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REPORT ON THE TIN-MINING DISTRICT OF BEN LOMOND.

Government Geologist's Office,
Launceston, 30th June, 1901.

SIR,

ACTING on instructions received from Mr. W. H. Twelvetrees, Government Geologist, I left Launceston on the 10th June to examine and report upon the tin-mining district of Ben Lomond.

The field is a large one, and will, I think, in the near future, become important. There was only one mine actively engaged in mining operations at the time of my visit; but I do not think that this is a state of affairs which will be of long duration. Tin ore is distributed more or less freely over the whole district, and there are, in my opinion, a large number of shows which are well worth opening up. It is, of course, too much to expect that all, even of the promising shows, will develop into permanent ore-producing mines, but, I think that, in a district like this, where tin ore occurs, not only in small veins and stringers, but also in large and massive formations, it is safe to predict that some really good mines will be developed which will contribute in no small degree to the mineral output of the State.

Ben Lomond is situated about 14 miles north of Avoca, and the mining district lies to the south of the mountain. The general geology of the district is, with the exception of some of the occurrences of the greenstone and Mesozoic strata (which do not affect the mining industry in this district) very simple. The general features of the country are shown upon the geological sketch map of the district (Plate I.), and the geological section (Plate II., Fig. I.) appended to this report. The bedrock of the district is granite of Devonian age. This rock solidified under a probably massive covering of Silurian sedimentary rocks—slates, sandstones, &c.; but these have long ago been removed over the greater part of the district. Remnants,

however, remain in several places, especially in the eastern and north-eastern parts of the field, where, in the vicinity of Storey's Creek, a considerable area is still covered by Silurian strata. These rocks are also found in the north-western portion of the field, and further south, very small isolated patches are sometimes encountered on the summits of the highest ridges. The denudation and removal of the Silurian strata must have taken place during the later portion of the Devonian period, for, lying on the top of the granite, and often covering the remnants of Silurian strata, we find horizontal beds belonging to the Permo-carboniferous period. These have however, also been very largely denuded, and in the southern portion of the field, are for the most part confined to the tops of the granite spurs, where the harder grits and sandstones have resisted denudation, and have protected the softer or more easily decomposed granite underneath. Much of the northern portion of the field is overlaid by quite a thin layer of Permo-Carboniferous strata, and through this the granite outcrops frequently. Further north, on the slopes of the mountain itself, the Carboniferous strata increase in thickness until the perpendicular cliffs of columnar greenstone, which form the massive capping of the mountain, are reached. The contact however, of the columnar greenstone and the Permo-Carboniferous rocks is obscured by a heavy talus of greenstone blocks fallen from the mountain. Next to the Permo-Carboniferous strata in question of age are the Mesozoic strata, which are mentioned by Mr. Montgomery* as occurring on the mountain at an elevation of 4000 feet above sea-level, and apparently, from his sketch, overlying the greenstone. Unfortunately, I was unable to examine this occurrence, as, at the time of my visit, the mountain was inaccessible, owing to snow. I found, however, the typical felspathic sandstones of Mesozoic age in the valley of Gipps Creek, at an elevation of only 1400 feet, apparently underlying the greenstone. These rocks are exposed in steep cliffs, rising up on the western side of the creek for a height of about 200 feet. Above these there are, perhaps, 500 feet of columnar greenstone. The dip of sandstone is about 15° or 20° to the south-west. On the eastern side of the creek we find horizontal Permo-Car-

* Report on the Ben Lomond District, 5th May, 1892.

boniferous sandstones resting on the granite. The position is a difficult one to explain, unless we assume that faulting on a very large scale has taken place. Unfortunately, the time at my disposal did not permit me to inquire into this question as fully as I should have liked, and it is quite possible that further investigation may suggest another explanation.

The eruption of greenstone took place towards the end of the Mesozoic period, as has been proved in other parts of the State. Its relation to the Permo-Carboniferous and Mesozoic strata are extremely various and perplexing, sometimes overlying, sometimes underlying, and sometimes breaking through these rocks; but in order to obtain a safe interpretation of all the phenomena presented, it will require a much more exhaustive examination than I was able to give it. The greenstone question is one of the greatest practical importance in connection with our coal measures, and I believe a careful study of the Ben Lomond district during the summer months, when the Mesozoic measures on the mountain could be examined and compared with those occurring in the valley of Gipps Creek, would yield much valuable information.

The district is of great interest from the point of view of the mining geologist, as affording much evidence concerning the origin of metalliferous deposits. As everything which throws light upon this subject is not only of absorbing interest, but of great practical importance, I consider it advisable to describe the occurrences somewhat in detail.

The majority of the granites in which the deposits of tin ore occur are composed essentially of feldspar and quartz, there being very little mica present. Much of the feldspar (orthoclase) occurs in fine large crystals of the Carlsbad twin type, distributed porphyritically through the groundmass of the granite, which is composed of a finer-grained, but thoroughly granular mixture of quartz and feldspar. In many places a rock very much finer grained than the granite, but composed of the same constituents, is to be seen. Only once did I observe this rock *in situ*, and then it formed a small dyke in the granite. It is probable that the other occurrences are of the same nature. Quartz porphyry also occurs, sometimes forming the margin of the granite mass, but at other times possibly forming dykes in the granite. One interesting occurrence is to be

seen on the old Republic Mine, where a quartz porphyry occurs with perfect double-ended crystals of quartz distributed through it. The granite is traversed by numerous veins of pegmatite, varying very largely in composition; occasionally they are found composed mainly of giant crystals of quartz, feldspar, and mica, with needles of tourmaline, and in one conspicuous instance, with very large crystals (up to 2½ inches in diameter, and 5 or 6, or even 10 inches in length) of beryl embedded in the quartz. Mr. W. H. Twelvetrees has examined thin sections of this beryl under the microscope, and has proved the presence of minute enclosures of liquid carbonic acid, proving that the mineral has been deposited under conditions of very high pressure. The pegmatite veins very frequently contain tin ore, and in one case, the old Lomond Mine, extremely rich patches of tin ore were found in a small vein of pegmatite. A careful study of these pegmatite veins proves indisputably that they pass over by insensible gradations, *i.e.*—by loss first of mica and then of feldspar—into quartz-tourmaline veins, which are usually more or less tin-bearing, and these again pass over into plain quartz veins, with only, very occasionally, a content of tin oxide. However, these veins of tourmaline-pegmatite, tourmaline-quartz, and quartz, although all are at times tin-bearing, do not by any means represent the typical tin ore of economic importance in the district. A very small proportion of the tin is found in the veins themselves; it is found very much more abundantly in the rock on either side of the veins, and very often the vein is so small and so insignificant, in comparison with the impregnation which has taken place from it, that it may very easily escape notice altogether. The typical tinstone of the district occurs as a hard, highly quartzose granular rock, seldom containing true mica, but frequently a massive mineral of almost the same composition, locally called porphyry, steatite, talc, &c., but really, I think, being a variation of one of those massive muscovites which have been grouped together under the general name of pinite. Chlorite is also almost always present, even in the hardest portions of the stone. Tourmaline occurs sometimes in large quantities, but more often in the normal tinstone it is absent. Fluorspar is apparently always present; it occurs somewhat sparingly as the filling of

small veinlets running through the stone, though occasionally it is met with in larger masses. Of the metallic constituents, tin oxide (cassiterite) is the most abundant, and the only one of commercial importance. It occurs in fine grains and crystals throughout the stone. Besides this, we find in small quantities, blebs of galena, black zincblende (marmatite), chalcopyrite, arsenopyrite, and pyrite, distributed through the stone. These minerals also occur in small irregular veins and patches, and one case is recorded in which a considerable mass of argentiferous galena, assaying 80 ozs. of silver to the ton, was found in the tinstone at the surface. The component minerals are not evenly distributed throughout the tinstone; often it is composed entirely of granular quartz, and, as a rule, quartz is very much more abundant than any other mineral. After quartz, chlorite is the most regular constituent. Pinite occurs sometimes distributed evenly through the stone, at other times in irregular patches, in which case it is often highly tin-bearing. Topaz is apparently absent. Genetically, the tinstone is closely allied to greisen, but as mica is absent, I think it advisable to retain the miner's term, tinstone. The German miner has the convenient term "zwitter" for such stone, but I am not aware of any English equivalent. The term tinstone must not be taken to imply that tin is necessarily present in payable quantities. I believe it will always be found to contain some tin, but the tin content may fall so low as to become practically indeterminable by ordinary methods.

The boundary between the tinstone and the granite is not marked by any defined wall; there is rather a passing over from the one to the other, though this cannot be said to be gradual, since it takes place within the space of a few inches. The stone in the vicinity of the granite is apparently always poor in tin. From the nature of the boundary existing between the two rocks, only one conclusion can be arrived at, namely, that the tinstone is a product of the alteration of the granite. This conclusion is abundantly demonstrated by an examination of the mineralogical and structural character of the tinstone. In the massive tinstone pseudomorphs of various minerals after feldspar are often to be found. Thus, during my examination of the district I was able to identify the form

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of the original porphyritic crystals of feldspar occupied by the following minerals:—(1) cassiterite; (2) cassiterite and quartz; (3) chlorite; (4) chlorite and quartz; (5) pinite; (6) tourmaline. This amounts to definite proof that all these minerals occur as a replacement of the feldspar in the granite. The replacement is of course not evident in all the stone; it is only occasionally that the shape of the feldspar crystals can be observed, and it was only after diligent search that specimens of evident pseudomorphs of all of the above minerals were obtained. But the fact that replacement of feldspar has certainly taken place by all these minerals in some instances goes far to prove that the whole mass of the stone has been produced by similar alteration.

It is, therefore, very clear that the tinstone has been produced by the action of mineralising solutions circulating through small fissures generally now filled up by pegmatite or quartz. The general composition of the solutions may be inferred from the alteration which they have produced on the wall-rock, and from the minerals which they have deposited. Evidently, they were very highly charged with silica, and contained also in smaller quantities boron, fluorine, sulphur, and carbonic acid. Of metals there were present tin, tungsten, copper, lead, zinc, silver, and probably gold (see later).

The connection existing between the deposits of tinstone, quartz-veins, and pegmatite-veins affords the strongest evidence that they were formed during the latter stages of the consolidation of the granite. We may assume that the solutions emanated from this rock, and are the result of a process of differentiation during the cooling of the granite whereby the residual liquid (or gaseous) portion of the magma becomes very aqueous and very siliceous, and has the property of retaining in solution the heavy metals, tin, wolfram, copper, &c., originally present in the magma. This residual portion becomes expelled from the granite mass through small cracks and fissures, and owing to its high temperature and the presence of boron and fluorine, possesses extremely active chemical properties which are capable of bringing about profound alterations on the wall-rock of the fissure in the cooler parts of the granite mass. It is very possible, indeed probable, that the emanations were above the

critical temperature of water (365° C.), and in this case would be in a gaseous condition. Daubrée, the illustrious French Geologist, long ago proved the extraordinary chemical activity of superheated steam containing boron and fluorine, and was able to produce synthetically many of the minerals which we find associated with tin; so that it is quite certain that these two elements have had a most important part to play in bringing about the phenomena connected with tin deposits.

