections, and each property must stand on its own merits.

Unfortunately no work was being done at Dunne's when I was there, and I could only notice the pyritic schist lying about at the mouths of the two prospecting shafts. There are great facilities for deep tunnelling. The indications are that the ore will be similar in character to that of the Mount Reid; but nothing very definite can be said as to quantity in the present undeveloped state of the mine.

RED HILLS DISTRICT.

The mines in this field are in the country to the southeast of Mount Read, and can be approached from the Mount Read mines by an old foot-track over the summit of that mountain, 3800 feet above sea-level, through button-grass moors and thin scrub. None of the mines at the Red Hills were working when I was there, but since I have returned work has been resumed at the principal mine, the Red Hills. Subsidiary mines are North Red Hills, South Red Hills, Red Hills Proprietary, and the Moxon. A good bridle-track from the White Spur, 7 miles, may also be used in making this journey. The inclement weather on these high ranges prevented me from visiting any other than the Red Hills and Red Hills Proprietary, about six miles from Mount Read.

In proceeding east from Mt. Read, we appear to leave the Read argillitic schists, and traverse chloritic schists

and quartz felsites. The argillites are confined to the west slope of Mt. Read, at the summit of which green chloritic schist prevails. All these rocks have an easterly dip, which continues on descending the eastern slope. On this side there are compact felsites, sandstones, and schists, till we ascend the north end of Rob's Lookout, which is also the north end of the Tyndall Range, about a mile west of the Red Hills blocks. The rock here begins to dip west, and turns to massive pink quartz-felsite, which forms the eastern slope and stands up in bold cliffs on the crest. East of this, chloritic schists occur, then slate, also with westerly dip, just above the Red Hills Camp, 2000 feet above sea-level. Lakes Westwood and Julia lie about a couple of miles south, having the aspect of tarns occupying rock basins in glaciated country. Despite these suggestive lakes and the general appearance of the country, which is in harmony with the former occurrence of a glacier epoch, I could find no direct evidence. No *roches montonnées* are to be seen, and the numerous large boulders may have come to occupy their present position by gravitating down the adjoining hill slopes. They do not look waterworn, nor do they appear as if they had travelled any distance. The surrounding hills are composed of grits and conglomerates (Devonian?) resting unconformably on quartz felsites and chloritic schists, and this upper formation has been greatly denuded. The denudation has liberated enormous boulders of conglomerate, which have simply fallen down to positions of rest. The conglomerate is part of the widespread beach formation which caps so many mountains on the West Coast, and always overlies the Silurian slates and schists. Its exact age is not settled, but it is probably Devonian or at the base of the Carboniferous. It is usually horizontal, but, occasionally, is slightly arched. The Red Hills, which is a flat-topped ridge, bearing a few degrees west of north, consisting of quartz felsites and chloritic schists dipping W. and rising to 2600 feet above sea-level, were once covered with the conglomerate, and the felsites can be seen east and west passing beneath it. This fact indicates that the removal of the conglomerate was not completed so very long ago, and that the felsite has not suffered much from denudation. As the ore deposits do not extend upwards into the conglomerate, the process of

mineral deposition took place, probably, prior to the Devonian. Sometimes the blebs of quartz in the felsite are abundant and well defined; or the rock is non-porphyrific and homogeneous to the naked eye. When well preserved, porphyritic crystals of pink feldspar are visible, and the hue of the rock is dark brown or reddish. To this is due the name Red Hills. This reddish colour changes to green with the development of chlorite, and where the rock has been crushed and foliated, the processes of dynamic metamorphism have converted it into a dark green chlorite schist. Viewed microscopically, porphyritic crystals of feldspar still survive in the most densely chloritic rock, and I am strongly of opinion that the chlorite schists of this district are metamorphosed felsites, though the physical change is so great that, at first, it is difficult to believe both to be the same rock.

Red Hills Mine.

