

REPORT ON THE IRON AND ZINC-LEAD ORE  
DEPOSITS OF THE COMSTOCK DISTRICT.

[Two Plans.]

*Zeehan, 1st February, 1903.*

SIR,

I HAVE the honour to forward you the following Report, the result of my recent examination of the ore deposits of the Comstock district.

This district is situated to the south-east of Mt. Agnew, and is distant from the Town of Zeehan about four miles, in a westerly direction. I also add a few notes on the prospects of the Little Henty district, to the south and south-west of Mt. Agnew.

Mining has been carried on in the Comstock district in a somewhat desultory manner for many years, being principally confined to the operations of small parties of tributors. Insufficiency of capital and the impossibility of getting the low-grade ores to market at a reasonably low cost have been great obstacles to progress. The latter of these causes has, however, lately been removed by the construction of the 2-foot gauge Government railway, connecting the district with the main system of railways at Zeehan, and it is to be hoped that capital will shortly be available for working the mines systematically. The main products of the district are zinc-blende and argentiferous galena, but it is only comparatively lately that the value of the former mineral has been recognised. Zinc-blende commands a ready sale in Europe, and provided that the mineral can be obtained in a moderately pure state, and in fairly large quantities, the price is such as to render mining highly profitable. It is now evident that zinc-blende is destined to become the main product of the Comstock district, though no doubt galena will still remain an important part of the output.

The districts under review are situated to the south-east and south of the Heemskirk granite area. The prevailing rocks consist of Silurian slates, limestones, sandstones, tuffs, and several altered rocks, the product of metamorphism at the contact of the granite. A large mass of gabbro occurs

to the south-west of the Comstock district, which is believed to be older than the granite; but both are intrusive in, and therefore younger than, the Silurian strata.

There are two main types of ore deposits represented in the district, namely, (1) magnetite lodes, (2) pyritic zinc-lead lodes. These two types, though differing very greatly in the relative proportions of their metallic contents, are connected by intermediate types, and evidently owe their origin to the same geological processes. I believe the facts of their occurrence will throw much light upon the origin of other important mineral deposits on the West Coast.

(1) *Magnetite Deposits.*—These deposits occur in great abundance in the Comstock district, especially in the vicinity of the granite contact. In their typical development they are never found within the granite itself, but either at the contact or in its vicinity. In some cases they are found as far as one mile from the contact, but the majority are confined to within one-third of this distance, and some of the largest occur right at the contact. These magnetite deposits are not confined to the Comstock district alone, but occur at intervals all round the Heemskirk granite area. During my examination of the tin ore deposits of Mt. Heemskirk, I noted a number of them at North Heemskirk, some occurring nearly as far north as Granville Harbour. They also occur to the south of the granite, one deposit crossing the Little Henty River to the south-east of Trial Harbour. They are sometimes found at the contact of the gabbro and Silurian strata, and perhaps also in the gabbro or serpentine itself; but even in these instances the granite contact is never far distant. The strike and dip of the deposits appear to be often the same as those of the strata in which they occur, but this is by no means always the case. Sometimes the deposits form well-defined lodes, and their outcrops may be traced continuously for long distances in a straight line, but there is generally a tendency to form large lenticular masses, and these appear to be sometimes quite isolated. In one locality at West Heemskirk, to the north of the Gentle Annie Rise, I counted six of these masses or "blows" within an area of a few acres. Each "blow" formed a small hill covered with trees and scrub, rising out of the button-grass plain. The larger "blows" are often several chains in width, but no doubt the actual width of the lodes is much less, as there is always more or less of a talus of ironstone blocks at the outcrop.

The magnetite lodes have not yet proved of commercial value, and in consequence they have received little atten-

tion at the hands of the miner. In most cases the outcrop of the deposits is all that can be seen. In a few instances, however, some prospecting work has been done, and in the case of one mine (The Tenth Legion) the mineralogical evidence disclosed is of the most important description. The following is a list of the minerals which have been observed in connection with these deposits:—

*Magnetite* occurs in great masses, often almost pure, but sometimes distributed in grains through various silicates which accompany the deposits. The massive portions often contain small cavities lined with well-formed crystals (dodecahedra). In some cases the massive magnetite passes over into a highly impregnated and indurated slate, pointing to the fact that much of the magnetite may be a replacement mineral.

*Pyrite, Chalcopyrite, Arsenopyrite, Galena, and Zinc-blende* usually occur in small quantities only, but occasionally one or other is present in larger amounts. Galena is perhaps the least abundant of these minerals; while zinc-blende, arsenopyrite, chalcopyrite, and pyrite are occasionally found in considerable quantities. In the Comstock district proper, arsenopyrite only occurs in small quantities.

*Cassiterite* (tin oxide) has been noted in one instance (The St. Dizier Mine); it occurs in irregular veinlets and grains in a magnetite silicate rock, and was first examined by Mr. A. D. Wilson, a graduate of the Zeehan School of Mines.

*Diopside* (lime magnesia pyroxene). A white crystalline mineral, cleaving in three directions, viz., parallel to the prism and ortho-pinatoid, and with a distinct parting parallel to the base. Microscopic examination shows that the basal parting is due to twin laminae. A section cut approximately parallel to the plane of symmetry gave an extinction angle of 38°. The specific gravity is 3.23, and the hardness about 6. Mr. Pascoe, late assayer at the Magnet Mine, has very kindly made an analysis of this mineral, with the following result:—

Silica (SiO <sub>2</sub> ) .....	52.1
Alumina (Al <sub>2</sub> O <sub>3</sub> ) .....	3.0
Magnesia (MgO) .....	15.0
Calcium oxide (CaO) .....	27.7
Ferrous oxide (FeO) .....	2.3
	<hr/>
	100.1
	<hr/>

*Lime-silicate Hornstone.*—The diopside occurs in occasional patches of irregular shape in a dense, white lime-silicate hornstone, of specific gravity 3·20, and hardness from 5 to 6. Microscopic examination of the margins of the patches of diopside show that the crystals of the latter gradually reduce in size and pass over into the dense rock, so that I think that there is no doubt that the lime-silicate hornstone is composed essentially of massive diopside. The specific gravity of the rock would also lead to the same conclusion. This rock is a product of contact metamorphism of either limestone or dolomite in which the carbonic acid has been replaced by silica. The rock was first examined microscopically by Mr. F. J. Ernst.

*Tremolite* occurs in slender prisms of a white or light-grey colour. It usually accompanies the magnetite, and occurs in large quantities at the Tenth Legion Mine. Micro-examination shows the angle of extinction to vary from 0° to 18°. The mineral is also associated with lime-silicate hornstone.

*Actinolite* occurs in fibrous radiating bundles. The colour varies from nearly colourless or very light green to dark green and greenish-brown. Under the microscope the pleochroism is very faint. Mr. A. Watson, assayer at the Magnet Mine, has kindly made the following analysis of the light green mineral:—

Silica (SiO <sub>2</sub> ) .....	54·75
Alumina (Al <sub>2</sub> O <sub>3</sub> ) .....	2·25
Magnesia (MgO) .....	20·72
Calcium oxide (CaO) .....	15·82
Ferrous oxide (FeO) .....	5·85
Manganous oxide (MnO), undetermined	

---

99·39

*Garnet.*—Two varieties have been noted; one, yellow, occurring as grains and crystals through the silicate hornstone; the other, light brown, occurring in a more massive form.

*Epidote* occurs in the silicate hornstone at the Tenth Legion Mine, and also in considerable quantities, with magnetite, at the St. Dizier Mine.

*Vesuvianite.*—Recognised microscopically, associated with epidote and garnet, at the Tenth Legion Mine.

*Chlorite* occurs abundantly in the majority of the deposits, generally as a fine-grained dark-green rock, when it

appears to be formed by the metamorphism of slate; also in large flakes of a light-green colour.

*Phlogopite* (magnesia mica).—This mineral occurs on Section 5367-93M, charted in the name of A. D. Sligo, in hornstone, associated with very large bodies of magnetite and zinc-blende. It occurs in large hexagonal crystals, with a very perfect micaceous cleavage. The colour is light-green, varying sometimes to greyish-brown. The mineral was identified by Mr. R. F. Waller, General Manager of the Magnet Mine, who writes as follows:—  
 "The mineral gives off very little water when heated to a bright-red in hard soda-glass tubing. It cannot therefore be clinocllore. The flame, examined through cobalt glass, gives a distinct re-action for potash. It is easily decomposed by boiling  $H_2SO_4$ —in fact, decomposition sets in before the liquid starts to boil. The specific gravity is 2.815—the mean of several determinations ranging from 2.8 to 2.825 (sp. gr. of clinocllore = 2.65 to 2.75). I think the mineral is without doubt phlogopite."—See page 284, Brush and Penfield, "Determinative Mineralogy."