The above theory, known as the "pneumatolytic" theory of the origin of tin ore deposits, is that which is now very generally accepted by mining geologists as affording a good and sufficient explanation of the facts as observed. I have dwelt upon it at some length for two reasons: in the first place the Ben Lomond district is of exceptional interest as affording very strong evidence in favour of the theory; and, in the second place, I think there is a great probability of a connection being established between the deposits of tin ores and those of other metals, especially those of copper, silver-lead, zinc, and gold. It has already been pointed out that besides tin ore the deposits in the Ben Lomond district contain small quantities of copper, iron and arsenical pyrites, argentiferous galena, and zinc blende (marmatite.) These minerals have evidently been deposited by the same granitic "after-action" process which deposited the tin ore. This is proved by the widespread association of these minerals with the tin ore and the fact that they so commonly occur disseminated through the hard tinstone. It should, however, be added that Mr. A. Montgomery, who visited the district in 1892, considered the galena to belong to a younger generation than the tinstone. This opinion was based upon observations made upon the rich patch of silver-lead ore found near the surface at the Mount Rex Mine. This patch cannot, however, be regarded as the typical mode of occurrence of galena in the district. Judging from the descriptions which have been given me, I think there is no doubt that this patch was of secondary origin, and therefore, does belong to a younger generation, but this does not affect the origin of the original galena in the deposits, for there is everything to show that this was deposited during the formation of the tinstone, and, therefore, by the same solutions which produced the alteration. I think it is also

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very possible that a little gold will be found associated with the pyrites of these deposits. It is generally got in small quantities by alluvial miners when working the surface gravels for tin. I think there is little doubt that its origin is to be found in the pyrites of the tinstone deposits.

Now, the geological proof of the derivation of ores of copper, lead, zinc, silver, and probably gold from the granite by "after-action" processes, is of great interest to the student of ore deposits, for it opens up the question as to how far these pneumatolytic processes have contributed to supplying the metallic constituents of deposits other than those of tin. In the Ben Lomond district there is often a distinct tendency for the copper contents of the veins to increase, and one or two of them have been actually opened up for copper lodes. In my report on the Scamander River Copperfield I have suggested a similar origin for the copper deposits in that district. Subsequent microscopic examination of the ores and rocks from the Scamander and St. Helens districts has gone far to confirm the views I then expressed. On the whole, I think we have in this question a field for investigation which may prove to be extremely fertile.

There is one other mode of occurrence of tin ore in the Ben Lomond district which I must mention. It consists of a highly feldspathic, rather fine-grained, rock, containing, as far as can be seen with the naked eye, quite a subordinate amount of quartz. This tin oxide occurs distributed through the stone in fine grains, and, I believe, is an original accessory constituent. I did not notice any other minerals present. Mr. W. F. Petterd has shown me similar stone from this district, with galena present in the place of the tin, and he tells me that it contains an appreciable quantity of gold. The exact nature of this rock is at present obscure. Unfortunately, I had no opportunity of studying its contact with the normal granite. It is pretty massive, and if it occurs as a dyke, it must be over 20 feet in width. I am inclined to regard it as a product of differentiation during the consolidation of the granite, allied to the pegmatites, but of earlier birth, and deposited from a less aqueous solution. It is more basic than the normal granite, but this may be accounted for by supposing differentiation to take place during

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deposition, the greater part of the silica in the solution being carried on and deposited at a higher level.

Besides the quartz veins associated with the veins of pegmatite and the deposits of tin ore, there is a another totally different set of quartz veins running, as a rule, parallel in strike, and sometimes also in dip, with those already described. These veins are usually much larger. The quartz is of an extremely dense, massive, almost chalcedonic, appearance, and often contains a good deal of iron pyrites. Very often the quartz retains the impressions of crystals of some mineral crystallising in cubes, probably pyrites, but every vestige of the mineral has been removed. These quartz veins are very much younger than the veins which are associated with the tin ore deposits. The latter are always cut off quite sharply by the Permo-Carboniferous measures, and, therefore, were already formed before the latter were laid down. But the newer quartz veins pass up from the granite into the Permo-Carboniferous strata. This is well seen in the adit of the old Ben Lomond mine, of which a section is shown in Plate II., Fig. 3. It will be seen from this section that, near the entrance of the tunnel, the granite is overlaid by strata of the Permo-Carboniferous period, and that about 12 feet in from the adit-mouth a strong quartz vein was cut, rising up through the latter. Further in, several similar veins were cut, as well as one belonging to the older formation. The difference between the two formations is very remarkable; the younger veins cut through the granite without any perceptible alteration of the wall-rock, whereas on either side of the older vein the feldspar of the granite has been eliminated for three or four feet, and been replaced by quartz. These younger quartz veins are widely distributed all over the district; they are, apparently, quite barren, containing no mineral of economic importance; but they sometimes appear filling the same fissure as the older quartz. I noticed one excellent example of this on Section 4851-93M. The fissure had evidently been reopened, and the younger quartz now occurs as a filling of the druses in the older vein. Another case I noticed was where fragments of the old tin and tourmaline bearing quartz were enclosed in the younger massive quartz. It is important that those who are engaged in mining and prospecting in the district

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should make themselves familiar with the appearance of these veins. They are easily recognised, and should not be confused with the veins which are connected with the tin deposits. Unfortunately, in the past, a lot of money has been fruitlessly expended in sinking and driving on these veins without any result. They are frequently met with in the Permo-Carboniferous strata, and, in some parts of the district, the whole of the pyrites has been removed, and the veins occur as big gossan lodes. Many of these were taken up for silver at one time, though, according to Mr. Montgomery's report, it is very doubtful if a trace of silver has ever been got from them.

As throwing further light upon the age of the veins of this quartz-pyrite formation, I must mention a remarkable formation, to be seen at the contact of the greenstone and the granite, near the Mount Rex Mine. Between these two rocks there exists a vein filled with fragments of Permo-Carboniferous sandstones and shales, tightly cemented together with the same dense quartz as is found in the younger veins in the granite. This vein also contains iron pyrites and, in parts, the same impressions of crystals of cubes which I noticed in so many places. I think there is no room for doubting the identity of this quartz with that occurring in the veins in the granite. The vein can be traced for at least over a mile in length, and preserves its character throughout. I think there is no doubt that it is a fault-fissure which was formed after the consolidation of the greenstone, and, since it has been filled with the same dense quartz as occurs in the other veins, it follows that the latter is of more recent age than the greenstone. The greenstone eruption took place towards the end of the Mesozoic period, and therefore the quartz veins are probably of Tertiary age. This occurrence is worth bearing in mind when we are considering the origin of quartz veins. It shows that the mere connection of quartz veins with granite is not sufficient to establish a pneumatolytic, or "after action," origin for the quartz veins. It is not possible for the "after action" to have continued from the Devonian period up to the Tertiary. I think it will probably be found that the phenomena connected with the alteration of the wall-rock will afford valuable criteria as to the origin of quartz veins, and of mineral veins in general.

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The Mount Rex Tin Mining Company, No Liability.

Mr. Mark Ireland, manager. This company holds Sections 4345-93M, 1608-91M, 3473-93M, 1191-87M, 1520-87M, 4547-93M, with a total area of 240 acres ; also eleven other sections, with a total area of 400 acres. The latter are situated about 2½ miles north of the mine, and are held for the purpose of securing an extensive dam-site and water reservoir. The mine is about five miles north-west of Avoca, with which it is connected by two rough cart-roads. The most direct of these is about six miles in length, but is so steep in places, and in such bad repair, that it is impassable for cart traffic. The other road is very circuitous, being about 12 miles in length, but, as the grades are better, all the mine supplies are at present brought by this route. The Government has lately agreed to spend £500 on a new road to the mine, and I understand that a fair grade has been obtained, following in general the shorter of the two present roads. The mine is situated near the boundary of the granite and the greenstone, three of the company's sections being almost entirely in the latter rock (*see* Plate I). Towards the north the granite is overlaid by horizonal layers of granitic wash and sandstones of Permo-Carboniferous age. The granite is composed almost completely of quartz and feldspar, with the latter often developed in large crystals. Several tin-bearing formations are known on the company's sections, the most important, as far as is known at present, being situated about the centre of Section 1191-87M, and all the energy of the company is at present being concentrated upon this deposit. It consists of a large mass or chimney of tinstone, from 60 to 80 feet in diameter. A general idea of the shape of the formation may be gathered from Plate III. Fig. 1 is a plan, and Fig. 2 a vertical section, of the mine workings. Figs. 3 and 4 give separate plans of the mine workings at two levels, showing the contact of the tinstone and the granite as far as has yet been determined. It will be evident from these that the shape of the deposit is very irregular, and the horizontal section is very different at the two levels. It is almost too early yet to form a correct idea as to the strike of the deposit, but, by comparing Figs. 3 and 4, it would appear that the greatest dimension is, approximately, north and south. At the

upper level (Fig. 3) it appears to be a little west of north, but at the lower level appears to be a little east of north. The general strike of many other tin-bearing veins in the district is a little west of north, and there is some reason for believing that this will also prove to be the case with the Mount Rex deposit. The latter is often traversed by small quartz veins, which have a general strike west of north, and it is in all probability these which have served as the channels for the tin-bearing solutions. There are also small, and often discontinuous, veins of fluorspar running through the stone, but these do not appear to have any regular strike. As has already been shown, the tinstone has been formed by the alteration of the granite under the action of hot mineralising waters or vapours. It is not definitely known what the conditions are which determine the alteration of the granite in certain places, or why some parts of the granite should be altered for 20 or 30 feet away from the fissure which has brought the mineralising solutions, while in other parts the alteration has only extended for as many inches. It is probably due to the irregular distribution of minute fissures and cracks through the original granite. However this may be, the fact remains that in all tin-mining districts the zones of impregnation are somewhat irregular in their occurrence. The shape is usually more or less lenticular, and in all probability this will be in general the shape of the Mount Rex deposit. When mining operations have proceeded further, the axis of the lens-shaped mass will be more accurately determined, and it will probably be found that it continues in the direction of its greatest length as a vein, or series of veins, with more or less alteration of the wall-rock. These should be followed up in strike, with the object of discovering other lenticular masses, of the presence of which evidence at the surface is not entirely wanting.

Besides tin, the stone contains small quantities of galena, copper, iron and arsenical pyrites, and zinc blende (marmatite). These minerals cannot be separated by mechanical means, but, by a process of roasting the first concentrates, re-dressing, and leaching with dilute sulphuric acid, practically everything but the lead can be eliminated. The latter is, however, present in such small quantities in the bulk of the stone that it is not anticipated that the value of the bullion will be greatly depreciated;

in fact, I understand that local buyers are prepared to pay for the tin, after usual deductions for freight and smelting charges, &c., at the rate of 30*s*. per ton below the current price of the best Australian tin.