The sections comprise 485 acres to the south of Mt. Murchison, and the mine works have been carried on upon a broad flat hill, 2700 feet above sea-level, called the Red Hill. The hill is about three-quarters of a mile long, one-quarter of a mile broad, and bears a little west of north. A large outcrop of hematite, averaging 150 feet in width, and occurring in quartz-felsite, traverses Sections 954-93M and 714-93M. Its linear extension is in the same direction as that of the felsite belt. It is often soft and earthy, sometimes more solid, and on Section 714 I noticed it was magnetic. It contains crystals of feldspar, and, to my mind there is little doubt that it is a replacement of the original felsite. As the original rock is an igneous one, there can be no reference of the hematite to any ancient lake bottom, and as the feldspar crystals themselves are occasionally seen partly converted into hematite, it must be inferred that the latter has not resulted from the oxidation of pyrites, but has been deposited by way of substitution. If this process is established for a typical area of ore deposition in the West Coast range, it is probable that further instances of it will be found along the same mineral belt. This belt of quartz-felsite rock, with bodies of hematite and magnetite, and containing pyritic copper ore distributed with some

irregularity through its mass, is continuous in an unbroken line from Mt. Farrell in the north to Mt. Darwin in the south, and forms the backbone and crests of the range (often capped with the later conglomerate). It passes at the back of Mt. Murchison, through Mts. Tyndall, Huxley, Jukes, and Darwin, and its characteristic features, from a mineral standpoint, are the constant occurrence of masses of iron oxides and copper sulphides. Up to the present the copper ore has not been found in sufficient quantity to form any payable mines along this belt, but there is no saying what continued prospecting may not result in. There is no use in comparing it with the Mt. Lyell copper deposits. It is not on the same strike, but lies between the Mt. Read series on the west, and the Mt. Lyell schists on the east. If we could be sure of its age, and of the eruptive, or rather, intrusive nature of the felsite, it might be possible to formulate a theory connecting the copper deposits of the flanking schists with the igneous felsite as a source. But these questions are unsettled. There is a good deal of evidence in favour of the felsitic rock having been a lava flow, contemporaneous with the schists, and subjected, with the latter, to later foliation and mineralisation. Further examination may be expected to throw more light on this interesting point. The students at the Zeehan School of Mines have a grand field open to them in the investigation of the relations of these copper and iron bearing felsites to the cupriferous schists as well as to the associated granite.

On Section 954 two tunnels have been driven by the company from opposite sides of the ridge, one N. 85° E., and the other S. 85° W. The former is the No. 1 west tunnel, the latter the No. 2 east tunnel. The distance to drive right through the hill would be about 1500 feet, and the backs above No. 2 tunnel (100 feet lower than No. 1) are mostly between 180 and 200 feet vertical. If either of these tunnels is driven right through the hill it will intersect the lens or body of hematite. No. 1 west has been driven 104 feet in dark green chlorite rock, which I take to be a modification of the quartz-felsite. The tunnel is a little shallow for good prospecting: the present end is not more than 30 feet below the surface, and it would never be over 100 feet in depth. No. 2 tunnel E.

has been driven 77 feet into the hill, and, if continued, as it ought to be, it will cut into the hematite at a good depth, and enable the contact line to be explored. Some copper and iron pyrites are in the rock at the approach, but these disappear further on in the drive, and the end is in barren, dense felsite. It will take nearly 400 feet of driving to get under the line of hematite outcrop, but until the footwall of that formation is reached, there is no need for despondency. The tunnel may or may not cut across hidden ore-bodies in its course, but its objective is the hematite, and its purpose is not attained until that is reached, and the footwall country well tested. The trend of the hematite, N. 20° W., is the same as that of the laminations of the country-rock, wherever the latter is at all schistose.

No. 3 east tunnel, driven S.W. 57 feet in rather soft chloritic rock, is on the north section, just below an outcrop of hematite and magnetite, but is not more than 30 feet below surface, and will not increase its backs by additional driving. It carries a little copper ore, and has been sampled in 10-foot sections, but, all through, assays of under one per cent. were obtained. The end is in soft green chloritic rock, with a good deal of iron pyrite.

At the S.W. end of the hill is No. 2 tunnel west, driven 157 feet N.E. below a series of benches which have been cut in the face of a ravine, descending from the button-grass flat above. The country-rock is dark green chloritic felsite, impregnated here and there with iron and copper pyrites. It is massive, with cross-jointing, which gives a delusive appearance of horizontal bedding. The tunnel has passed through hard, dry, unpromising rock. Just behind the face it is jointed into flat floors, and grows softer. The sole encouragement is the softer nature of the rock. It has nearly come below No. 2 bench (140 feet above), which has a face of dark green chloritic rock (not quite so hard as elsewhere), showing nice patches and veins of pyrites in the joints and the rock mass. No. 1 bench is higher up, and is in the same rock as No. 2, only it has less copper, being very slightly impregnated. The tunnel would get here 200 feet of backs for an equal distance of driving. This ore is a good bit west of the hematite, and seems to be part of a chloritic ore-bearing zone running along the western slope

of the hill. About 400 feet to the west of these benches are the mine butts and office, which are on a belt of slate; consequently, this line of country, well sprinkled with copper pyrites, lies along a contact margin, though its intrusive nature is very uncertain. The No. 1 west tunnel probably passed through the last of the bench line of mineral at its approach, and left it behind to the west.