*Talc* occurs occasionally in small crystals, and also in large masses as an impure steatite. This is no doubt a product of the surface decomposition of lime-silicate hornstone.

*Serpentine* occurs as an apple-green massive mineral, occasionally with a fibrous and radiating structure associated with magnetite and various silicates; also as a dark-grey or black massive mineral, with conchoidal fracture of a peculiar opaline appearance. I believe this mineral has no connection with the serpentine rock which is associated with the gabbro and pyroxenites throughout the West Coast, but is due to the alteration of the numerous magnesium-bearing minerals associated with the deposits.

*Calcite* frequently occurs in small quantities, associated with the deposits.

*Quartz*.—Crystalline quartz is not abundant. It occurs occasionally in small nests in the lime-silicate hornstone. There are large masses of a dense white quartz-hornstone associated with many of the deposits. It may be distinguished from the lime-silicate hornstone by its greater hardness and smaller specific gravity.

*Manganiferous Siderite* occurs in a vein with cubical crystals of iron pyrites at the Tenth Legion Mine. This is possibly of later date than the magnetite.

The above list includes a number of minerals which are highly characteristic of contact metamorphism, viz., diop-

side, lime-silicate hornstone, tremolite, actinolite, chlorite, garnet, epidote, vesuvianite, and phlogopite. The association of the deposits with these minerals is not a matter of chance, since it has been observed in a number of different deposits in different parts of the district. Hence, we are justified in the assumption that the deposits owe their origin to the same geological processes which have produced the contact metamorphism. Mr. A. Montgomery\* suggested that the deposits were caused by the metamorphism of pre-existing lodes of carbonate of iron, the heat engendered by the granite eruption being responsible for the driving away of the carbonic acid. With our extended knowledge of the distribution of the magnetite lodes and the carbonate of iron lodes on the West Coast, this theory has become untenable, for if it were true, we should expect to find large lodes of iron carbonate outside the metamorphic zone. Instead of these, we find pyritic lodes with little or no iron carbonate. These certainly could not have been converted into magnetite by contact metamorphic agencies. Mr. W. H. Twelvetrees, in his report on the mineral districts of Zeehan and neighbourhood, suggests that the deposits may be connected with the gabbro and serpentine contacts; and as far as the deposits in the Comstock and Trial Harbour districts are concerned, there is much to be said in favour of this view. The deposits sometimes occur right at the contact of the gabbro with the Silurian strata, and in some cases (viz., on the beach at Trial Harbour) small veins and impregnations of magnetite associated with chlorite are found in the serpentine rock itself. In these cases the magnetite contains a small percentage of chromic oxide, which is highly characteristic of serpentine.

The presence of so many minerals rich in magnesia and of small quantities of the mineral serpentine in the deposits is also suggestive of a connection with the eminently magnesium-bearing rocks serpentine and gabbro. My examination of the whole Heemskirk district, however, together with observations in other magnetite deposits in other parts of Tasmania, have led me to the conclusion that the majority of the deposits are connected with the granite, and not with the gabbro or serpentine. Up to the present these rocks are only known to occur to the south of the Heemskirk granite area, and have not been found north of the Comstock district. It is, however, probable that serpentine will

---

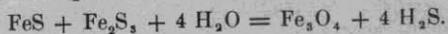
\* Report on the progress of the mineral fields of the county of Montagu, 20th May, 1893, page 17.

7/36

yet be found to the north-east of Mt. Heemskirk, for in the alluvial tin-drifts of this region there is an abundance of chromite occurring in small angular crystals. This mineral has probably been derived from the denudation of some mass of serpentine of limited dimensions, which has not yet been discovered. The magnetite deposits on the other hand occur at comparatively short intervals all round the granite, and are apparently confined to the contact metamorphic zone of the granite. This is very strong evidence of their connection with the granite, for they appear to be independent of the presence of gabbro and serpentine, and dependent on the granite. Another very strong point in favour of the granitic origin of the magnetite is the presence of tin oxide in the deposit at the St. Dizier Mine.

The magnetite deposits of the Heemskirk district correspond almost exactly with a type which has become known as the Christiania type of contact metamorphic deposits, and have been exhaustively studied by Prof. J. H. L. Vogt, in Norway. These deposits are always found within the granite contact zone; they are invariably associated with well-recognised contact metamorphic minerals, viz., andalusite, chiastolite, chlorite, &c., when they occur in slates, and diopside, lime-silicate hornstone, tremolite, garnet, epidote, vesuvianite, &c., when they occur in limestone. The source of the metals (principally magnetite with smaller quantities of chalcopyrite, arsenopyrite, galena, and zincblende) is believed to be the original granite magma from which they were expelled in the form of solution in highly-heated aqueous vapour. The same solutions which carried the metals are believed to have also contained large quantities of silica, and to have been the direct cause of the transformation of the limestone into lime-silicate rock. From the fact that they always occur outside and never within the granite, it is concluded that they were formed before the granite had consolidated, otherwise we should expect to find them, like tin veins, in the granite as well as along the contact. It is not known in what state of combination the metals were present in the solutions. Vogt suggests carbonic acid or sulphur as the "mineralising agent," and is inclined to favour the former. As will be seen later, there is much evidence in the Comstock district that sulphur was present in large quantities in the solutions, and if this is granted, there are grounds for belief that the iron was expelled in combination with this element. The sublimation of iron oxide from gaseous solutions of iron sulphide may be accounted for on the same lines as

the sublimation of iron oxide from vapours containing iron chloride, observed in the fumaroles of modern volcanoes. The chemical equation may be thus expressed:—



It must be admitted, however, that all speculations as to the state of combination in which the iron was expelled from the granite, and the chemical reactions which determined its precipitation as magnetite, are at present purely hypothetical, and have not yet been verified by experiment. Still, the main facts as to the origin and relative age of the deposits are supported by such a mass of evidence that they may now be regarded as thoroughly established. It will be observed that the presence of magnesium minerals, as in the Comstock deposits, is not a feature which is confined to the contact zones of basic rocks. The Christiania deposits are certainly *granite* contact deposits, and yet here also we have a preponderance of magnesium-bearing minerals. It appears certain that the vapours given off by granite in the early stages of its consolidation contain considerable quantities of magnesia. We have evidence of this on the East Coast of Tasmania, where gabbro and serpentine do not occur. At the North Scamander Mine there is a magnetite deposit occurring in slate not far from the granite contact. The slate has been largely converted into chlorite rock in the vicinity of the deposit. At St. Helens, also, there is much chlorite rock found along the granite contact. For the formation of this chlorite, a considerable amount of magnesia must have been present in the emanations from the granite. It is, of course, quite possible that some of the magnetite deposits in Tasmania may be connected with the basic rocks. The magnetite deposit at the Rocky River Mine appears to be a case in point. Mr. W. H. Twelvetrees records the presence of nickel ores in this deposit, and these would point to the gabbro as the primary source of the metal. In this case the serpentine contact is close at hand, but the granite is some three miles distant.

From an economic point of view, the contact metamorphic deposits are not at present of much importance. In one instance there appears to be sufficient zinc-blende present to warrant some further development, but the majority of the deposits consist almost wholly of magnetite associated with more or less non-metallic minerals. The magnetite is a primary mineral, and there is no prospect of its changing to sulphide ore in depth, though both in depth

and near the surface it may be associated with small amounts of sulphide. It is unlikely that any of these deposits will ever become considerable producers of silver-lead ores.

It is possible that in the event of the iron industry being established in the Commonwealth, the magnetite may become of value as an ore of iron. Magnetite is the richest ore of iron, and when pure contains 72·4 per cent. of metal, hematite coming next with 70·0 per cent. In the Comstock deposits much of the ore is exceedingly pure, but I think that in bulk it would be unsafe to estimate it at more than 65 per cent. The ore is, so far as is known, remarkably free from deleterious substances. The only impurities which are to be feared are the sulphides, viz., pyrites, blende, &c., but these appear to be totally absent wherever the magnetite occurs in large quantities and in the massive form. The chief impurity in the ore consists of silicates of lime and magnesia, which can readily be slagged off in the blast-furnace. Phosphorous only exists in traces, and sulphur in very small quantities. The following assays of the ore have been made by Mr. W. F. Ward, Government Analyst:—

	I.	II.	III.
Iron, per cent. ....	61·8	70·7	60·1
Sulphur, per cent.....	0·2	0·1	—
Phosphoric acid, per cent.	trace	trace	—
Chromium, per cent. ....	trace	nil	0·4
Titanium, per cent. ....	nil	nil	—

- I. Magnetite from Tenth Legion Mine. Sample taken from tunnel below the oxidised zone.
- II. Massive magnetite, slightly oxidised, from large outcrop, Tenth Legion Mine.
- III. Magnetite in serpentine near granite contact. From beach, north of Trial Harbour.