It will be seen from plate III. that a large chamber has been excavated at a depth of about 80 feet from the surface. Part of this had been mined before the present company took over the property, and I have been unable to obtain accurate information as to the amount of tin actually won. The present company has crushed 1160 tons, with the very satisfactory return of 81 tons of concentrates, or nearly 7 per cent. The latter averaged 68 per cent. of metallic tin, and, after treatment in Sydney, were sold at a satisfactory figure. A shaft has been sunk to the south-east of the deposit to a depth of 142 feet. From this, a cross-cut has been driven across the deposit. The tinstone was struck first, at a distance of 48 feet from the shaft. The crosscut continued in tinstone until, at a distance of 126 feet from the shaft, the granite was again met with, making the deposit in this direction 78 feet wide. At distances of 65 feet and 98 feet from the shaft, cross-drivages were put in on either side of, and a right angles to, the crosscut. In three of these the granite boundary has been reached, but the fourth, or most northerly of the cross-drivages, has not yet struck the contact. Since my visit, this drivage has been extended from 20 feet to 36 feet, and is still reported to be in tinstone. The width of the deposit in the direction of this cross-drivage is proved to be over 74 feet. As regards the tin content of the ore at the lower level, this seems to be satisfactory. Some is very rich, and other parts poor, but, as far as one can judge at present, it appears to be about the same as that at chamber-level. The average tin content of the ore-body is a figure which cannot be correctly estimated at the present time. It might be thought that the 1160 tons taken from the chamber, which yielded 7 per cent. of concentrates, might be taken as a fair bulk sample. It is true that the stone was taken just as it came, and was not picked or classified in any way before crushing, but several very rich bands of ore were struck, which must have had the result of raising the average of the sample above that of the deposit as a whole. The average of the deposit can, however, afford to fall a good

deal below this figure. If the deposit will bulk one-fourth of this amount the mine will still be a very payable one. The tin contents are by no means uniform—rich bands and patches occur along with poor ones—and a correct idea can only be obtained after large parcels have been treated in the battery. For the present, all that can be said is that some of the stone is very rich; a large portion is certainly payable; and it is quite possible that, under the economical conditions for mining and treatment which the mode of occurrence and the position of the ore-body renders possible, almost the whole of the ore-body will pay to put through the battery. In order to give an idea of the amount of stone available, I have estimated the amount of stone now proved to exist between the crosscut and the bottom of the chamber: this amounts to 25,000 tons. The actual amount between these two levels must be more than this, because the limits of the deposit have not yet been definitely determined. There can be very little doubt as to the ore-body living in depth. From all we know of tin ore deposits, they are certainly of deep-seated origin. The present position of the surface of the ground can have had nothing to do with the deposition of the tin, because the surface has only been brought to its present position by long periods of denudation, and at the time of the deposition of the tin must have been many hundreds, more probably thousands, of feet higher than it is at present. Moreover, we are unacquainted with any means by which a concentration of tin oxide could be brought about by surface waters, as this substance is unsoluble in all the acids occurring in these waters. The soft and decomposed portions of the deposit may have been enriched by a mechanical process of concentration, but these patches are only very small and unimportant. The bulk of the tin is contained in the hard quartzose tinstone. Even the Ben Lomond district itself affords evidence of the permanency of tin in depth. The Great Republic Mine worked its shoot of ore (compared with the Mt. Rex deposit, a small one) to a depth of 450 feet, and then abandoned it, not because the tin gave out, but because, owing to the low price of tin and the increased cost of mining, the [illegible]ture ceased to be profitable. I think there is every reason to believe that the Mt. Rex deposit will live down to very great depths, though its size and contents may vary at different depths; at any rate, we

can reasonably hope that the mine will become one of the permanent metal-producers of the State.

In the upper portions of the Mt. Rex deposit considerable quantities of galena were found, and, as a matter of fact, the mine was first started as a silver mine. This was on the strength of a large mass of galena, which was discovered on the surface. About 20 tons of silver-lead ore were taken out, which are said to have assayed as muc as 80 ozs. of silver to the ton. The old company drove an adit under the supposed galena lode, at a depth of about 40 feet, and was much disappointed to find a good deal of the galena replaced by tin ore. The mixture of galena and tin proved a most unsaleable product, and cast a cloud over the prospects of the company for many years. Happily, below the old adit level (*i.e.* the top of the present chamber) the percentage of galena in the ore has decreased very much, and is now so small as not seriously to affect the sale value of the tin ore. I think there is no doubt that the galena which was found in the upper-levels was principally of secondary origin, due to the leaching out by surface water of the lead from portions of the deposit now removed by denudation, and the precipitation of the same at lower levels. If this is the case, there need be no fear of encountering other large masses of highly refractory ores in depth.

About 7 chains north of No. 1 deposit, which I have just described, another tinstone formation is exposed in some trenches and open workings. We may call this No. 2 deposit. From No. 2, about 20 tons of stone have been stacked for a trial crushing. The stone is of the same nature as that occurring in the other deposit, and contains nice visible tin. It will be very interesting to learn if this deposit is connected with No. 1. I think it will prove to be another lens-shaped mass connected with the same series of veins which traverse No. 1. It is a promising show, and should receive attention as soon as work on the present deposit is placed on a firm footing.

On the eastern portion of Section 1520 a third (No. 3) deposit exists. Two old shafts have been sunk about 50 feet apart, from which some stoping has been done; an open cutting has also been made. The formation is a large one, and apparently strikes about 70° west of north. Some very rich stone was obtained in years past, and the remains

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of an old stamp-shoe and springer still exists where a party of working men were engaged in crushing the stone. It is stated that over a ton of tin ore was won by this primitive appliance. About four years ago thirty odd tons of stone were put through the battery from this place, and are said to have returned 6 per cent. of ore, assaying 73 per cent. of metallic tin. I learn from Mr. Fritz Rubenach that the good stone is about 8 feet wide—the total width of the formation being from 20 to 30 feet. About 120 tons of stone are now at grass; these have been taken out with the object of obtaining a trial crushing. The stone looks well, and apparently carries a fair percentage of tin.

The company has lately erected a 20-stamp battery, with a complete concentrating and calcining plant, for the treatment of their ore. The battery is situated in a convenient position below the main shaft. The ore from the mine is shot into an ore-bin, from which it passes over a grizzly into a jaw-breaker. The products of both jaw-breaker and grizzly pass into a large ore-bin, which delivers into four challenge ore-feeders. The battery consists of 20 heads of 1000-lb. stamps, crushing to 14 mesh. The pulp passes through a pair of spitzlutten, which separate the sands from the slimes. The former are treated on two compartment jigs, and the latter, after further classification, in spitzkasten, are treated on Wilfley tables. The whole of the tailings are to be passed over a pair of Munday's concave buddles, with the object of catching any tin which may have escaped the other saving appliances. The calcining plant attached to the battery is of somewhat novel design. It consists of six circular compartments, separated from each other by steps and cast-iron bridges. The draught from the furnace passes successively over the ore contained in the compartments. In each of these there is a revolving arm or raddle, put in motion by gearing from the top, which keeps the ore in a state of agitation, and continuously exposes fresh surfaces to the heat of the furnace. Each compartment is connected with the next one lower down by means of a slot in the bridge, which can be opened or closed at will, and thus the rate at which the ore travels from one compartment to another can be regulated. In order to prevent the cast-iron bridges and raddles from burning away, those belonging

to the first two compartments are water-jacketed. It is expected that the temperature in the other compartments will be so low that water-jacketting will be unnecessary. I am doubtful as to the wisdom of introducing a new machine like this on a mine which is just starting operations. As a rule, there are quite enough risks to be run in the mining part of the venture, without trying experiments with new machinery.

The first concentrates from the jigs and Wilfleys are to be calcined to get rid of the sulphur and arsenic, and then re-dressed. This will eliminate the greater part of the iron originally present in the pyrites, but now converted into oxide. The second concentrates will be leached with dilute sulphuric acid, in order to get rid of the zinc and copper. Lead, unfortunately, cannot be got rid of by this means, on account of the insolubility of the sulphate.

The Mount Rex Company has secured a most extensive dam-site and water reservoir, and its capable manager has projected an extensive scheme for water conservation, upon the capabilities of which I am instructed to report by the Hon. the Minister for Mines.

The scheme involves the construction of two large dams on Egan's and Buffalo creeks, about 2½ miles north of the mine. North of the dam-sites, the creeks flow through extensive marshes, which extend almost to the foot of Ben Lomond, and are separated from each other by a low, flat ridge. The largest of these dams, that on Egan's Creek, has already been constructed in part, but in the complete scheme it is intended to increase its present height by 16 feet. When complete, this dam will be 1120 feet in length, and will give a maximum depth of 41 feet of water in the reservoir. The dam on Buffalo Creek will be 272 feet in length, with a maximum depth of water of 21 feet.

The two reservoirs are connected by means of a flood channel across the intervening ridge, so that one by-wash serves both reservoirs. In order to secure as large a catchment area as possible, the company propose to construct a race 3 miles in length, bringing the head waters of the Ben Lomond Rivulet into the watershed of the Buffalo Creek. A temporary race is being made to bring the waters of Buffalo Creek into the present reservoir through the flood-channel. It is expected that this will give a sufficient supply of water to keep the mill going,

except during the very driest portion of the summer. The dam is a very massive structure, and reflects very great credit upon its designer. A detailed description of it will be found in the *Australian Mining Standard*, November 22, 1900. The site is a magnificent one, and when complete will dam back the water for nearly a mile up the marsh. In order to get an idea of the capabilities of the scheme for affording a regular supply of water, it is necessary to have the following data :—

1. The capacity of the water reservoir.
2. The catchment area.
3. The rainfall record for the district.

Concerning the first of these items, this cannot be accurately determined without a very careful contour survey of the reservoir; this was out of the question in my necessarily hurried examination, and I had to content myself with somewhat rough measurements. I estimate the capacity of the two reservoirs, when complete, at 300,000,000 gallons, or 1,334,300 tuns of water. This estimate is liable to an error of perhaps 25 per cent., but I think it is near enough for the purposes of the present estimation.

In estimating the catchment area, I was at a disadvantage in not being able to ascend Ben Lomond on account of the snow; I therefore could not tell what proportion of the top of the mountain, and this is very large in area, was to be included. I have therefore been compelled to make a conservative estimate, and one which I think will be exceeded. My estimate of the catchment area is 6000 acres.

I have before me the rainfall records of the districts of Avoca, Ormley, Fingal, and Mathinna, all in the vicinity of Ben Lomond. Of these the rainfall at Avoca is decidedly the smallest; it is, however, the nearest station to our catchment area, and I have based my calculations upon it. This is certainly very well within the mark, as the greater part of the catchment area is on Ben Lomond, where the rainfall is no doubt much greater than that at Avoca.

In the following table column I. gives the average monthly rainfall for the last ten years. Column II. gives the monthly rainfall for the driest year during the last ten years—1900 :—

TABLE I.

RAINFALL AT AVOCA.