Last year a Melbourne option syndicate carried on exploratory work for six months, spending £1500 on the property. At the expiration of the term they withdrew, finding the results unsatisfactory. Their principal work was at the north end of the ridge, where trenches and open cuts exposed good copper pyrites. A No. 1 north tunnel has been driven N.E. a little over 100 feet, which, if continued, would get 100 to 150 feet backs. This tunnel has a good band of ore at the approach and in the open cut above it. Two pyritic quartz veins intersected in the tunnel have been driven upon a short distance south. The south drive on No. 2 vein is in rock, slightly disseminated with pyrites. This drive is 36 feet from mouth of tunnel, and has been driven 22 feet. The drive on No. 3 vein is 75 feet from the approach, and is 51 feet in. The end is in barren chloritic felsite. The drive hugs a quartz vein on the E. side, behind the face. At the entrance to the adit a winze was sunk 40 feet, and a crosscut driven east into a body of ore represented by a small pile stacked at surface. There are also here two stacks of ore won from the first 70 feet of the tunnel, mostly from near the entrance. The first-class ore comprises a heap of about 40 tons, and the second-class about 200 tons. The published bulk assays of these heaps are: first-class, 4.9 per cent., and second-class, 2 per cent. copper. Some selected pieces from shaft and crosscut returned 22.1 per cent. and 16.4 per cent. copper.

Numerous assays have been made of bulk samples from the different workings on the property. As might be expected, they vary greatly, and unless they are based on workable quantities of ore, do not give any really important results. Bulk assays have been made from the south benches and No. 2 west tunnel, showing considerable variations. Thus the assay of the first 12 feet across No. 2 bench was 1.7 per cent. copper, and of the second 12 feet 2.1 per cent., while the average of the country all through

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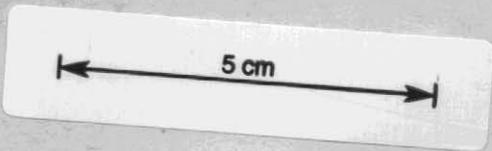
these benches was only 0.48 per cent., and the average of the tunnel 0.252 per cent. The average of the ore-body at entrance to tunnel No. 1 north was from 4.15 per cent. to 5.1 per cent. copper. Clearly, payable quantities have not yet been met with, and the undertaking simply resolves itself into a large prospecting proposition. The prospecting carried out by the option syndicate comprised the following:—Two open cuts N., shaft at No. 1 N. adit, crosscut from shaft, continuation of No. 1 N. adit, driving on two veins intersected by adit, continuation of No. 2 tunnel W., and a little work on No. 2 bench S.

No prospecting has been done along the trend of the hematite, and, looking at operations as a whole, I should say that too little driving on the course of the ore-belt has been done in proportion to the amount of crosscut tunnelling, though the latter also is quite insufficient for the proper testing of the property.

No. 3 tunnel E. could be continued W., and then a drive extended south with any quantity of backs. There is a band of chlorite schist with quartz S.E. from Nos. 2 and 3 open cuts which might be explored. Above all, the hematite line must be prospected by continuing No. 2 east tunnel, and driving along the footwall of the iron ore-body. This line is the one which offers most chance of success. Since my visit a little exploratory work has been continued at the north end, I am told, with promising indications. Of course, there is a possibility that an ore-body may make anywhere in this felsitic country, and one may be struck haphazard at any time when least expected. But, reasoning from analogy, the ore is more likely to occur in the neighbourhood of the concentrations of iron than at a distance from it, and a programme of thorough prospecting ought to take account of this probability. This has not been done, and the present unsatisfactory state of things is the result. The property, in its actual imperfectly developed condition, does not excite any very sanguine hopes, nor, on the other hand, does it deserve utter condemnation. It will probably stand or fall with the whole of West Coast range south of Queenstown, where the conditions for ore depositions are identical. The same country-rock, the same hematite and magnetite masses, the same general absence of true lodes, the same disseminations of iron and copper pyrites through the rock-mass