None of these are bulk samples, as it is impossible to take true bulk samples without more mining work being done. Only in one instance (at the Tenth Legion Mine) have the deposits been explored below the surface, and in this instance a spot was chosen for the tunnel midway between two large masses of magnetite, as the object of the tunnel was not to prospect for iron ore, but to test the formation for silver and lead. The result is that the magnetite was cut in what is probably the poorest part of the deposit. The piece chosen by me for assay (Sample No. I.) is representative of the bands of purer ore met with in this tunnel.

10/30

The impurities consist entirely of lime magnesia silicates. Sample No. II. was taken from a large mass of pure magnetite, outcropping at the surface to the west of the tunnel, and I believe large quantities of ore of this grade are obtainable from the deposit. Sample No. III. is from a comparatively small vein occurring in the serpentine at Trial Harbour.

Compared with the hematite ores of the Blythe River, I think the Comstock ores are likely to prove richer in iron, and, in consequence, freer from silicate than the latter. Moreover, the silica in the magnetite is already combined with lime and magnesia, so that less lime will be required as a flux in the smelting operations. The ore is at least as free from phosphorus as that of the Blythe River, but probably contains a little more sulphur.

It is difficult at present to form even an approximate estimate of the amount of ore available. The outcrops of the lodes form the crests of long ridges, which are covered with dense scrub and timber, and the heavy talus of ironstone blocks and gravel obscure the true width of the deposit. Several of the deposits appear to be several chains in width, but are probably composed of bands of high and low grade ore. I think it is safe to say that the amount of high-grade ore available, and which can be mined cheaply by the open-cut system, amounts to many millions of tons.

As regards means of access, the deposits in the Comstock district could be easily connected with the 2-foot gauge railway junctioning with the main line at Zeehan. This would, however, necessitate reloading at Zeehan, and it is unlikely that the price obtainable will ever bear the cost of transport by this channel. If the deposits ever come within the sphere of practical mining, a standard gauge railway might be made to Zeehan. This would bring the deposits within 34 miles by rail of the Port of Strahan.

#### *Pyritic Zinc-lead Lodes.*

These deposits occur at some distance from the granite contact, either in the outer portions of, or beyond, the contact metamorphic zone. The lodes are fissure-veins, presenting the typical banded or comb structure, often to a remarkable extent, but there is evidence of a large amount of replacement of the wall-rock on either side of the veins; especially is this the case where the lodes traverse limestone. In the majority of cases the lodes have only been worked at shallow levels, and the true character of the

deposits is obscured by surface decomposition and secondary deposition of sulphides.

There is very conclusive evidence of a direct genetic connection between the pyritic zinc-lead lodes and the magnetite lodes in this district. The pyritic zinc-lead lodes which occur within the contact zone are characterised by the same mineral combination as that of the magnetite lodes. They are, in fact, an intermediate type between the magnetite lodes proper and the pyritic zinc-lead lodes proper. The best example of this is to be found in the main lode of the Kynance Mine (the old Silver Stream). Here we have a large lode-formation associated with an impure steatite, which is almost certainly a decomposition product of the lime-silicate hornstone met with on the adjoining section (the Tenth Legion). The contact minerals, garnet and epidote, have been recorded by Mr. A. Montgomery, late Government Geologist, as occurring in the lode, and magnetite also occurs in seams associated with decomposed silicates. The principal metallic minerals are, however, zinc-blende, galena, and iron pyrites. The relation between the metallic contents of the two types may be correctly expressed by stating that the magnetite lodes contain much magnetite, with a small quantity of sulphides, while the intermediate type contains much sulphides, with a small quantity of magnetite. The difference in the mineralogical composition of the two is, therefore, quantitative, not qualitative.

Another instructive example is the copper lode on the Kynance section. This has every appearance of being a direct continuation of the big magnetite lode on the Tenth Legion Mine, the gossan capping having been trenced on at short intervals along the strike of the lode right through the Kynance section. In several of these trenches pyrites with zinc-blende and galena was cut, while magnetite is only present in small quantities. Where this lode is cut in the long tunnel it is composed of impure steatite, with some pyrites and magnetite and a good deal of carbonate of copper. This change in the character of the lode takes place as the lode recedes from the granite contact.

The typical pyritic zinc-lead lodes are found outside the contact metamorphic zone, and these contain no magnetite; but there are, even in these lodes, occasional evidences that the contact metamorphic agencies have not been entirely exhausted. Thus, in the lower tunnel at the Comstock Mine, the limestone in the vicinity of the lode often

contains small crystals and flakes of talc, and, less frequently, seams of tremolite occurring in slender crystals. This is, I think, an important link in the chain of evidence connecting the pyritic zinc-lead lodes with the magnetite lodes.

The above facts afford the strongest evidence that the pyritic zinc-lead lodes may be regarded as a continuation of the magnetite lodes outside the contact metamorphic zone. It appears quite clear that the solutions originally emanating in a gaseous condition from the granite deposited the iron first in the form of oxide and later as sulphide. The cause of the alteration in the nature of the precipitate may be ascribed to decreasing temperature. It is probable that, at very high temperatures, the oxides of the metals are precipitated in preference to the sulphides. We have evidence of this in the prevalence of oxides in other types of deposits which have been formed at very high temperatures, as, for example, tin veins and apatite veins; and in the prevalence of sulphides in deposits which are formed by ordinary thermal waters, as, for example, the ordinary types of silver-lead veins. In the Comstock district we have the oxides close to the granite associated with contact metamorphic minerals, and evidently formed at very high temperatures. Further away, the oxides and the contact metamorphic minerals decrease, while the amount of sulphides present increase. Further away still the oxides disappear altogether, the contact metamorphism has almost disappeared, and the whole of the metals are present in the form of sulphides. The facts therefore are in complete accordance with the theory, otherwise verified from the facts of the occurrences of deposits formed at very high and moderate temperatures, that with decreasing temperature the character of the precipitate changes from oxide to sulphide. I think, therefore, that this theory accounts satisfactorily for the presence both of the magnetite lodes and the pyritic zinc-lead lodes in the Comstock district.

In my report on the zinc-lead sulphide bodies of the Mt. Read district, I have shown that much of the zinc-lead sulphide in that district is of secondary origin, formed by the leaching away of the zinc and lead contents of the upper (oxidised) portions of the lodes and the redeposition of the sulphides lower down, by reactions with iron pyrites and hydrogen sulphide. Also that, for the precipitation of zinc-sulphide, the presence of carbonate of lime is necessary in order to neutralise the solutions, since zinc-sulphide cannot be precipitated in an acid solution. Further, that

from the fact that lead has a greater affinity for sulphur than zinc, we may infer that the upper portions of the secondary zone will be richer in galena than the lower portions. I think there is no doubt that this process of concentration has been at work in the Comstock district, and that much of the zinc ore is of secondary origin. The occurrence of bunches and masses of zinc-blende in the decomposed limestone in the vicinity of the lodes is strongly suggestive of the fact that these masses are replacements of limestone, while the irregular admixture of iron pyrites in much of the ore points to the fact that zinc-sulphide has also replaced this mineral. At the Hercules Mine I have suggested that some of the pyrite may be of secondary origin, formed by neutralisation of acid solutions containing  $H_2S$ , by carbonate of lime. At the Comstock district there is definite evidence that this has taken place. The decayed limestone is frequently full of minute crystals of pyrite, which are absent from the undecomposed rock. A thin layer of pyrite is also sometimes found coating crystals of galena and blende, or filling cracks in the latter mineral. The effect of this secondary concentration of the lead and zinc ore on the behaviour of the lodes will be that, with increasing depth there will be a falling off, first, in the amount of galena, and then in the amount of zinc-blende contained in the lode channel. Whether this will take place to such an extent as to render the mines unworkable at great depths, can only be decided by actual work. The question may well be left in abeyance at present, since the amount of ore which the mines are likely to yield from their upper levels will be sufficient to keep the district busy for many years to come, and long before these are worked out we shall have more definite knowledge as to the behaviour of the lodes in depth.

I may here mention the presence of the mineral Hisingerite, which is, I believe, a new mineral to Tasmania, in the pyritic zinc-lead lode of the Comstock Mine. The mineral was identified by Mr. R. F. Waller, General Manager of the Magnet Mine. It is a hydrated silicate of iron, occurring in amorphous masses associated with pyritic ore. The colour is black, fracture conchoidal, hardness 3, gravity 2.50. It occurs in the lode-matter exposed in the lower tunnel of the Comstock Mine. The mineral is generally regarded as of secondary origin, and constitutes evidence that the formation of secondary minerals has in the Comstock lode proceeded to the level of the lower tunnel. The mineral is of no economic value.