Month.	I. Monthly Average.	II. Driest Year (1900.)
January	1·474	0·89
February	0·578	0·45
March	1·353	0·42
April	1·992	1·01
May	1·421	0·40
June	1·676	1·00
July	1·628	1·58
August	2·141	2·61
September	1·634	0·23
October	1·501	1·12
November	1·102	0·57
December	1·443	1·37
TOTAL	17·943	11·65

In my estimate I have used the figures in Column II., that is, I have taken the lowest rainfall of any year during the last ten years. Before these figures can be used, however, we must allow for absorption, evaporation, &c. The factor of available water discharged by streams draining such an area as we have here would be about ·7 during the wet months, and ·4 during the dry months. I have, therefore, used these factors, the former for all months the rainfall of which was one inch and over, and the latter when the rainfall was under one inch per month. From the figures thus obtained I find that a constant monthly supply of 363,400 tons of water can be taken from the dam throughout the year.

In the following table Column I. gives the available monthly rainfall in inches after allowing for absorption, &c. Column II. gives the amount of water in tons which the rainfall in Column I. represents over the catchment-area of 6000 acres. Column III. gives the amount of water in tons taken from the reservoir each month, and Column IV. gives the contents of the reservoirs in tons at the end of each month. The table starts with August, the wettest month, when the reservoir may be supposed to be full:—

TABLE II.

Month.	I. Available Rainfall.	II. Water flowing to Reservoir.	III. Water taken from Reservoir.	IV. Content of Reservoir at end of Month.
	(inches.)	(tons.)	(tons.)	(tons.)
August	...	...	...	1,339,300
September	0·092	55,200	363,400	1,031,100
October	0·784	470,400	,,	1,138,100
November	0·228	136,800	,,	911,500
December	0·959	575,400	,,	1,123,500
January	0·356	213,600	,,	973,700
February	0·180	108,600	,,	718,900
March	0·168	100,800	,,	456,300
April.....	0·707	424,200	,,	517,100
May	0·160	96,000	,,	249,700
June	0·700	420,000	,,	306,300
July	1·106	663,600	,,	606,500
August	1·827	1,096,200	,,	1,339,300

This proves the water scheme to be capable of affording a constant supply of 363,400 tons of water per month. Assuming the water is used for 25 days in each month, this represents a daily supply of 14,536 tons, or 3,256,064 gallons. I estimate that the battery and concentrating mill now being erected at the Mount Rex Mine will require 1,500,000 gallons daily when working three shifts. There will, therefore, be a surplus of 1,756,064 gallons, or a little over eight Tasmanian sluice-heads per day of 24 hours during 25 days per month over and above the present requirements of the company. As I have already pointed out, the estimate is based upon the driest year in the last 10 years. The wettest year in this period had nearly twice the rainfall of the year taken. In this case the supply would, of course, be much greater, but not necessarily proportionately greater. During wet weather much water will be lost, owing to the dam being full.

The land held by the Mount Rex Company for its reservoir site is, of course, all low-lying, and a large portion of it is covered by Permo-Carboniferous strata. It is possible that, in that portion which is not covered by these strata, tin lodes may exist, but none have so far been discovered. Flat ground is not, as a general rule, a likely place to look for tin lodes, for the very good reason that, as

a rule, they are accompanied by an induration or hardening of the granite in their vicinity, and this naturally produces irregularities in the surface as denudation progresses.

Section 3676-93M (40 acres), A. J. Ritchie. This section is situated directly north of the eastern portion of Section 1520-87M, belonging to the Mount Rex Company, About the centre of the section, and directly north of the Mount Rex No. 3 deposit, a shaft has been sunk on a tinstone formation, from which a few tons have been taken with the object of obtaining a trial crushing. Some of this stone contains very good tin, and is of practically the same nature as that occurring on the Mount Rex Mine. North of this again, there is a second shaft sunk on similar stone, containing a little tin, together with pyrite, marmatite, &c. Both these shafts were full of water, so that the stone could not be examined *in situ*, nor could any idea be obtained as to its extent. The stone is of a favourable appearance, and is well worth testing.

Section 3677-93M (40 acres), A. J. Ritchie. This section is north and adjoining Section 1191-87M, belonging to the Mount Rex Company, and the Mount Rex No. 2 deposit is situated only a couple of chains from the boundary. On the southern portion of this section, a strong tourmaline lode has been exposed in several trenches, and a shaft has been sunk upon it for some distance. A little tin appears to have been got, but the tourmaline stone seems, for the most part, barren.

A quartz vein some feet in thickness, belonging to the younger quartz pyrite formation, occurs near the tourmaline lode, and some work has been done upon it. It should be remembered that this quartz is not tin-bearing, and, as a rule, work expended upon these reefs is wasted. The exception occurs when the younger reef follows the course of an older tin-bearing reef. This does not appear to have happened in this instance.

Section 3460-93M, C. R. Foster. This section is northwest and adjoining section 1191-87M of the Mount Rex Company. On the southern portion of this section there is a lode with apparently well defined walls, about 3 ft. 6 ins.

in width, dipping vertically and striking west of north. Although the walls appear to be well defined, and have more the appearance of the walls of a true fissure vein than of a tinstone lode, I am doubtful if they are really walls. I broke into one of them and found it to consist of similar stone to that contained between the walls. In prospecting the mine, I should recommend the walls to be broken into from time to time, with the object of ascertaining the character of the stone, and whether it contains tin or not. The western wall, at any rate, is occupied by a small quartz vein, which will probably be found to have altered the rock on both sides. A good deal of tinstone has been taken out of a prospecting shaft which has been sunk on the lode, and some of this contains good tin. A trench two or three chains north of the shaft has exposed similar stone. The show is certainly worth a trial.

Section 4234-93M, J. C. Macmichael. This section is situated about three quarters of a mile to the north-east of the Mount Rex Mine. A little to the north-east of the centre of the section a lode, known as "Christoe's Show," has been uncovered by trenching along its course for some chains; the strike is about east and west. The lode consists of small veins of quartz and tourmaline, and on either side of these the granite has been altered by the replacement of the feldspar with quartz, &c., for some feet, and contains some very nice tin ore. The tin-bearing stone goes up to six or eight feet in thickness. Towards the west the stone which is exposed is poorer, but the same characteristics continue. The lode is a promising one, and is worth prospecting. The ground falls sharply to the north, affording good facilities for tunnelling. A large portion of the section is covered with old Permo-carboniferous grits or wash, which is often very difficult to distinguish from granite. Both in an east and west direction the lode must dip under these old beds of wash. It is impossible for it to live through them, since it was already formed before they were deposited. This must be borne in mind when prospecting the section, and care must be taken to distinguish between the granite and the old granite wash. The approximate position of the lode is shown on Plate I.

Section 4260-93M, E. Gaunt. Near the centre of this section a shallow shaft has been sunk on a tin lode about two feet in thickness, and striking about east and west. The stone is the typical tinstone of the district, being composed of quartz, chlorite, &c., with a little pyrites; it is for the most part poor in tin. Further west another shaft has been sunk for a considerable distance on a vein of white dense quartz of the younger quartz-pyrite formation. Curiously enough some tinstone has been got out of the shaft, but the latter cannot be connected with the quartz-reef. It is probable that this quartz-reef has followed the course of an older tin-bearing lode, the old fissure being re-opened at a later date when the younger quartz was introduced. I have definite proof that this has taken place in two other instances in this district.

Section 4652-93M, P. C. Weetman. This section is situated about three quarters of a mile to the north of the Mount Rex Mine. A very promising formation is exposed in the eastern portion of the section. It consists of tinstone of a similar nature to that occurring at the Mount Rex Mine, and contains, in places, very good tin. The surface of the formation is only exposed in a few places at present, and the extent of the tin-bearing stone cannot be determined. It is well worth opening up. A tunnel might be driven from the valley of a small creek to the north of the show. With 100 feet of driving perhaps 50 feet of backs could be obtained.

Section 4851-93M, C. E. Cheshire. This section is about three quarters of a mile south-east of the Mount Rex Mine. Two promising lodes have been discovered on this section. The first examined is situated to the south of the centre of the block and is opened up in a trench, from which a ton or so of really rich stone has been taken. Enough work has not been done to prove the extent of the formation, but the stone is of the same character as that occurring at Mount Rex, consisting of quartz with chlorite pseudomorphs after feldspar; the tin is finely distributed through the stone. The second lode is north of the first, and has had very little work done upon it. Such stone as has been taken out is, however, rich in tin. This lode presents some very interesting features.

The tin occurs, as usual, in the altered granite on either side of a quartz-vein, and where exposed, the stone is very rich. The vein contains quartz belonging both to the tin formation and also to the younger quartz-pyrite formation. The older quartz is easily distinguishable from the younger, being white and crystalline, and forming the lining of both walls of the vein, whereas the younger quartz is dense, light yellow in colour, and occupies the centre of the vein. It is quite evident, in this case, that the older fissure has been reopened at a later date, and the younger quartz has been introduced, filling up the druses formed in the older vein.

Both lodes on this section are promising, and are well worth prospecting.

Section 4986-93M, E. Williams and J. A. Lyall. Several prospecting shafts have been put down on this section, on tin-bearing formations, none of which I was able to examine, owing to the shafts being full of water. In two of these the typical tinstone of the district occurs, and some of it contains good tin. I also noticed a vein of white quartz on the section, containing tin ore. This is not a usual occurrence in the district, as the tin is, as a rule, only present in the altered granite on either side of the quartz vein. The same quartz vein carries a little feldspar in places. I would not be at all surprised to hear that it passes over into a true pegmatite. I should say the the prospects met with, so far, are promising.

The Ben Lomond and Great Republic Mines.

Both these old mines are now held by the same company. The sections include 3750-93M, 3751-93M, 3752-93M, 3990-93M, 4079-93-M, 4232-93M and 4796-93M; with a total area of 200 acres. They are situated about three miles distant, and a little west of north from the Mount Rex Mine. Both the old Ben Lomond and the Great Republic mines were carefully described by Mr. A. Montgomery in 1892, when the latter mine was in operation, and, as there has been very little work done on either since, it will not be necessary for me to go over the whole ground again. In the old Republic Mine, a rather small, but very rich, shoot of tin was

successfully mined to a depth of about 450 feet. The shoot is described as being from 10 to 17 feet in thickness, and from 20 to 30 feet in length. It occurs on a small fissure vein of quartz and fluorspar, and represents a zone of impregnation from this fissure. The shoot appears to have maintained its tin contents as depth was gained, though varying in richness in different places. Shutting down the mine was caused by the fact that the shoot of tin was not large enough by itself to bear the whole cost of the dead-work which its exploitation necessitated. It is most unfortunate that the old company did not do more driving along the vein of fluorspar, with the object of discovering other shoots of ore. Had the company had one or two other shoots to share the cost of the deadwork, there is no doubt that the mine would be working to-day. The mine was abandoned when the price of tin fell so low as to render mining unprofitable. From all I can hear about the mine, I think it is quite possible that the shoot of ore would be payable at the present price of tin, but it would be the height of folly to attempt to work it unless the company were prepared to pursue a vigorous policy of development, by driving along the fluorspar vein in both directions from the known shoot of ore. It is highly improbable that the shoot is the only one on the vein; it is much more likely to be one of a series which can only be discovered by systematic development. The Great Republic shaft is situated in the north-western portion of Section 3751-93M. The mine workings were, of course, inaccessible, and my conclusions are, therefore, based only on the reports of others.