RED HILLS MINE
SKETCH MAP

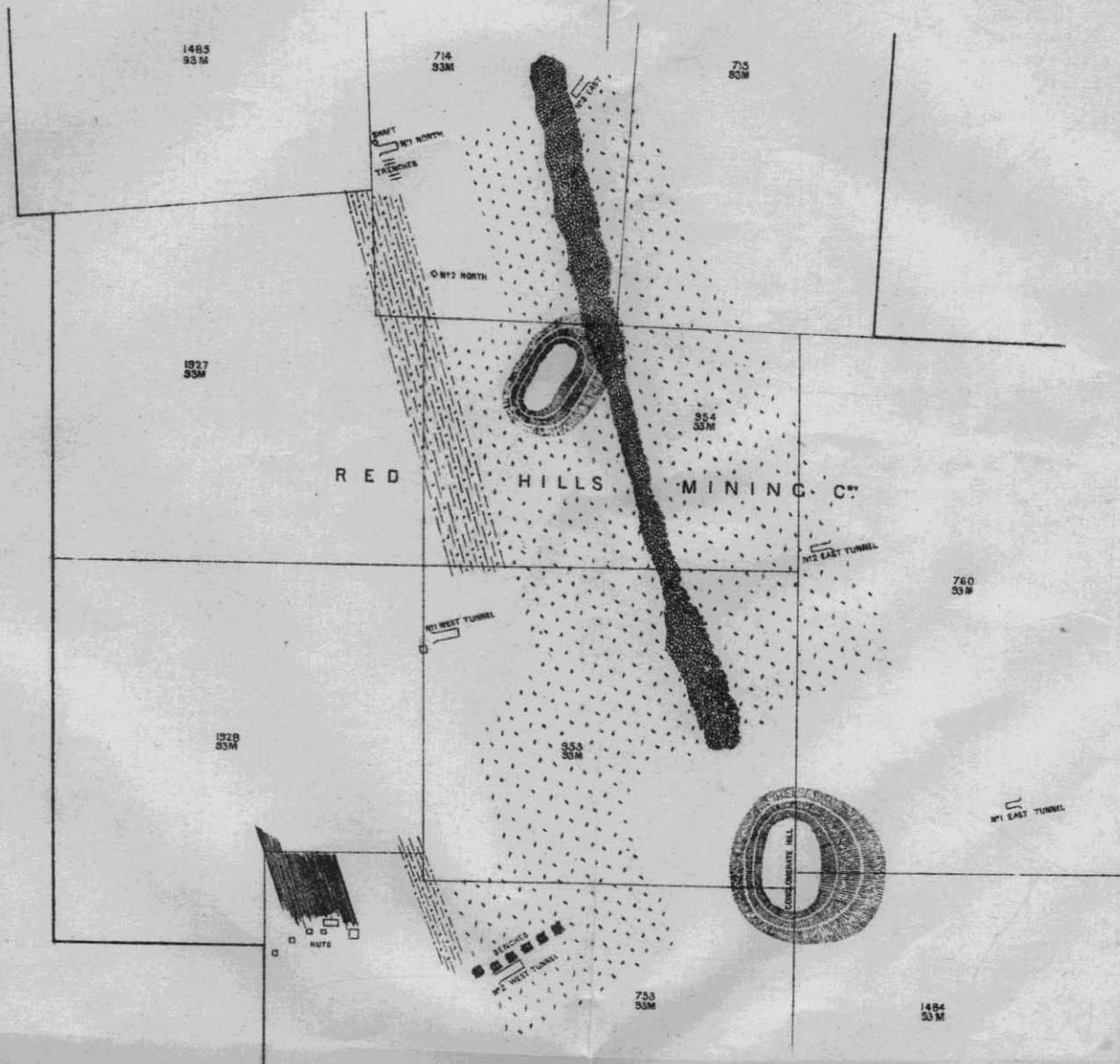
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Scale 0 100 200 300 400 500 600 700 800 900 1000 Feet



W. H. Twiss
Gov. Geologist
October 1900



exist there as here, and the suggestion that more profitably concentrated deposits of copper ore exist somewhere within reach seems a reasonable one. Consequently, continued judicious prospecting appears to be perfectly justifiable. My thanks are due to Mr. Hy. Castle, the manager, who took me over the property in stormy weather.

Red Hills Proprietary Mine.