*The Tenth Legion Mine.*

Section 4760-93M, 70 acres. This mine has already been referred to in the first part of this report. The section is about 35 chains distant from the granite contact. A very strong magnetite lode lives through the southern portion of the section, striking about N. 55° W., and forming the crest of a timbered ridge of considerable size. The magnetite appears to vary very considerably in width and massiveness; its average width might be taken at about a chain, though it is very difficult to estimate, owing to the whole ridge being more or less overlaid with ironstone. A tunnel has been driven south underneath the spur from Pine Creek, and has cut through the formation in a diagonal direction. Plate I. gives a section of the formation exposed. For the first 132 feet the country consists of quartzites, indurated slates, and hornstones irregularly jointed and showing no defined planes of stratification. Then a small vein was cut carrying cubical crystals of iron pyrites and manganese siderite (carbonate of iron and manganese). This strikes 72° west of north, and dips to the north at an angle of 70°. For the next 50 feet the country is more regularly jointed parallel to the pyrites vein. These joints probably represent the original planes of sedimentation. At 180 feet from the entrance a lode-formation was cut, consisting of two seams of black pug and rubble about 3 feet apart, with hard rock in between containing specks of pyrites, blende, and galena. Beyond this the magnetite rock is entered. The magnetite is nowhere very pure in this tunnel, except for quite short distances, being mixed with silicates, viz., tremolite, serpentine, chlorite, silicate hornstone, and in some places it appears to be merely disseminated through indurated slate or chert. This magnetite rock continues on both sides of the tunnel for 32 feet, when dense silicate hornstone comes in on the west side of the tunnel. The contact between this rock and the magnetite is fairly well defined, though in many places the silicate hornstone is impregnated with magnetite for a short distance from the contact. There are, however, no signs of slickensides or anything to suggest faulting at the contact. The plane of contact continued in the tunnel for a distance of 24 feet, the silicate hornstone being on the west side and the magnetite rock on the east. At a distance of 239 feet from the entrance the contact passed out of the tunnel to the east. Where first cut the dip was towards the west, but this gradually changed till, where it dis-

appeared on the east side of the tunnel, the dip was to the north of east. For the next 36 feet the tunnel is entirely in silicate hornstone, after which it passes through a second band of magnetite rock about 20 feet in thickness. Finally, it enters silicate hornstone again, which it penetrates for about 17 feet. The total length of the tunnel is 312 feet. I believe the explanation of this section is to be found in the assumption that the tunnel has crossed four alternate bands of magnetite rock and silicate hornstone, having a general strike parallel to the course of the lode, but strongly contorted in places. The separate bands represent original layers of strata of different composition. The silicate hornstone was certainly limestone or dolomite, while the magnetite rock may have been a calcareous slate. As has already been shown, the change was produced by contact metamorphism, *i.e.*, by heated solutions emanating from the granite before the latter had consolidated. It is probable that these solutions proceeded along fissures, and from the latter impregnated the more porous or soluble strata, attacking them and producing the various silicates of lime and magnesia which have been described. The Tenth Legion Mine is of the very greatest interest geologically, but I fear that from an economic point of view its value is small. The magnetite is not, as has been sometimes supposed, the oxidised capping of an ordinary sulphide lode. The magnetite is a primary mineral, and although there is a chance that both zinc-blende and galena may be associated with it, the general experience of this type of deposit in other countries is against these minerals being found in payable quantities. In the event of the iron industry being established in the Commonwealth, there are however future possibilities in store for the section. It is true that the magnetite which was cut in the tunnel is not sufficiently massive to be of any value, but this is, I believe, mainly owing to the fact that the tunnel was put in at a spot where the lode had pinched. This is shown by the fact that immediately above the tunnel there is a decided saddle in the ridge, while both to the east and west there are large knobs showing very dense ore on the surface. The quality of the ore could be readily tested now by driving along the course of the lode, either east or west, and cross-cutting when the dense ore was entered.

It may here be mentioned that there is another large magnetite ridge about half a mile south of the Tenth Legion. This deposit appears to be of precisely the same type as that just described, but no work has been done on

it. A third deposit of similar dimensions occurs to the north.

*Section 109M, 80 acres.*

This section is situated west and adjoining the Tenth Legion Mine, and the Tenth Legion lode continues through the northern portion of this section. A tunnel has been driven into the end of the spur which runs from the Tenth Legion ground in a south-easterly direction on the hanging-wall of the lode, but the magnetite itself has not been cut. This tunnel is in white, clayey steatite, and is evidently decomposed lime-silicate hornstone. By continuing the crosscut south from the end of this tunnel, the magnetite should soon be entered. Further west, on the flat, a water-wheel has been erected and a shaft sunk for some distance, but these workings could not be examined. There is said to have been some galena obtained, but I could find no trace of ore in the dump-heap. Some of the ore is said to have assayed rich in silver. In the approach of a tunnel near by there is a good deal of green crystalline chlorite showing. The gossan outcrop may be traced right across the flat from the Tenth Legion spur. I am informed that a small patch of alluvial gold was discovered on this section, and that some pieces of magnetite were picked up carrying free gold. Some similar specimens of free gold in magnetite were shown me from the Rocky River district some time ago by Mr. D. Jones, authorised surveyor. Vogt states that small quantities of gold are not uncommon in contact metamorphic deposits.

*Section 5367-93M, 80 acres.—A. D. Sligo.*

This section is situated about a mile to the south of the Tenth Legion. The margin of the gabbro passes through the south-eastern corner of the section, while that of the granite passes through the north-western. Between the two the country consists of intensely indurated slates and hornstones. There are several very large magnetite deposits on the section, but it is so heavily timbered, and the compass is so strongly affected by the magnetite, that it is difficult to locate their positions accurately. A little to the south-west of the centre of the section, what is known as "the blende show" has been discovered on the bank of a creek. The metalliferous formation is about 12 feet wide, and has been exposed at the surface by a surface-cut about 20 feet in length. It consists of curiously irregular masses

of zinc-blende and magnetite, with various contact metamorphic minerals, viz., chlorite, tremolite, lime-silicate hornstone, &c. In places the blende is almost pure for several feet in width, and then it changes abruptly to magnetite, without any distinct parting dividing the two. Both minerals occur in irregular masses, there being no sign of a banded structure. The rocks in the vicinity consist of hard hornstones, with seams of green phlogopite crystallising in large hexagonal flakes, and occasionally a little blende and magnetite. The facilities for testing the formation are excellent, a large amount of backs being obtainable by driving a tunnel from creek-level, and considering the amount of blende exposed at the surface I think it would be worth doing.

The massive magnetite lodes on this section would be capable of supplying enormous quantities of iron ore, provided, of course, that they prove in depth to be sufficiently free from sulphur to be amenable to metallurgical treatment.

#### *Kynance Prospecting Association.*

Section 5142-93M, 62 acres. This section, formerly known as the Silver Stream, is situated south-east and adjoining the Tenth Legion. The magnetite lode already described as occurring in the latter section continues through the Kynance on a course of S. 54° E., but changes its character. The amount of magnetite decreases, and is replaced by iron and copper pyrites, with some zinc-blende and galena. A little tunnelling has been done on this lode in the north-western portion of the section, but the workings were all inaccessible at the time of my visit. I understand that a little blende and galena were obtained, but nothing of a payable nature. This lode is cut again in the south-western portion of the section, in the long adit, where it is known as the copper lode. There it is about 60 feet in width, and consists largely of kaolin, steatite, and gossan, much stained with copper carbonate. The whole formation is completely decomposed. According to Mr. A. Montgomery's report of 1893, magnetite was also present at this point, but I did not find it. A bulk sample of copper ore taken from the best-looking part of the lode for a width of 3 feet 6 inches gave a return of 9.3 per cent. copper and 1 oz. 19 dwts. 4 grs. of silver per ton. This is very encouraging. The lode should certainly be driven on, as if a large quantity of similar grade ore exists it would be payable. Of course, the copper ore is of secondary

origin, and due to the decomposition of the original copper pyrites. If this ore proves to be extensive, the lode is worth sinking on, as there is a likelihood of rich copper sulphides being found below water-level.

The principal lode on the section, now known as the main lode, strikes to the east of north, and is situated in the eastern portion of the section. About 400 tons of galena are said to have been obtained from the upper levels of this lode by the Silver Stream Company, and later by tribute parties. The lode was worked by two adits 30 feet apart vertically, the lower one being driven a distance of nearly 600 feet before the lode was cut. The workings were allowed to collapse after they were abandoned by tributors, but the Kynance Company have recently driven through the lode again, just north of the old crosscut, from the lower adit, and in doing so crossed the old north drive, which was found to be in good order. The lode is 40 feet wide at this point, and consists of 9 feet of gossan on foot-wall, then 14 feet of gossan with seams and slugs of galena and zinc-blende, then 9 feet more gossan, and finally 8 feet of gossan and decayed slate and steatite on the hanging-wall. The crosscut continues for some distance further. It follows a flat seam of steatite about 5 feet thick, which is accurately interbedded with decomposed slates, which at this point occur in flat anticlinal folds. The drive north along the lode, which followed the main lode channel, has an average course of N. 34° E. for a distance of 90 feet. There is a good deal of stoping done above the drive, but the metal appears to have given out going north, and the drive was continued in gossan. The end of the drive is now in hard quartzite, with no sign of the lode showing. For some reason it was bent round to the north during the last 10 feet, and the footwall broken into. There is every appearance of the lode continuing to the east of the end of the present drive. The south drive is not quite in line with the north drive, and has an approximate course of N. 10° E., so it appears that there is a bend in the lode where it was first cut by the adit. Another crosscut was started on the south side of the old workings, in order to pick up the lode to the south of the broken ground, but hard country was met with, and, to avoid this, the course was altered and came upon the old workings. By driving south it should now be an easy matter to get beyond the broken ground and into the main lode channel.