The old Ben Lomond Mine (Sections 3750-93M and 3990-93M) has been practically at a standstill since before Mr. Montgomery's visit in 1892. The two principal lodes (Nos. 1 and 2) are situated in Section 3750. No. 1 is a tinstone formation, on which two underlay shafts have been sunk—one 80 feet, the other 50 feet, in depth. Mr. Montgomery states that this lode was said to have averaged 3 feet 6 inches in thickness, and I note from a report of Mr. J. H. Rilstone's on the property, that it goes up to 15 or 20 feet. The stone at grass is mostly very poor in tin, but, as Mr. Montgomery observes, presumably the best of the stone has been sent to the battery. In the most northerly of the two shafts, a little work has been

done lately, and the stone which has been taken out carries very fair tin. It seems pretty evident, therefore, that Mr. Montgomery's conclusion is correct, and that all the stone carrying payable tin has been crushed. North of these two shafts two more openings have been made on the lode. In the first of these, the tin is, for the most part, confined to the fissure vein, which is from three to eight inches in thickness, and most of it is rich in tin. In the tinstone, or altered granite, the tin appears to be present only in the joints and floors. In the next opening, further north, tin is again met with, but the lode appears to be considerably broken up. The strike of this lode is 37° west of north, and dips to the east. A main shaft has been sunk to a depth of 100 feet, with the object of working the lode, but I could not ascertain if the lode had ever been intersected by crosscuts from the shaft: I think probably not. As to the economic possibilities of this lode, I cannot pretend to have been able to come to any conclusion, as I could not examine it where it had been best opened up, owing to the two underlay shafts being inaccessible. The character of the stone is favourable, carrying, as it does, small veins of fluorspar, and I think it is certainly worth a trial.

No. 2 "lode" appears to have been a rich patch of ore which cut out about 12 or 15 feet from the surface, but from which about 38 tons of tin ore have been won. Little is to be seen now at the surface to indicate the former presence of the tinstone, as the bottom of the open working is now mostly covered with mullock. From Mr. Montgomery's report I note that the lode continued downwards, "as a small vein of quartz and quartzose granitic matter, showing little or no tin, and enclosed in hard country." The rich patch, moreover, was "in soft granite, and when the hard country came in the ore died out." From what I can learn of this deposit, the whole of the tinstone was quite soft, and of a different nature from that which I have described as the typical tinstone of the district. Under these circumstances it is possible that a large amount of mechanical concentration of the tin oxide may have taken place near the surface. The open working from which the tin was taken has been driven under, at a depth of 120 feet, by a long tunnel, and, with the exception of a small vein of quartz less than

a quarter of an inch in thickness, nothing was found to which the tin above could be attributed. It is possible that, by following up this small vein, other patches would be discovered, but, unless this could be done in conjunction with other necessary mining work, I do not think it would be worth following.

The Ben Lomond adit, a very unnecessary piece of work at the time when it was put in, is 735 feet in length, driven on a course of 57° east of north, and is still 120 feet short of No. 1 lode. Its chief interest at present is that it affords valuable information concerning the age of the lodes of the quartz-pyrite formation. In Plate II., Figs. 3 and 4, the tunnel is shown in plan and section. From the section it will be seen that the first 140 feet were driven through Permo-Carboniferous wash, overlaid conformably by shales of the same age. It is often extremely difficult to distinguish between this wash and the decomposed granite. Mr. Montgomery, on his visit to the mine, was unable to examine the tunnel beyond the first 100 feet, and, therefore, had no opportunity of comparing the stone near the mouth of the tunnel with that occurring further in. Under these circumstances, I am not surprised that he mistook the old granitic wash for granite, and, in his report, gives a sectional sketch of the mouth of the adit, showing the granite apparently intrusive in the Permo-Carboniferous shales. In Mr. Montgomery's sketch, if we alter the granite to granite wash, conformable with the shales, the meaning of the section is at once apparent, and the positions of the strata are satisfactorily explained by faulting. The same section is shown to a smaller scale in Plate II., Fig. 3.

I noticed that seven different veins or lodes had been cut in this tunnel. In order not to lead to confusion with other older descriptions which may be in existence, I have denoted these veins with letters A. to G., in the order in which they were struck in the tunnel.

Vein A. was struck about 12 feet from the mouth of the tunnel. It is a very strong reef, composed of dense flinty quartz, and a good deal of pyrite. Apparently, it is quite barren. It cuts through the Permo-Carboniferous wash, and is, therefore, younger than these rocks. As I have shown elsewhere, there are strong reasons for believing that the veins of this quartz-pyrite formation are

as late as the end of the Mesozoic period. The fact that these are younger than the Permo-Carboniferous rocks is the strongest evidence that they do not belong to the tin-bearing formation. Were there no other reasons for believing the tin to be older than the Permo-Carboniferous rocks, the presence of alluvial tin in ancient wash of Permo-Carboniferous age (at Roy's Hill and, to a limited extent, also, in the Ben Lomond district,) would be abundant proof of this.

Veins B. and C. are both strong formations, composed of the same dense quartz. Here the country rock is granite, and the reefs cut through this rock without producing any perceptible alteration of the walls, the feldspar being quite unaltered.

Vein D. is a small one, striking a little west of north, and is composed of quartz and mica. It apparently belongs to the tin-bearing formation, but it was not well exposed.

Vein E.—This is a typical vein of the tin-bearing formation. It consists of a small vein of quartz and a little kaolin, with the feldspar in the wall-rock converted into quartz for a distance of 18 inches to 3 feet on either side of the vein. It has been driven on on both sides of the adit for a total distance of about 100 feet, and the stone has been shot away overhead for a distance of 10 or 12 feet. I did not notice any tin in the stone, but it is quite possibly present. In any case, the vein is worth following up. The strike is about 30° west of north, and the dip easterly.

Vein F strikes almost at right angles to the majority of the others met with in the adit; namely, 50° east of north, dipping to the south. It is a strong reef of the quartz-pyrite formation, and is, evidently, the line of a fault of considerable magnitude, as shown by the large amount of crushing to which the granite has been subjected. This reef will probably be found to fault all the tin-bearing reefs which it crosses. This is a point worth bearing in mind.

Vein G is very small, being in places less than $\frac{1}{8}$ of an inch in thickness, and certainly very little, if any, alteration of the granite has taken place in its vicinity. Still, from its general appearance, I am inclined to regard it as belonging to the tin-bearing formation. It appears to be

the only continuation of No. 2 deposit on the surface which has been struck in the adit. If driven on, it would probably widen out. All these reefs are shown in the plan and section of the adit in Plate II. The only one worth paying further attention to, in my opinion, is Vein E.

On the southern portion of section 4232 a new lode, known as "Rilstone's" lode, has been uncovered in a surface trench. It consists of a small vein or fissure, with the wall-rock altered on either side. A good deal of the stone carries nice tin. The strike of the formation is about 30° west of north, and the dip easterly. That it has not been struck in the adit is, I think, to be accounted for by the fact that, where it crosses the adit, the latter is in Permo-Carboniferous strata into which the tin-lodes never penetrate. If this is the case, it is quite possible that it may exist in the granite below the Permo-Carboniferous strata which has been passed through by the adit. The show is certainly a promising one, and is worth a trial.

On the most northerly of the sections held by the Ben Lomond and Republic Company (3752-93M) there are two formations which I consider well worthy of attention. The first of these is situated about the centre of the southern portion of the section. It consists of a large formation of stone of a similar nature to that already described as the typical tinstone of the district. I did not see any tin in the stone, but it contains a little zincblende and pyrites. The second formation is situated some chains to the north-east of this, and is of a different character. The stone here is composed almost entirely of white feldspar, with a little quartz. A large open cutting has been made, and evidently the greater part of the stone has been removed and crushed. About 20 tons, however, are still at grass, and all this contains good tin distributed through it in fine grains. If this 20 tons can be taken as a sample of the stone, the show is certainly payable. Unfortunately, owing to the excavation being full of water, I could not examine it *in situ*. Very similar stone, belonging probably to the same formation, is met with in another excavation further south, but most of the stone at grass is poor in tin. I was told a crushing had been also taken from this hole, so that, presumably, the good stone has all been removed. The formation is a large one, and if it can be proved to contain even a small percentage of tin it

would be very valuable. This is a really promising surface show and should not be allowed to remain untried.

These were all the shows which I examined on the Ben Lomond and Republic Company's sections. Several of them are, in my opinion, very promising, and are well worth prospecting. The company holds a large area of ground, and to do it justice will require the expenditure of a large amount of capital.

Section 5305-93M, J. Rilstone and T. Briggs. About the centre of this section two parallel holes have been cut in a number of trenches. They are about 40 feet apart, and strike 30° west of north. All the trenches were full of water, so that the stone could not be examined *in situ*. Judging by the stone at grass, this consists of the typical tinstone of the district, and contains very fair tin. Mr. Briggs tells me that the tinstone is about 7 feet wide in the lode on which most work has been done.

Sections 4397-93M and 4395-93M. These sections, formerly known as the Lomond Tin Mine, are not held at the present time. An extraordinarily rich patch of tin was discovered and mined some years ago. The stone is described as being almost massive tin oxide, containing 80 per cent. of ore, and, indeed, numerous large blocks of stone still remain which would carry nearly this percentage. The shoot appears to have been very limited in extent, and to have cut out at 10 or 12 feet from the surface. The vein where I saw it was composed of pegmatite and contained little bands of dense massive cassiterite, as well as a good deal of tin in the form of small grains. In some places the country rock has been slightly altered, but to no great extent. The vein has been traced for a long distance through both sections. If the vein were exploited other rich patches would no doubt be met, but the venture would, to say the least of it, be a risky one.

Section 3865-93M. I understand this section is held under a Prospecting Licence by J. Rilstone. Near the north-west corner of the section a lode exists on which some stoping has been done from an underlay shaft. The stopes are mostly fallen in now, and I could not get a good view of the formation; it is striking a little to the north

of west and dipping towards the south. The lode is about two feet in width. Most of the stone has been removed and, presumably, taken to the battery. Some of the stone at grass carries very fair tin, but of course the best of it has been taken away.

The St. Aubyn Tin Mining Company.