Section 1325-93M, 40 acres. This is S.W. of and adjoining the Red Hills property. A quartz outcrop is visible on the top of a N. and S. hill of quartz-felsite rock. About 70 feet down, a tunnel has been driven into the hill E. for 40 feet, but has a long way to go yet before it can intersect any vein below the surface outcrop. The felsite joints have a general dip to the W., and the rock is impregnated with a little pyrites and galena, especially along the bottom of the tunnel. West of this tunnel the felsite becomes laminated, and further west chloritic schist, the westerly dip continuing. Across the flat to the W. is a heavy capping of bedded conglomerate.

South Red Hills.

The felsitic rock of the Proprietary spur continues south into this property, and has been trenched and prospected without satisfactory results. The section is now lying dormant.

Mt. Tyndall Copper Mine.

Section 3709-93M, 80 acres, at Mount Tyndall, Mr. M'Peak, Manager. The mine is on the W. slope of the mountain, seven miles S.E. of the mines on Mt. Read. The country is the contact of the Red Hills quartz-felsite with green schist. Button-grass hills and gum forest surround the mine, which can be approached from Mt. Read by the Tyndall track—available for horses. The mine is about 640 feet above sea-level.

A large quartz lode, carrying clean galena, blende, copper and iron pyrites, crosses a creek in a direction N. 15° W., and dipping N.E. Its exposed width is about a chain, including bands of the quartz-felsite rock interstratified with it. It has been trenched for about 300 feet along its course. It is mainly in the felsitic rock, but towards the south shaft it seems to be along, or very near, the

contact of that rock with the schist which is seen on the west bank of the creek, and continues further west below the house. From its position it is permissible to judge the ore-channel to have been influenced by this contact.

A north shaft has been sunk on the east side of the creek, 46 feet deep, but had been stopped, owing to heavy water, and was about to be unwatered when I was there. This has since been done, and, at the 60-foot level, a cross-cut is going west through the lode, showing some galena and copper pyrites. Another shaft, 230 feet south of the previous one, has been sunk 38 feet, and a crosscut W. into schist intersected a little galena and copper ore. I fancy the main part of the lode lies to the E.

The minerals met with in this lode, so far, are clean and solid. They are not blended with each other in the way prevalent in the zinc sulphide schists, but are clean, bunchy, and scattered, after the fashion characteristic of the quartz-felsite zone. From my observations of the mineral deposits of this zone, I believe, notwithstanding the handsome galena ore which has come from the Tyndall lode, that the staple mineral will be copper pyrites. Too little is yet known of the behaviour of ore deposits in the felsite belt to dogmatise on the probable character of the lode in depth. In such a siliceous rock, the origin of the lode quartz is uncertain. At the first blush it looks like the filling of a fissure, but, bearing in mind the occurrence of scattered copper pyrites in the country-rock for miles along this belt, the veins might just as well be the result of segregation. It is of no use to compare this mine with mines in the schist belt, for the latter are not parallel cases.

We have, as yet, no properly productive copper mine in this felsite belt, but the copper ore which I saw at Tyndall was nice-looking, and went 25 per cent. copper and 3 ozs. silver per ton. The galena, too, was inviting, but I do not anticipate this will be a permanent ore. A sample, assayed by the Government Analyst, returned 51.82 per cent. lead, 19 ozs. 12 dwts. silver per ton. Mr. J. R. Booth's assays were 70 per cent. lead, 30 ozs. silver; and 81 per cent. lead, 50 ozs. silver. The company's published assays by Mr. Ahern are—lead, 82.5 per cent.; silver, 51 ozs. The average ratio of silver would thus be about $\frac{1}{2}$ oz. to the unit of lead—a good deal lower than the proportion ruling in the productive Zeelian mines.

This lode should be well tested. If operations here prove successful, useful guidance will be furnished for the exploration of other points in this cupriferous zone.

Eden Coal Mine.

Coal measures have long been known to exist along the Zeehan-Strahan Railway line. Last year, while dragging piles for the Strahan wharf to the railway, to the south of the Eden station, a small seam of impure clod and coal, about 4 inches thick, was disclosed in the bush track half a mile west of the line. It was overlaid by surface clay, and was associated with greenish micaceous grit and sandstone belonging to the lower coal measures.

The coal has been analysed by the Government Analyst, and contains :—

				Per cent.
Fixed carbon	...	...	...	61·6
Ash	...	...	...	10·5
Gas, etc.	...	...	...	26·5
Moisture	...	...	...	1·4
				<hr/>
				100·0
				<hr/> <hr/>

It is a caking, quick-burning coal, and has been favourably reported on at Lyell. The fixed carbon is rather low, and the ash a little high for a first-rate coal, but really good samples have not been available.