As regards the metallic contents of the lode-matter, I find that the gossan is practically of no value. I took a

19/36

number of samples from different parts of the lode, and these were submitted to Mr. W. F. Ward for assay. The results ranged from  $1\frac{1}{2}$  to  $3\frac{1}{2}$  ozs. of silver to the ton. The only minerals of value, therefore, are the galena and zinc-blende. These minerals occur in payable quantities through a width of 14 feet, provided a concentrator were available for saving the galena in the second-class ore. The blende which could not be separated by hand would be lost in this ore, because it is associated with limonite, which has nearly the same specific gravity as blende. At the mouth of the tunnel there is a large heap of second-class ore, which was obtained in driving through the lode. It consists principally of gossan, but contains a large proportion of concentrating ore (containing galena and blende) through it. A sample from the latter assayed by Mr. Ward yielded 28.4 per cent. lead, 10.5 per cent. zinc, and 16 ozs. 6 dwts. 16 grs. silver to the ton. Besides this heap, 4 tons of galena were obtained in driving the crosscut, and sold to the local smelters. A sample taken from a seam of second-class ore 15 inches in width in the crosscut to the east of the north drive yielded 29.2 per cent. lead, 1.6 per cent. zinc, and 13 ozs. 7 dwts. 10 grs. silver to the ton. It should be understood that this ore was obtained from the lode after the main shoot of galena along the north drive had been taken out, this having been previously removed by tributors. This shoot is said to be still good underfoot, though it has been under-hand stoped for a few feet below the level, and therefore could not be examined.

With regard to the ore which remains to be mined above this level, it may be assumed that as far as they went the tributors removed all the first-class galena. It is probable, however, that there is still a large quantity of second-class ore, such as is exposed in the crosscut at the lower level, for this would not have paid the tributors to remove, since they had no means of treating it. It is said that there is a lode 5 feet wide in the south end, consisting principally of blende, with some galena and iron pyrites. This lode became too poor going south to work for galena alone, but, now that there is a good market for blende, it may very well be payable. It is certainly worth while driving south to examine this lode. The remainder of the lode above the adit level is in all probability unpayable without a concentrator, and as there are only some 35 feet of backs, it would not be worth while erecting a concentrator for this ore alone. Below the level there are good indications of payable ore existing. The valuable metals

20  
36

have been largely leached away from the upper portions of the lode, and when this happens experience shows that they are often redeposited at and below water-level, thus producing a rich sulphide zone below the gossan. Before this can be proved, the erection of pretty heavy pumping machinery will be necessary. I am of opinion that the indications quite warrant the expenditure necessary to carry out this work.

*The Zeehan South Comstock Mining Company,  
No Liability.*

This is a London company which was formed to work Section 966-93M, formerly known as the South Comstock. Operations have been carried on on a limited scale for over a year, the object being to test the value of the deposits and to demonstrate the practicability of profitably exporting zinc-blende to the European market. The operations have proved so far satisfactory that the company has lately acquired the section north and adjoining, No. 711-87M, known as the Comstock Mine; the two sections now forming a continuous block of ground of 160 acres in area.

Both of these sections have already been somewhat extensively worked in the shallow levels for galena, by parties of tributors who were unable to work the ground to any great depth on account of the large amount of water which was encountered. Zinc-blende was usually associated with the galena in considerable quantities, but at the time these workings were made there was no local market for the ore, and it was either left standing, or, if it had to be taken out, was thrown on the dump-heap. All the old heaps have since been carefully picked over, and in this way a considerable amount of zinc ore has been won. It is now evident that zinc-blende is destined to become the most important product of the mine. It has been proved to exist in large quantities, and much of it is sufficiently pure to be saleable as a zinc ore with no further preparation than a rough hand-sorting. It would, however, be too much to expect the whole of the ore to be as pure as this. Zinc ore does not pay to export if the zinc contents fall much below 40 per cent., consequently any ore that cannot be hand-picked up to this standard is valueless without proper means of concentration. It is probable that as depth is gained the proportion of second-class ore will increase, so that the consideration of dressing-appliances will become a matter of the highest importance in the future

development of the mine. The second-class ore consists of zinc-blende, galena, and pyrites, with a small quantity of quartz (hornstone) and calcite. The galena carries on the average about 1 oz. of silver to the unit of lead. The blende generally carries two or three ounces of silver to the ton, but this is probably connected with galena, which is usually present in small quantities. The pyrites carries only one or two ounces of silver to the ton and traces of gold. Almost the whole of the value of the ore would be obtained by making a separation of the galena and blende as separate products, and discarding the pyrites. As a general rule, it may be said that the minerals do not exist as an intimate mixture. A separation could be effected by comparatively coarse crushing, say down to  $\frac{1}{2}$ -inch cube, with recrushing of middle products. In this respect the ore differs essentially from those of Mt. Read, where the minerals often exist in an extremely fine state of intermixture. The specific gravities of the minerals contained in the ore are as follows.—Galena 7.5, pyrite 5.0, zinc-blende 4.0, calcite 2.85, quartz 2.65. In most of the ore calcite and quartz are present in very small quantities, and in much of it they might be disregarded altogether. The principal problem, therefore, is the separation of galena, pyrite, and blende. This separation has to be made in most zinc-mining districts, and is therefore possible here. The losses of mineral will, however, be necessarily heavy. Between galena and pyrite there will be an unsaleable middle product containing a percentage of the blende. Where calcite is present in considerable quantities there will be a further unsaleable middle product between blende and calcite. For purposes of calculation it would be unsafe to reckon on a smaller loss than 33 per cent. of mineral. Taking this figure as a basis, we can form a rough estimate of the minimum zinc contents of the second-class ore which it will pay to mine. At present the zinc contents of hand-picked ore is 46 per cent. The product of the concentrator should be at least as high as this. I am informed by Mr. A. M. Reid, jun., that according to the present tariff under which the company disposes of its ore, this is worth at the present price of spelter (£19 10s. per ton) £3 10s. 6d. per ton bagged on the mine. The value of the unbagged concentrates may be taken at £3 6s. per ton. Taking the cost of breaking and concentrating the ore at 12s. per ton, a recovery equivalent to 18.2 per cent. of concentrates, or 8.4 per cent. of zinc in the crude ore would pay expenses. Allowing 33 per cent. for loss in concentration, this gives 12.6 per cent.

zinc in the crude ore as the minimum which will pay for breaking and dressing on the zinc contents alone. Considering that at present all ore which contains below 40 per cent. zinc, or which cannot be hand-picked up to 40 per cent., is unsaleable, it is evident than an efficient concentrator would enable a much larger proportion of the lode-matter to be profitably treated than would be otherwise possible. Besides this, a considerable proportion of the zinc ore which is now being shipped contains galena as the chief impurity. Most of this galena could be separated by concentration, and if such ore were treated separately there need be, practically, no loss of mineral, as the whole of the tails would be saleable zinc ore. I believe, therefore, that it will become advisable in the near future to take the erection of a thoroughly equipped concentrator into consideration, but of course its erection should not be decided on until the amount of second-class ore available has been proved sufficient to warrant the expenditure.

Plate II. gives a topographical sketch plan of the two sections, and on this are marked the principal mine workings. There are four parallel lodes known on the sections, striking from 10° to 15° west of north, and dipping to the east at from 60° to 80°. The general position and strike of these lodes is marked on the plan by dotted lines, though of course it is not expected that the lodes will conform strictly to the lines as marked.