This company holds 18 sections, comprising 930 acres, charted in the names of W. Martin, R. J. Sadler, P. Barrett, and S. Pinnington. Unfortunately, no one was present at the mine at the time of my visit, and it is possible that I did not see everything which was to be seen. The sections are situated at the head of Gipp's Creek, about three miles north-west of the Ben Lomond Mine. Section 4484 was the most promising of the sections visited by me. On this section several large quartz-tourmaline lodes have been discovered carrying a fair percentage of tin. The first of these examined is situated in the south-east portion of the section and on the southern slope of a creek which flows diagonally through the section. It is composed of quartz and tourmaline, with a little tin. The quartz is of two generations, one belonging to the tin formation, and the other to the younger quartz-pyrite formation; the latter often enclosed angular fragments of the former in its mass. This lode, where exposed, does not carry payable tin. A little further west and on the same side of the creek there is a large quartz-tourmaline lode; it has been broken into in the end of an excavation which has been made alongside it for a distance of two feet six inches, but the hanging-wall was not reached, so its actual width is unknown. The stone is composed of hard quartz impregnated strongly with tourmaline; in places the latter is nearly massive, and contains a good deal of tin distributed through it in large brown crystals. The quartz also contains some visible tin, but it is difficult to identify on account of the presence of the tourmaline. A little wolfram is also present. On the other side of the creek what I take to be the same lode, or a parallel one of the same nature, has been cut. It is 5 or 6 feet wide, and is composed of quartz and tourmaline, with a fair percentage of coarse brown tin distributed through the stone. East of this, and higher up the creek, a couple of trenches have

been cut, from which a great deal of similar quartz-tourmaline stone has been got. The lode, however, as far as I could see, has not yet been found *in sitú*. Some of the blocks are rich in tin and evidently come from a strong lode. It is thus evident that two or more strong parallel lodes occur on this section. The results which have been got by surface trenching are most encouraging, and they should be followed up by a more thorough scheme of exploitation. I should recommend an underlay shaft to be sunk upon the most promising of the lodes, and the stone taken from it to be carefully sampled or sent to a battery. The desired information may be had by sampling, provided sufficient care and labour is expended on it, but a battery test is generally more convincing.

On Section 4452 a tunnel has been driven into the side of the hill for a considerable distance. It starts in a north-easterly direction, and after 93 feet of granite had been passed through, a strong quartz vein, 3 feet in thickness, was cut. This vein strikes west of north, and dips easterly. It was followed for at least 180 feet, but at this point the roof had fallen in, and I was unable to proceed further. The vein is evidently one of the quartz-pyrite formation, and, therefore, could not be expected to carry tin. Above the adit three underlay shafts or winzes have been put down. One of these follows the quartz-pyrite vein, and connects with the drive below, near where the adit struck the vein. The other two have been sunk on a tourmaline quartz vein, carrying a good deal of copper pyrites. This is apparently parallel, and very close to the other vein. That this vein has also been cut in the adit is shown by the presence of quartz, with tourmaline, copper pyrites, and a little tin oxide at the mouth of the tunnel. Not having had an opportunity of seeing this tourmaline-quartz lode *in situ*, I am unable to form any opinion as to its value, but, according to Mr. Montgomery's report, the lode is well worth a practical trial. Two other tunnels have been driven on the property, one of them being 560 feet in length. This was driven for a large part of the distance on a course of 12° west of north, or just about parallel to the general strike of the lodes in the district. It is, therefore, not surprising that very little was discovered. All this work was done a long time ago. A large amount of money was spent upon it, but so

injudiciously that it cannot be said that the prospects of the mine are any better or any worse than before it was spent. It has been practically thrown away, though possibly some of the old tunnels may be used in further prospecting the ground.

On Section 4453 a vein carrying some very good wolfram ore has been cut in a small trench. Unfortunately, the trench had partly fallen in, and I was unable to examine it *in situ*, but certainly the stone at grass looks promising. I take this vein to be a parallel one to two others occurring on the Ben Lomond Tungsten Company's ground, which will be described below.

There is some alluvial ground on the Company's property, but time would not permit of an exhaustive examination. Without this, it is impossible to form an opinion as to the value of alluvial ground.

The Ben Lomond Tungsten Mining Company, No Liability.

This company holds Sections 3679-93M, 4802-93M, and 4918-93M, with a total area of 72 acres. The mine workings are situated about the centre of Section 3679. No. 1 vein, on which most work has been done, is from 18 inches to two feet in thickness, and consists of quartz, tourmaline, tungsten, and very small quantities of tin and galena. It is very flat, dipping not more than 20° to the south, while the strike is about east and west. No. 2 vein is parallel to No. 1, and, perhaps, 20 feet below it, vertically. It is, apparently, of exactly the same nature and about the same size. These flat veins or reefs are not uncommon phenomena in connection with intrusive masses of granite. The original fissure is believed to be caused by the contraction of the granite during the process of cooling. They usually occur as a series of veins, roughly parallel to the margin of the granite mass. Plate IV., Fig. 1, gives a diagrammatic representation of similar occurrence at Zinnwald, in Saxony, after H. Zinkeisen.*

No. 1 vein has been opened up along its outcrop for a distance of a couple of hundred feet, and the stone taken out until the overburden increased to 8 or 10 feet. In the eastern end of the workings a tunnel has been driven

* R. Beck. Lehre von den Erzlagerstätten.

along the vein for a distance of about 30 feet, and a portion of the vein has been stoped out. Some of the stone lying at grass is very rich in wolfram, and all of it contains a little. The vein will, probably, prove to be patchy, but, judging by the work done, the patches are fairly close together. Mr. T. Briggs, the late mine manager, tells me that 16 tons of wolfram ore were obtained from the mine, assaying from 68 to 70 per cent. of tungstic acid. There is a small crushing and dressing plant on the mine; it consists of a jaw-crusher and rolls combined, and a Wilfley table, the power being supplied by a small vertical engine. The crushing apparatus is a mere toy, and totally inadequate to crush the hard stone in which the wolfram is enclosed. Mr. Briggs tells me that a ton of quartz per shift was as much as could be treated. Under these circumstances, I am not surprised to hear that, as soon as the price of tungstic acid fell, the mine ceased to be profitable. I think that it is very possible that, with more appropriate machinery, the mine would become a profitable concern. It does not want a large plant, but one which will be effective. I should suggest a jaw-crusher, preferably with the greatest motion at the top end of the jaw (*i.e.*, pivoted at the bottom), in order to get as uniform a product as possible. This would crush to $\frac{3}{4}$-inch cube. The sands and slimes should be screened off, and treated on the Wilfley table, and the coarser product treated on a jig. The tailings from the jig might be recrushed in a ball-mill of the Grüssonwerk type, and treated on another Wilfley table.

Storey's Creek Tin Mining Company.

Sections 3272-93M, 3275-93M, and 856-93M. In all 125 acres. This mine is situated in the north-eastern portion of the field. The country rock is composed of Silurian strata, overlaid in parts by Permo-Carboniferous grits and sandstones. A great deal of alluvial tin has been obtained from these sections in years past, and two men are still working the surface soils and gravels. That the wash is rich is shown by the fact that in many places the surface soil has been stripped, even where it is only six or eight inches in thickness. At the time of my visit, unfortunately, there was no one at the mine, and I did not see all

the workings. As far as I can learn, the only underground mining which has been carried on of late years is in connection with some quartz veins which were worked for wolfram. One of these veins has been followed, striking west of north from the valley of a creek into the side of the hill by means of a tunnel. At 120 feet a crosscut was driven to the east, and, about 10 feet away from the first, a second parallel vein was cut. These veins have both been stoped out above the tunnel for about ninety feet in length. At the end of the stoped ground the two veins are close together. At this point the western vein is 2 feet in thickness, and the eastern vein 18 inches, with about two feet of mullock between. I could not examine the drive further, on account of the water being dammed back at this point. The crosscut mentioned above was extended for over 300 feet, and, about 70 feet from the drive, another lode was cut, one or two feet in thickness. This was also driven on and some stopes taken out, but, again, the water prevented me from completing my examination. In all these veins the stone carries a little wolfram, and, of course, the parts which have been stoped were much richer than that which has been left. I am told that another good shoot of ore is exposed in one of the drives; but this I did not see. Apparently, the results obtained by the company were not satisfactory, as it has sold its battery and concentrating appliances, and these have lately been removed. From Mr. Montgomery's report, I note that a number of small tin veins had been discovered on the property. To these he attributes the presence of the alluvial tin.

Egan's Freehold.

Lot 982. 620 acres. This freehold property was leased some time ago to a party of prospectors, who set about prospecting it in a very energetic manner. Several lodes have been uncovered, the most promising of which is exposed in a good-sized excavation. The stone is composed of quartz and massive muscovite, with a little tourmaline. Most of the stone taken from this hole carries little or no visible tin, but one paddock, containing, perhaps, 20 tons of stone, carries good tin. The venture has been abandoned, but I think there is still a possibility of a good shoot of stone being discovered.

Section 5051 (Brooks' and Millers')—I visited a small prospecting shaft on this section, from which some tin-bearing stone had been taken out, containing also tourmaline and a little copper pyrites. The stone has been apparently taken from a large formation, but I could not examine it *in sitû*. Several trenches have been cut to the west of the shaft, from which similar stone has been obtained.

The Demmocks Prospecting Association.

Sections 4568-93M, 4539-93M, 4482-93M, 4483-93M.—These Sections are situated on a steep granite spur, which runs in a north and south direction, several miles to the east of the country I have been describing. On the top of this spur several parrallel tin lodes, striking W. of N, have been discovered. They are all, practically, of the same character, being composed of granular quartz, with a little tourmaline, chlorite, &c.—in fact, the typical tinstone of the district. These lodes have been exposed in a great number of trenches and small shafts, and almost everywhere I was able to find tin in the stone; a good deal of it contains fairly rich tin. The lodes are from four feet up to 12 or 14 feet in width, and look very promising. Eventually, they could be mined by means of adits driven from either side of the spur, but, for the present, it would be more economical to sink a shaft and cross-cut across the whole system. From this cross-cut, each lode should be driven on, and the stone which is taken out should be carefully sampled. The show is a really good one, and is well worth developing.

The Excelsior Mine.

This mine is situated to the east of the Demmocks Prospecting Association. Unfortunately, I had not heard of it when visiting the district, and, therefore, did not see it. Mr. Fritz Rubenach tells me the show is an excellent one.

The mines which have now been described include all the tin lodes which I visited in the Ben Lomond District proper. I was agreeably surprised at the promising character of many of them, and I am still surprised that the district has not attracted more attention from the

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investing public than it has done. The cause, however, is not far to seek. A large amount of money was expended in the district some years ago, and that having failed to develop any good mines, it was naturally supposed that there were none to develop. As I have already pointed out, the greater part of this money was spent so unwisely that it did not really affect the prospects of the field at all. In the only mine on which work has been carried on to any depth, it was proved that the shoot of tinstone which was first discovered lived down. That it was not large enough by itself to bear the whole cost of developing the mine is not surprising, and is no discredit to the field; but that it lived down as far as it was followed is, to say the least of it, most encouraging to other mine owners. On two other mines a large amount of money was spent without finding anything of value. Had the intention been to avoid coming in contact with deposits of tin, the money could hardly have been more effectually expended.

At the present time the prospects of the district largely depend upon the result of the Mount Rex Company's operations. This company has a good mine, and a good manager, and I have very little doubt of the success of the venture.