The dip of the seam is towards the N.E., at a low angle, and a trench dug while I was there higher up the hill to the N., about 100 feet from the track, showed, below the subsoil, indications of coal in the same strata. A small prospecting shaft was sunk here 50 feet, in green micaceous sandstone, containing imprints of fossil leaves and carbonaceous markings, with a few pebbles here and there. It passed through the following indications of coal :—At 30 feet down, a small 1-inch seam; at 38 feet, a 3-inch seam, tapering off to a mere track at east side of shaft; at 40 feet, a 1½-inch to 1-inch seam, thinning out on E. side; at 45 feet some clod.

The bottom is in grey greenish sandstone. The seam met with at 38 feet is probably the one uncovered in the track, and is useless. The syndicate, therefore, may be said to have accomplished their object, and definitely proved the nature of the seam found at surface. Having done this, they naturally decided to spend a little more money in testing the ground still deeper by means of boring. They put down a bore not far from the shaft, and passed through two of the small seams already intersected, but work has recently been suspended for want of funds. The boring enterprise is a perfectly legitimate one, and there is no geological reason for stopping it before the Silurian strata are reached.

Southwards along the railway to the Henty River the country consists of white and light-coloured sandstones, belonging to the Permo-carboniferous system. North of the Henty, under the white grit, is soft, dark brown, clayey shale, full of plant impressions, among which I noticed a frond of *Neggerathiopsis*, a familiar plant of our lower coal measures. Between this and Eden there is a tract of such country at least two miles square, and I believe it highly probable that the measures extend southwards to Strahan below the Tertiary sands, which form the superficial covering of this area. Along the railway line are spots which could be selected for boring with the diamond-drill. Seeing how important a coal discovery would be for the whole of the Coast, it seems desirable to risk some expenditure, and see whether concealed seams do not exist in these strata. Without such a test, it can only be said that there are here beds belonging to the Tasmanian coal epoch, and in which coal may be quite reasonably expected to occur.

CONCLUSION.

I ought not to terminate this Report without referring to the smelting works erected a couple of miles south of Zeehan by the Tasmanian Smelting Company. As Mr. Max Heberlein, their General Manager, has lately furnished a detailed description of the works, I need not do more than emphasise the important assistance which this establishment has given to the mining industry of Zeehan and neighbourhood. Its proximity to that mining

centre enables several mines, which would otherwise be heavily handicapped, in getting their products to market, to sustain their output, and contribute to the mineral revenue of the district. Some of the increase in quantities exported may be fairly credited to the establishment of these works.

The Emu Bay Railway Company may also be expected to constitute a factor in the development of the resources of this part of the Island. Its line will be open to Zeehan at the end of this year, and will contribute in various ways to the general welfare.

As bearing indirectly on the progress of the fields, mention may also be made of the Zeehan School of Mines and Metallurgy, upon which I have reported elsewhere more particularly. This laudable institution, under the direction of an indefatigable committee and Messrs. Waller Bros., imparts instruction to about 40 students annually, with the intention of equipping them in assaying and metallurgy, or qualifying them for posts as mining managers. It has been doing good work, and the growing demand for its tuition is now compelling the committee of management to decide upon the erection of a larger building, towards which the Government will contribute £1000, conditionally on the remainder of the required sum being raised locally, which, thanks to the public spirit of the district, has been almost done.

In conclusion, the present state of the mining industry in this part of the Coast is both gratifying and promising. There is a steady increase in the volume of the output, and fresh ground within the borders of the field is being worked. In several instances, old sections, abandoned when the conditions for profitable working were not so favourable as at present, are being resumed, and with an increased disposition on the part of the Government to assist and foster the industry, there are increasing indications of activity among those engaged in mining. No feverish excitement about our West Coast ore deposits need be anticipated, but there are sound reasons for looking forward to a quiet, steady continuance of development and exploitation for many years to come.

I have to gratefully acknowledge the valuable assistance of Mr. James Harrison, Inspector of Mines for the West Coast, who accompanied me on several journeys, and

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the courtesies and attentions which were so readily bestowed upon me by mine managers and others too numerous to name.

I have the honour to be,
Sir,

Your obedient Servant,
W. H. TWELVETREES,
Government Geologist.

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