*The main or No. 1 lode* has been traced right through the Comstock section (No. 712-87M) and for a considerable distance into the South Comstock (No. 966-93M). It is a very strong lode, and in places attains a width of over 50 feet. It is a fissure-lode, in which the mineral matter occurs partly as a replacement of the wall-rock and partly as a fissure-filling. In places the typical banded structure of fissure veins is developed to a remarkable degree. The lode has been worked extensively in the shallow levels by tribute parties for galena, but the absence of pumping machinery prevented any depth being attained. There appears also to have been a tendency for the massive galena to give place to zinc-blende in depth, and as there was no sale for zinc at the time, the workings were abandoned. Taking the southern workings first, the lode was found to be very massive on the northern slope of the hill near the northern boundary of the South Comstock section. The formation here is about 50 feet wide, and consists of irregular masses of blende, with more or less pyrites and galena in decomposed limestone and slate. It has been

followed underground at the intermediate level for a distance of about 150 feet, and still looks well in the south end. The masses of solid zinc ore vary in size from a few feet up to 15 or 20 feet in thickness. The ore body was first worked for galena by tribute parties, who followed the makes of richer silver-lead ore, and left as much of the zinc-blende as possible standing, as there was no local market for the ore at that time. Many of the old stopes are said to be filled with payable zinc ore. Mr. W. Flaherty first worked the ore body for zinc, and is said to have shipped about 370 tons of ore. Since the present company has started operations, 1035 tons have been mined, to the value of £3040, or nearly £3 per ton. All this ore has been won by underground mining above the intermediate level. The workings are irregular, and most of the stopes cannot now be examined. The intermediate level was started on a course of S. 57° W., and cut the footwall of the lode 30 feet from the entrance. It was continued approximately along the footwall, and three crosscuts were put into the ore body about 50 feet apart. Between these crosscuts a good deal of zinc ore has already been taken out, and in one case, between No. 2 and No. 3 crosscuts, a block of ore 30 feet wide and 20 feet deep was stoped to within 20 feet of the surface. The rest of the stopes are irregular. There is said to be still a considerable amount of ore to the north of No. 3 crosscut, but this will not pay to take out by underground mining methods, as it is in irregular masses, and the soft nature of the ore body renders mining expensive. To the south of No. 3 crosscut, in a stope which had recently been started, I saw 12 feet of excellent blende showing in the face. In the end of a drive a little to the east of this the ore body is very massive, and contains a good deal of pyrites. The pyrites and blende, however, do not appear to be very intimately mixed, and I believe that most of the blende could be separated by hand-sorting. A bulk sample taken at this point across the face for a distance of 12 feet yielded zinc 24.1 per cent., lead 14.5 per cent., silver 14 ozs. 0 dwts. 5 grs. per ton, gold trace. Twenty feet above this intermediate level an open-cut has been started, but was not being worked at the time of my visit. From the end of this cut No. 1 level has been driven, and from this level a wide, low chamber has been opened out, from which a lot of ore is said to have been taken. A crosscut east from this followed a flat seam of blende and galena for 30 feet. The width of the ore body may be taken at about 60 feet at this point. The irregular nature

of the ore masses and the presence of the old stopes, together with the soft and crumbly nature of the country-rock, make it impossible to conduct underground mining in a systematic manner, and I think it is very doubtful if much ore can be won to the north of No. 3 crosscut at a reasonable cost by this method. On the other hand, the ore body is admirably situated for being worked by the open-cut system. There is plenty of room for stacking the waste rock along the sides of the hill, both east and west of the ore body. I should recommend three or four benches, 15 feet apart vertically, starting with the present open-cut at the 940-foot level. From these, side-trams could be run along the hillside east and west to get rid of the waste rock, and the blende could be lowered to the intermediate level by means of passes, two of which are already in existence, and could be utilised. For the sides of the cut a batter of  $\frac{1}{4}$  in 1 will probably be sufficient, as outside the ore body itself the country is fair-standing ground. There will therefore not be much country to shift beyond the soft mullock in the ore body. I think that, considering the soft nature of the ore body and the loose heady character of the ore 4s. 6d. a yard is a liberal estimate of the cost of removing the ore body down to No. 1 level. About three per cent of saleable ore would pay this cost, so that I believe there is a large margin for profit. Below the bench at the 940-foot level it will probably pay better to work the lode by underground mining, as there is a difficulty about getting rid of the waste rock. From No. 2 crosscut at the intermediate level a winze was being sunk at the time of my visit, with the object of under-hand stoping the large block of good ore already stoped above the level between No. 2 and No. 3 crosscuts. I am informed that since my visit this winze has struck good ore. The manager, Mr. H. Castles, has, however, wisely decided to work this ground from the bottom level, thus avoiding the excessive cost of raising the ore by windlass. At the intermediate level a crosscut has been put in to the west for a distance of 80 feet, and at a distance of 40 feet from the drive a large formation was entered carrying large bunches of pyrite and blende. It is not certain at present whether this formation, which is 30 feet in width, is a separate lode or a branch from the main lode, or whether it is merely a mass formed by secondary deposition. It is too poor to work at present, as there is little ore present that would pay for hand-picking, but it would probably be payable if a concentrator were available for treating the ore. A bulk

29/240

sample taken by me from the ore exposed, and assayed by Mr. W. F. Ward, Government Analyst, yielded zinc 19.3 per cent., lead 4.8 per cent., silver 3 ozs. 18 dwts. 9 grs. per ton, gold trace. This ore body should be driven on in order to ascertain its dimensions and value more definitely.

The main lode has been cut about 90 feet below the intermediate level by an adit 660 feet in length. This was driven by the old Comstock Company, who had the misfortune to cut the lode in a poor place. There is no doubt that the lode has been cut; the hanging-wall is well defined, and the footwall country for a distance of 12 or 14 feet contains benches of pyrites and blende with a little galena. The lode is, however, unpayable where cut, and the shareholders were so much discouraged by the result that the lode was not driven on for more than a few feet. This is greatly to be regretted as far as the old company is concerned, but the present company will doubtless benefit by the misfortunes of the old one. There was absolutely no reason for not driving on the lode, as has been pointed out by Mr. A. Montgomery, late Government Geologist. The rich shoots of ore at the surface were situated either to the south or to the north of the point intersected by the adit, but above this point the lode was poor. It is therefore not surprising that the lode was poor where cut underground. I understand that it is the intention of the present company to drive north on the lode from this point. This is most desirable, for, as will be shown presently, the lode has already been proved in the shallow levels to be productive for a distance of 800 feet in the Comstock section. This shoot is 600 feet north of the point where the lode was cut in the lower adit, but it is possible that good ore will be found before the whole of this distance is driven. The company is now cross-cutting east from the adit, to cut the lode below the South Comstock workings. When this is cut it will be risen on, and communication established with the workings at the intermediate level. When this work is completed there are good prospects of a large output of zinc ore from this portion of the mine.

Just north of the main workings, on the South Comstock section, four small underlay shafts have been sunk by parties of tributors (marked (1) to (4) on plan). In the first two of these the lode was productive, and was stoped for some distance north and south, the ore won being galena. There is still a good deal of pyrites, blende, and galena in the dump-heaps, but they have lately been picked over for blende. No. 2 shaft is said to be 80 feet deep, and if so it

would be an easy matter to connect this with the lower adit by means of a rise. This would give good air in the adit, and enable the lode to be examined above the adit at this point. As the tributors were only looking for galena, it is quite possible that they may have left workable bodies of blende standing. Shafts Nos. 3 and 4 were sunk on the lode, but no payable galena was cut. In the spur to the north of these shafts the lode is said to have been cut by a prospecting adit (5), but this was inaccessible at the time of my visit. This tunnel is said to have passed through lode-matter for 8 feet without reaching the hanging-wall. The lode was poor, and composed mostly of pyrites, with a little blende and galena. There is said to be mixed metal in the face.

The next shoot of payable metal was found about 400 feet north of the prospecting tunnel. There are five shafts, numbered 6 to 10, sunk along the course of this shoot, which is said to be almost continuously stoped for a distance of 180 feet, to a depth of 35 feet from the surface. The old main shaft (No. 11) was sunk by the Comstock Company; the lode is said to have been 4 feet 6 inches wide at this point and there is a large amount of second-class ore at the surface which has already been picked over for blende, but much of it would still pay to concentrate. The ore is banded, and consists of galena, pyrites, blende, and a little calcite. North of these workings the lode appears to have been faulted to the west. It was lost when working north from shaft (10), but subsequently picked up again to the north of the dam at shaft (12). Here the lode was surface-stopied for over 100 feet, and there is still a lot of concentrating ore at grass. North of this again, shafts 14, 15, and 16 are all said to have been sunk on good metal, viz., from 18 inches to 2 feet of galena. The ground is worked to a depth of 30 feet, and there is said to be good metal underfoot, which could not be taken out on account of the water. Going north the lode is said to have turned to blende, and was useless to the tributors. To the north-west of these workings is Whitelaw's shaft, which was sunk with the aid of machinery to a depth of 100 feet. From the bottom a crosscut was put in, and the lode was cut. It was driven on for a short distance north and south, but the lode was mostly composed of zinc-blende which, at the time, was unsaleable. The lode is said to have contained up to 14 feet of solid blende. Lately the dump-heap has been picked over, and 34 tons of zinc-blende, averaging 54 per cent. of zinc and 3½ tons of galena, were obtained. This was all

27/36

mined from the drive at the 100-foot level. Two more small shafts, (18) and (19), were sunk about 30 feet on what is said to be a good shoot of ore, but they are almost in the bed of the creek, and the water was too heavy. There is said to be about two feet of good galena ore in the bottom of these shafts. North of these again there is a pot-hole (20), in the bottom of which there is said to be 8 feet of pretty pure blende. These are all the workings on the main lode. As most of them were full of water at the time of my visit, I was only able to examine the lode *in situ* in a few places. I am indebted for much of the above information to Mr. M. McDonnell, a miner who has been working in the district for many years. From the extent of the old workings, and from the character and quantity of the second-class ore on the numerous dump-heaps, it is evident that the lode is a very large and strong one. It must be remembered that the tributors worked under very great difficulties in contending with a heavy inflow of water, and that the galena was to them the only mineral of value. When the lode is worked by the company from the lower adit, not only will the water difficulty be overcome, but the large bodies of zinc ore which have been proved to exist will become available. It is therefore evident that the prospects of profitably exploiting this lode in the manner now proposed are excellent.