The South Esk Tin Mining Company, No Liability. (LEONA)

Mr. A. Farquhar, mine manager. This company has acquired mining rights over a freehold block of 220 acres granted to J. Gilligan. The company also holds Sections 3937, 4869, 4281, 4895, and 3979, all 93M, with a total area of 76 acres. The mine is situated about 3½ miles north-east of Avoca. The ground which is at present being worked is in the western portion of an extensive alluvial flat, on the north side of the South Esk River. Gilligan's and Storey's creeks flow into the South Esk from the north, the former at the western, the latter at the eastern end of this flat. Besides these, several other smaller creeks flow into the South Esk (*i.e.*, across the alluvial flat) between the two larger creeks. There is strong evidence that the alluvial tin which the company is working has been brought down by these creeks. The company has been working along the western end of the alluvial flat, and has already worked the lead for about

9 chains in length. After the first 3 chains had been worked a granite bar was struck, which had to be cut through. This was about 2 chains in length. The total depth of the wash is from 15 to 20 feet, but, unfortunately, only a small portion is tin-bearing. The seam of tin-bearing wash varies from 1 foot up to 5 feet in thickness, and would average about 2 feet. To gain an idea of the quality of the wash, I measured up the last paddock which had been taken out, and from which Mr. Farquhar tells me he has obtained 6 tons 17 cwts. of tin. The total amount of dirt shifted amounted to 7746 cubic yards, and taking the tin-bearing wash as 2 feet in thickness, the total amount of the latter was 815 yards. This gives an average of ~~3¼ ounces~~ of tin per yard of dirt shifted, and a trifle over ~~2 lbs~~. per yard for the 2-feet seam of tin-bearing wash. The paddock paid its way, but I understand the margin of profit was very small. The lead of wash appears to be divided into two in the present face. The western half of the lead is composed almost entirely of granitic material, and this appears to be heading towards Gilligan's Creek. The eastern half is largely composed of the *débris* of Silurian quartzites, slates, &c., and appears to be heading round along the northern edge of the flat. It is remarkable that in both portions of the lead the tin appears to be always associated with fragments of dense yellowish quartz, evidently belonging to the quartz-pyrite formation, which I have already shown to be widely distributed throughout the Ben Lomond district. This is very strong evidence that the tin also has been derived from this district. We may, therefore, regard Gilligan's and Storey's Creeks, and the other smaller ones between them, as the feeders which have carried the tin from the hills to the alluvial flat. These creeks emptied their burden of gravel and tin into the channel of the South Esk River, and the latter deposited it in a more or less concentrated form in its bed. Mr. Farquhar tells me that the quality of the wash is improving as they go on, and he hopes that a good lead will be found to continue round the northern edge of the flat. I think this is very possible. The company is at a disadvantage as regards water supply, as there is only sufficient to carry on work during the winter months. The ground is very flat, and all the dirt has to be elevated hydraulically.

Erratum
2 lbs.
P.B.N.
18·8 lbs.

There is not sufficient water to enable the nozzle to be used for breaking down the dirt, and the more laborious process of ground-sluicing has to be resorted to.

North of the mine workings a little prospecting has been done, and a lead of tin has been traced underneath what was originally thought to be decomposed granite. This is, I believe, an old granite wash of Permo-Carboniferous age. Careful observation reveals the presence of the rounded outlines of the old boulders which have decayed in their present position. The intervening spaces are filled with granite wash of practically the same composition, and it is now difficult to distinguish between the substance of the old boulders and the old wash. I think that the lead is worth prospecting. There is no reason why rich stanniferous wash could not have been found in Permo-Carboniferous times, and there is, therefore, as much reason for locating the gutter as if the lead belonged to a more recent formation. Payable wash of Permo-Carboniferous age has already beea worked at the Roy's Hill mine, and it is quite possible that it may exist here.

On some of the sections taken up by the company fragments of tinstone of similar nature to that occurring at the Demmocks Prospecting Association has been found on the surface, and the company is engaged in prospecting for the lode from which they were shed. From their position it seems to be certain that the lode is on the company's ground. A vein of quartz belonging to the quartz-pyrite formation has been laid bare and a small shaft sunk on it. This formation, as I have already shown, is not stanniferous.

Roy's Hill Mine.

I received instructions to visit this mine and to furnish a supplementary report to that of the Government Geologist of the 28th October, 1899. A detailed description of the mine will, of course, be unnecessary. The deposit consists of a greisenised zone forming the margin of a small granite spur which rises out of the surrounding Silurian strata. The old mine workings are in the shape of a horseshoe extending round the northern end of the spur. From their extent it is evident that a good deal of tin has been taken out in years past. The mine has been

let to tributors, who have been working with small capital, and, owing to their inefficient crushing apparatus, have only been able to treat the richer portions of the stone. The deposit is patchy, and has earned the reputation of giving out in depth. As has been shown by Messrs. Montgomery and Twelvetrees, this latter is in the highest degree improbable. From all we know of tin deposits they are permanent in depth, though they may be patchy. Judging by the workings on this mine the rich patches are not separated by large areas of blanks, and there is no doubt that with more economical methods of mining and treating the ore, a much larger proportion of the deposit would prove to be payable. Under these circumstances I think the mine is well worth testing in depth. There has not been a great deal of work done since Mr. Twelvetrees' visit. A little stoping has been done on the south-west end of the deposit, and some good ore has been taken out; a good many tons are at grass which would not pay the tributors to crush, but which would pay well with an efficient battery. Two small shafts have been sunk in Silurian strata, but neither of these have yet reached the greisen zone. One of them is only a few feet ahead of the stopes, and is evidently just to the west of the greisen contact. North of the stopes another shaft has been sunk to a depth of 80 feet. This shaft was under water at the time of my visit, but Mr. Fritz Rübenach has kindly given me particulars of what was passed through.

The first few feet were sunk through horizontal Permo-Carboniferous strata, after which, highly inclined Silurian metamorphic slates were entered. At 30 feet from the surface the contact of the greisen and the Silurian strata was met with. The contact plane dips here to the west at a steep angle. At the contact, the greisen was fairly rich in tin. The tin-bearing stone appears to be about 6 feet wide, and dipped out of the shaft to the west, following the contact plane. After sinking 80 feet decomposed granite was struck. Fig. 2, Plate IV., gives a rough sketch of the section exposed by the shaft. As it is not from actual observation I cannot guarantee its accuracy, but I believe it represents the occurrence, at least, approximately. This confirms the supposition of Messrs. Montgomery and Twelvetrees, that the deposit is at the contact of a granite mass. It is evident that the mineral-

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bearing solutions travelled along the plane of contact, and attacked and replaced the feldspar in the granite from outwards. Of course, the solutions originally emanated from the heart of the granite mass. After passing up through fissures in the granite, they found the path of least resistance along the plane of contact, and followed it. It is, therefore, probable that if the mine is developed on a large scale, tinstone deposits will be discovered passing down into the granite. I believe the mine is well worth developing in depth, but none but a strong company should attempt it.

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

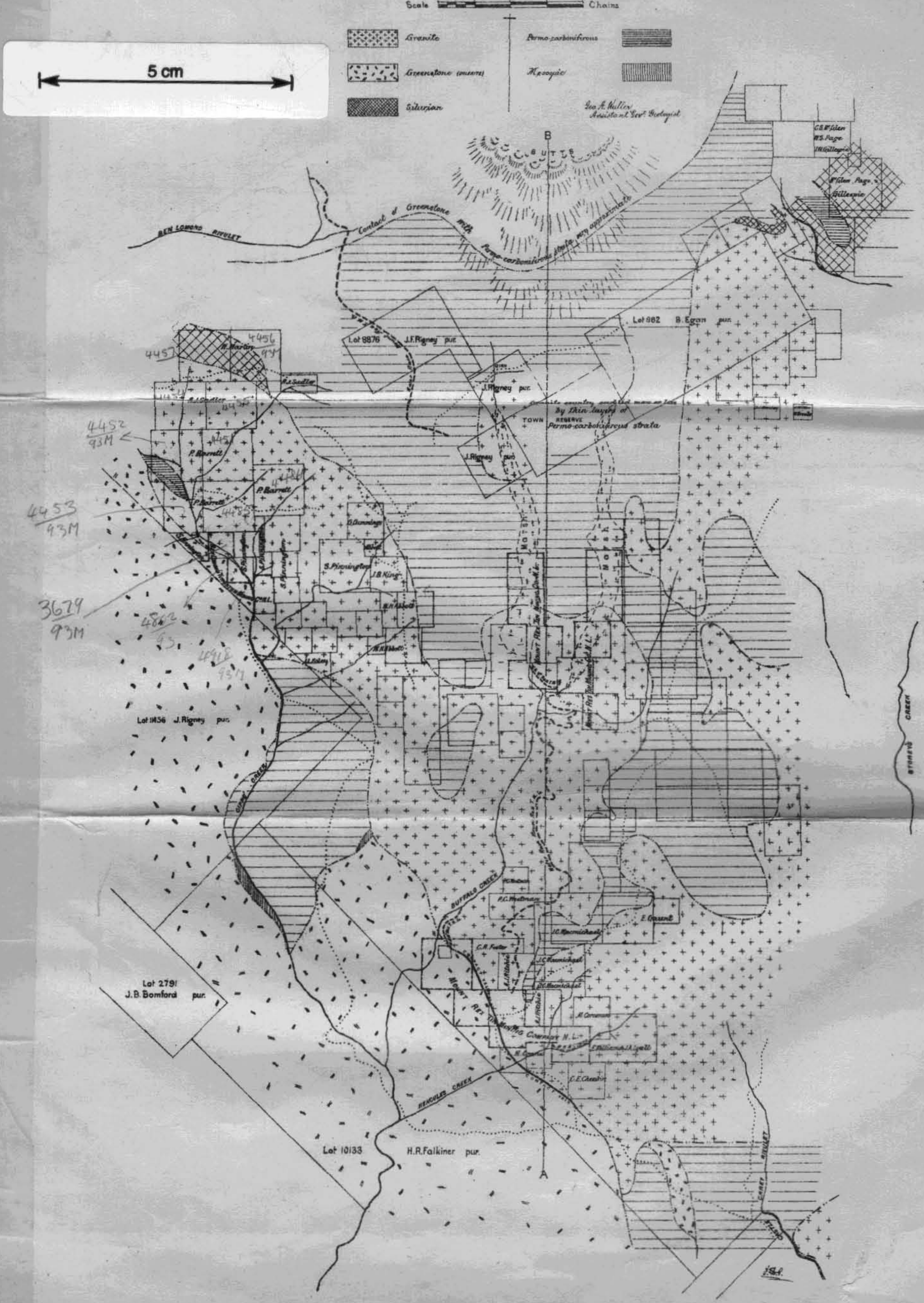
GEORGE A. WALLER,
Assistant Government Geologist.

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

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.