*The West Lode.*—This lode was cut in one of the cuttings of the Comstock Tramway to the west of the northern workings on the main lode. There is here a very wide decomposed formation containing bunches and masses of pyrites, blende, and a little galena. A little to the south of where it is cut in the railway two tunnels, (21) and (22), were put in to test the formation. The upper tunnel, (22), passed through the formation, but, with the exception of a good deal of pyrites with some blende and galena, nothing of importance was cut. In the lower tunnel a seam of galena was cut, from which several parcels of ore were obtained, but the ore was patchy. As this lode is a very large formation, it deserves to be further tested, and this may be most conveniently done by cross-cutting from the main drive when this has been brought up from the lower adit.

*No. 2 Lode.*—This is situated on the Comstock section, to the east of the main lode. It is a large pyrites formation carrying seams of galena and blende. A little mining work has been carried on from two inclined shafts, (22) and (23). From the former I am informed that 35 tons of galena

were obtained, worth £10 10s. a ton, as well as 7 tons of good blende; from the latter, 10 tons of galena and several tons of blende. Pretty dense pyrites with some blende is also exposed in trenches marked 25 and 26, so that it is evident the formation is of a large and irregular nature at this place. This is probably the same lode which was cut about 600 feet to the south of these workings, where a shaft (27) was sunk and some very high-grade galena, assaying 140 ozs. to the ton, was obtained. There is a good deal of pyritic blende ore with some galena still lying on the tip. A crosscut has already been driven for some distance from the end of the lower adit, with the object of cutting this lode. The country in the end of this crosscut is a highly-fractured graphitic slate, and may be connected with a lode formation. Graphite is, however, not looked upon as a favourable indication for ore. The crosscut has still about 150 feet to go before it comes into the line of No. 2 lode. It should therefore be continued, and when the lode is cut it should be driven on north.

*The East Lode.*—This is a fine-looking blende lode exposed in a shallow surface stope, to the east of the road from Zeehan, for a distance of 150 feet. The blende is very massive, but is mixed with a small quantity of pyrites and galena. In width it goes up to 12 or 14 feet, and for the whole 150 feet would average 5 feet in width. It is at present being worked for blende by Messrs. Allison and O'Neil. Fifty feet south of this there is another open stope on what is probably the same lode, from which some galena is said to have been obtained. There is from 9 to 12 inches of blende showing in the end of the stope at the present time. This lode has been also traced northwards from Allison's stope by several trenches. This lode should also be attacked from the lower adit. If No. 3 lode is driven on north from the end of the west crosscut, the lode could be most readily reached by means of a crosscut from this drive; this would give 140 feet of backs up to Allison's workings.

The Zeehan South Comstock Company has, in my opinion, a valuable property in these two sections, and it is to be hoped that mining operations will be carried on on an economical basis. Up to the present operations have been carried on with little or no working capital, and in consequence the mining methods employed are most uneconomical, and the cost greater than the grade of the ore will stand. The mine must be worked on a large scale, and the cost of pumping avoided by working from the lower adit. This adit has been driven by a former company almost to

the centre of the mineral-bearing area, and it now only remains to drive along the lodes in order to get below the outcrops of the several large shoots of ore which have already been opened up along the surface.

*Section 158M.—Stewart, Nicholas, and O'Neil.*

This is a 39-acre section, west and adjoining the Comstock. A few chains to the west of the eastern boundary a strong lode formation has been found, consisting mostly of pyrites, with a little blende and steatite. This lode appears to strike to the west of north. It has had very little work done on it so far, the lode-capping having been merely broken into. It has the appearance of being a strong lode, and should be prospected by deep trenching along its line of strike.

About 6 chains north-east from the south-west corner peg another lode has been cut. It consists principally of gossan, with patches of iron pyrites. The gossan consists in part of dense limonite and in part of soft iron oxide, with a little yellow ochre (lead oxide) through it. An assay from the latter is said to have yielded 51 ozs. silver to the ton. I took a sample by chipping the whole lode-matter here and there, and this, assayed by Mr. W. F. Ward, yielded 11 ozs. 8 dwts. 16 grs. of silver to the ton. It is probable that the silver is associated with the yellow ochre, which is present in small quantities only. A few chains further west another lode formation has been cut, and some been sunk at this point. Near the north-west corner of the slugs of galena were obtained in a prospecting trench which was put across it. A shallow prospecting shaft has also section, what is probably the continuation of one or other of the two lodes last described has been found on the north side of the ridge which runs through the section. Two short tunnels have been driven on this lode, about 25 feet apart, vertically, and a little stoping has been done. The lode is said to be from 2 to 3 feet wide on the average, going up to 4 feet. There are a few tons of second-class ore at the surface containing galena, blende, and pyrites, which is too mixed to dress without concentrating machinery. Six tons of galena are said to have been sold from these workings, assaying 55 ozs. silver and 62 per cent. of lead. The outcrop of this lode has been picked up as a gossan blow on the top of the ridge, 115 feet above the level of the lower tunnel, and it seems pretty certain that the lode runs right through to the outcrop in the south-western portion of the section. Without being able to examine the lode properly

in the tunnel, I am unable to form an opinion as to the value of the lode at this point, but from surface indications I should say that the lode deserves a further trial. Taking the section as a whole it is certainly worth prospecting.

*The Boss Mine.*

Section 2073-87M. This section is east and adjoining the Comstock and South Comstock sections. There was nobody on the mine at the time of my visit, and there appears to have been no work done since Mr. W. H. Twelvetrees, Government Geologist, visited and reported on the mine in 1900. There are three lodes known on the section, and a good deal of prospecting work has been done, but owing to the flat nature of the country and the large quantity of water met with underground, this is all confined to quite shallow levels. The main lode enters the section on the western boundary, quite close to the north-eastern corner of the South Comstock section. It strikes about 30° east of north, and has been traced right through the section. It is a strong pyrites lode, carrying in places a good deal of blende and galena. Near the boundary it has been trenched across in two places, but here it appears to carry pyrite only. Further north there are some open workings, from which some high-grade galena is said to have been obtained. There are a few tons of second-class ore, consisting of blende, pyrites, and galena at grass. Further north again the lode was cut in a shallow tunnel, and driven on for 70 feet. I was unable to enter the tunnel owing to it being partly silted up. The lode is said to be 16 feet wide, and composed of pyrites and blende, with veins of galena. Five tons of galena were obtained, and 30 tons of seconds were sent to the Argent Mill in Zeehan to be treated.

The west lode consists of a big gossanous outcrop, striking 30° west of north, and forms the ridge of a small hill in the north-western portion of the section. It has been cut at a shallow depth by an old prospecting tunnel, which is now fallen in. At this depth the lode was found to be still composed entirely of gossan, which, like nearly all the gossan in the district, is of no commercial value. This is probably the capping of a pyritic zinc-blende lode, and if so, there is a probability of an enriched zone being met with below the gossan. Another lode in the eastern portion of the section is described by Mr. Twelvetrees, but this was not visited by me. The heavy water will render further prospecting operations on this section an expensive item.