GEOLOGICAL SKETCH MAP
BEN LOMOND TIN-MINING DISTRICT

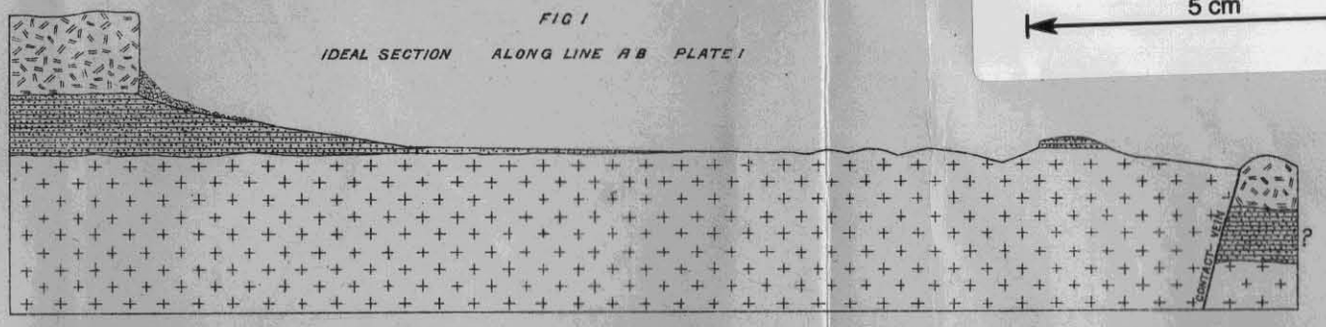
PLATE I



5 cm

FIG I

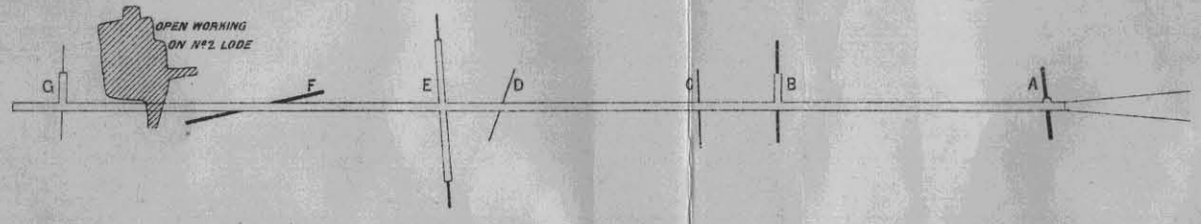
IDEAL SECTION ALONG LINE A B PLATE I

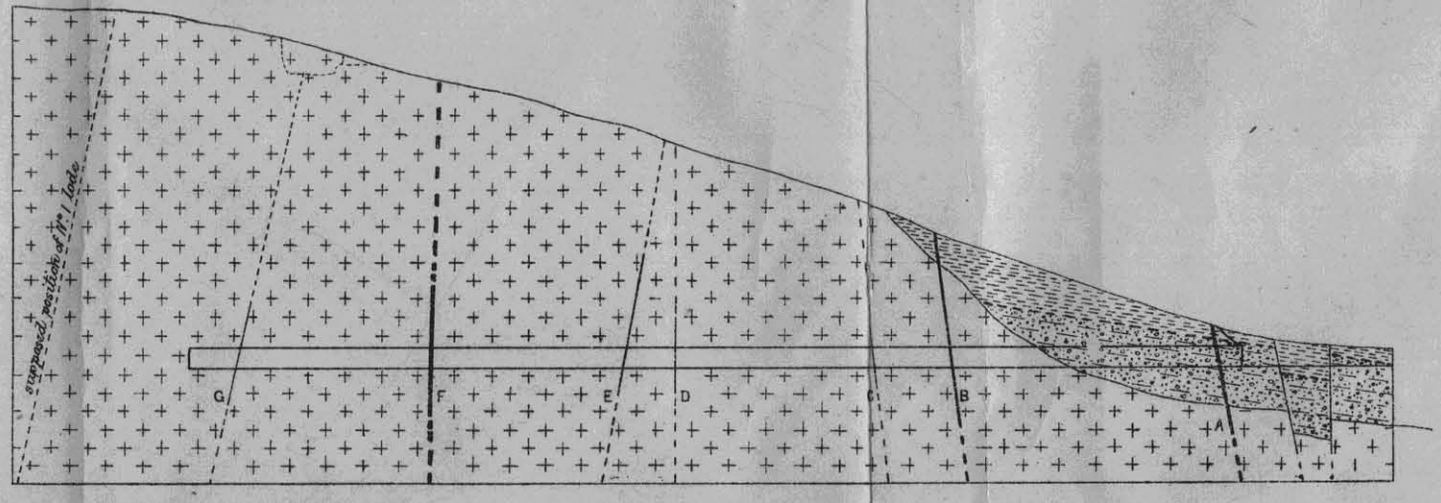


Granite | Permo-carboniferous strata | Greenstone (Dolerite) | Talus of greenstone blocks

0 10 20 30 40 50 60 70 80
Horizontal scale Chains

1000 0 1000 2000 3000 4000
Vertical scale Feet





Granite | Permo-carboniferous shales and wash

0 10 20 30 40 50 60 70 80 90 100
Vertical scale Feet

0 50 100
Horizontal scale Feet

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PLATE III

MOUNT REX TIN MINING COMPANY N.L.

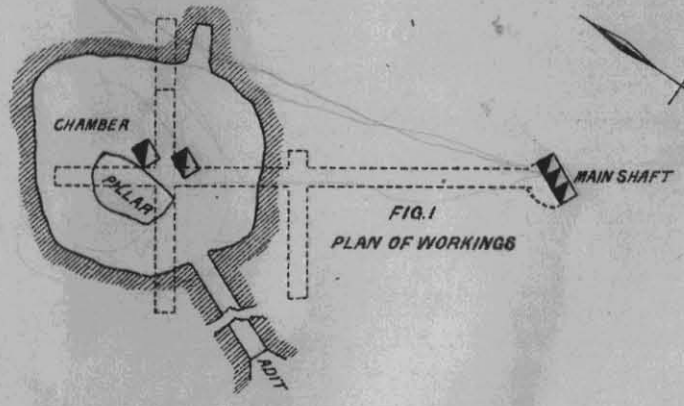


FIG. 1
PLAN OF WORKINGS

5 cm

Scale 10 0 10 20 30 40 50 60 70 80 90 100 Feet

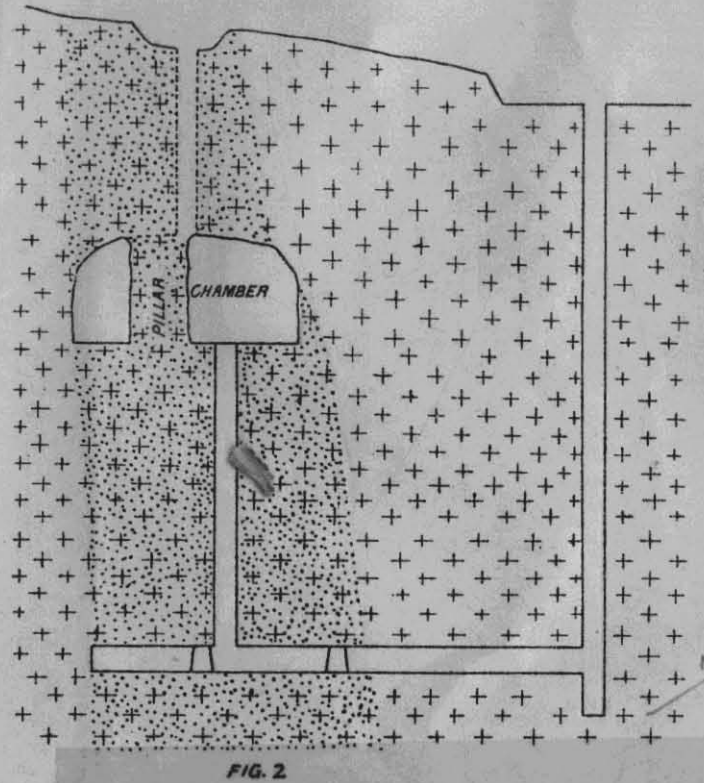


FIG. 2
SECTION ALONG CROSSCUT

FIG. 3
PLAN CHAMBER LEVEL

Granite

Tin-stone

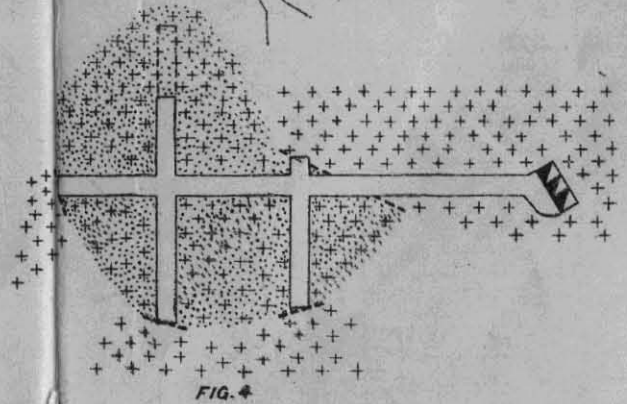
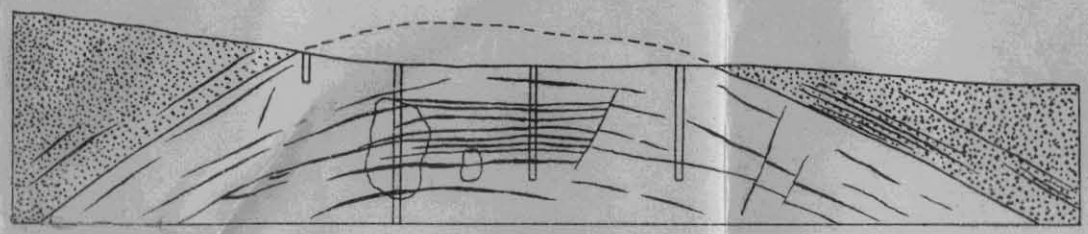


FIG. 4
PLAN CROSSCUT LEVEL

PLATE IV

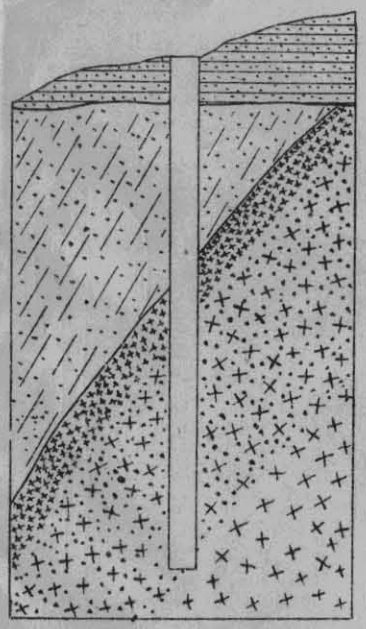
5 cm

FIG. 1



IDEAL SECTION THROUGH GRANITE BOSS OF ZINNWALD
SHOWING FISSURES OF CONTRACTION

FIG. 2



SECTION EXPOSED BY SHAFT
AT ROYS-HILL MINE

Permo-carboniferous wash and sandstones

Silurian metamorphic strata

Stanniferous greissen

Non-stanniferous greissen

Decomposed granite

10 0 10 20 30 40 50

Scale of feet