*Section 3728-93m.—A. T. Anderson.*

This section, commonly known as the Susanite, is situated north-east and adjoining the Boss section. A little to the east of the north-east corner of the latter there is a large outcrop of gossan striking about  $30^{\circ}$  west of north. It is composed principally of dense limonite, with fragments of sandstone through it, and is probably the capping of a large pyrites lode. No work has been done upon it on the surface, and I was unable to ascertain definitely whether it had been cut in the tunnel which has been driven from the southern portion of the section. Near the south-west corner of the section, to the east of the Boss, there is a large gossan and pyrites lode exposed. This has been cut about 35 feet from the surface by a tunnel, and a number of irregular workings have been made on the formation. It consists of gossan and pyrites, with small seams of galena associated with carbonate and sulphate of lead. There are two classes of galena present; one a dense fine-grained galena carrying about  $\frac{1}{2}$  oz. of silver to the unit of lead, the other a pure cubical ore containing over an ounce to the unit of lead. About  $2\frac{1}{2}$  tons of ore are said to have been obtained from these workings. A few chains to the east of these workings another long tunnel has been put in on a course N.  $20^{\circ}$  E., but a fall of earth 120 feet from the entrance prevented my examining the lode which was cut. There is a large amount of gossan on the dump, and some sugary pyrites. Associated with the latter, a considerable quantity of mimetite was obtained, which assayed high in silver. From 20 to 30 tons of ore are said to have been sold from this tunnel. I presume that this ore was obtained from the large gossan lode, the outcrop of which was first described. This outcrop is over 100 feet above the level of the tunnel, and the fact of so much gossan being found at the tunnel-level shows that most of the metallic contents have been leached away. It is probable that much of this will have been redeposited at and just below water-level, so that there is a probability of an enriched zone being entered a short distance below the level of the tunnel. The rich secondary silver ores which were discovered in the tunnel may represent the upper portion of this enriched zone. The lode is evidently a strong one, and although I am very doubtful about these pyritic lodes being profitably worked at great depths, I think that where there is evidence of secondary enrichment the chances of discovering a rich bonanza are amply sufficient to justify their exploration down to and for some distance below water-level.

*Section 5266-93m.—G. S. Clarke.*

This section is situated south of and adjoining the Boss, and was formerly owned by the Tasmanian Land Exploration Company. Near the centre of the section two parallel lodes have been worked, which are said to have produced a large amount of galena. There is, however, nothing to be seen now but the old stopes. The lodes strike  $35^{\circ}$  east of north. A main shaft was sunk to 100 feet, and from this level the lodes were driven on, with satisfactory results in both cases. One of them is said to have contained a shoot of ore 200 feet in length, with 12 inches of galena, which was stoped to the surface. The metal is said to be still good underfoot, but the pumping-plant which was erected was inadequate to cope with any increase of water, and the mine was shut down. The ore was the richest which has been produced from the Comstock district.

## THE LITTLE HENTY DISTRICT.

I paid a flying visit to this district, accompanied by one of the original prospectors, Mr. B. Thornes. The district is situated to the south-east of Trial Harbour, along the banks of the Little Henty River. No mining work has been done in the district for many years, and the scrub, which was then all burnt off, has now grown up again to such an extent as to render the country practically impenetrable. It would not be a difficult matter to burn the scrub off again, and this will certainly be necessary before any further prospecting can be done. I was obliged to confine my examination, to the country along the banks of the Little Henty River.

The country to the north of Trial Harbour is serpentine, which junctions with the granite about half a mile north of Reminé. This extends in a southerly direction almost to the Little Henty River, the western contact with the Silurian slates running nearly parallel with the coast-line. On the beach itself hardened slates and quartzites outcrop at short intervals. The serpentine belt is about one mile in width, but narrows down to one-third of this near the Henty River. To the east of the serpentine the country along the river is composed of indurated slates and quartzites for about two miles and a half, when gabbro makes its appearance. This gabbro is probably the same mass that outcrops on the road to Trial Harbour, from the South Comstock section down to M'Ivors'. It is also probably connected with the serpentine at Trial Harbour by a belt

running east and west, as I have found it in two places between the Little Henty and the Main Road to Trial Harbour, but had no opportunity of tracing it right through. To the south of the Little Henty there is much limestone, and this portion of the district is well worth the attention of prospectors.

About three-quarters of a mile from the mouth, the Little Henty River is crossed by a very large gossan lode, striking about N. 20° west. This rises abruptly as a precipitous mass for a height of 200 feet above the river, and then forms the crest of a long ridge running north. Where it crosses the river it is composed essentially of limonite, with a good deal of black oxide of manganese and fragments of hard red quartzite. This blow is situated near the south-eastern corner of Section 1388-93M, and has been traced in a northerly direction up to the northern boundary of Section 102-91M north and adjoining, where, I am told, it consists of massive magnetite associated with large quantities of arsenical pyrites. It has also been traced south of the Little Henty River, where it forms the crest of another spur running through Section 340-91M. This lode is evidently one of the contact metamorphic deposits of the same type as those occurring in the Comstock district. It is not certain, however, whether the limonite at the Little Henty River is derived from magnetite or from iron pyrites. I think it is quite probable that it may have been the latter. The lode is of no commercial value so far as it is at present known, but it is quite possible that if it continues in a southerly direction into the limestone country it may change into a pyritic zinc-lead lode, and in that case would be well worth prospecting.

About a mile further up the river, on Section 1570-93M, there are the remains of some prospecting work which was carried out on a large formation in limestone. The workings were overgrown with dense scrub, and could not be properly examined. A tunnel was put into the hill, and in the rock at the mouth I found splashes of galena, but the lode formation proper does not appear to have been cut. Above this there are a number of old trenches, said to have been made on a limestone formation containing veins of galena. The most promising thing I saw was a gossan formation which had been trenched across and sunk upon for a short distance. A little zinc-blende is said to have been obtained from this sink.

About a mile further up the river still, Marble Creek joins the Little Henty River. I went up this creek for

some distance. The country is mostly limestone, and there are quite a number of lode formations from which iron-stained water oozes continuously; one of these had been opened up in the bed of the creek. It contains iron pyrites, with a little blende and a good deal of magnetite associated with tremolite (?) and calcite. Evidently a characteristic contact metamorphic lode. South from this, I am informed that there is a lot of limestone country containing large gossan lodes, in which a little zinc-blende occurs near the surface. This country should be worth prospecting. The country examined by me was all within the contact metamorphic zone of the granite, and therefore unfavourable for the deposition of large quantities of sulphide ore. Further south, on the other hand, there are all the conditions necessary for ore-deposition, and I think it is quite possible that there will yet be found valuable deposits of zinc and lead ores in this part of the district.

In conclusion, I have to acknowledge my indebtedness to many mining men in the district who have done all in their power to assist me and supply information; especially would I like to thank Messrs. W. Thomas, A. M. Reid, jun., W. Flaherty, M. McDonnell, and B. Thornes. Also, I have to thank Messrs. Pascoe and Watson, of the Magnet Mine, for their valuable help in making analyses of several minerals.

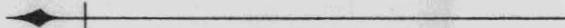
I have the honour to be,  
 Sir,  
 Your obedient Servant,

GEORGE A. WALLER,  
*Assistant Government Geologist.*

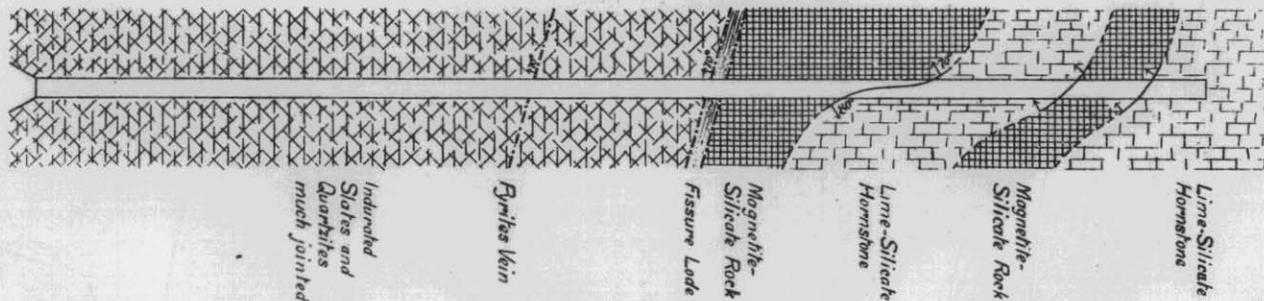
W. H. WALLACE, *Esq.*,  
*Secretary for Mines, Hobart.*

PLATE I.

SECTION EXPOSED IN TUNNEL  
TENTH LEGION MINE



SCALE OF FEET



Indurated  
Slates and  
Quartzites  
much jointed

Rhyolite Vein

Fissure Lode

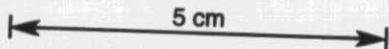
Magnetite-  
Silicate Rock

Lime-Silicate  
Hornstone

Magnetite-  
Silicate Rock

Lime-Silicate  
Hornstone

JOHN VAIL, GOVERNMENT PRINTER, TASMANIA.



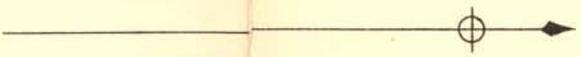
(35)

35/30

36/36

# SKETCH PLAN OF THE COMSTOCK AND SOUTH COMSTOCK MINES.

Scale of Feet



5 cm

