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No Liability.

REPORT

On the

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Held by the Association.

By

ITZ NOETLING, M.A., Ph.D., F.R.S.T., etc.

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REPORT

On the Copper Mining Propositions held by the Derwent Prospecting Association, No Liability.

BY

FRITZ NOETLING, M.A., Ph.D., F.R.S.T., etc.

I.—SITUATION OF THE COPPER MINING PROPOSITIONS.

The Derwent Prospecting Association holds at present the following claims:—

1. The Derwent Copper Mining Proposition, 160 acres.
2. The Cradle Mountain Copper Mining Proposition, 80 acres.
3. The Lake Windermere Copper Mining Proposition, 160 acres.

All these propositions are situated in the County of Lincoln, in the North-Western part of Tasmania, about 4 to 4½ miles east of Tasmania's highest mountains, viz., Barn Bluff and Cradle Mountain (5,069 feet). Inasmuch as the three propositions are in close proximity, the general description of the country will answer for the three of them, though from the geological and mining point of view each will be separately dealt with.

The country forms a high plateau, about 2800-3000 feet above sea-level, and above it, forming a pedestal, so to speak, there are piled up the huge masses of Mount Pelion East and

West, Barn Bluff, and Cradle Mountain. The photograph (pl. 1) gives a very good idea of this country. The most characteristic features of the plateau are its numerous lakes of glacial origin and the shallow valleys once filled up with glaciers. (See pl. 6.) The continuity of the plateau is, however, broken by the deep gorges and ravines intersecting it chiefly in north-southern, and to a lesser degree in east-western direction. The deep valleys of the rivers Mersey and Forth represent two typical instances of these gorges, which are, geologically speaking, of a much younger date than the shallow valleys or the plateau. It is interesting to note that the shallow glacial valleys can apparently be traced from one side of the gorge to the opposite one, thus proving that they have been cut in two by the subsequent erosion of the modern valleys.

All the glacial lakes discharge their water into the deep valleys, thus providing a splendid and permanent water supply, which will be separately dealt with.

II.—ACCESSIBILITY.

Though rather isolated and in one of the wildest parts of Tasmania, the property is even at the present time comparatively easy of access, in particular since a new track has been cut. The nearest railway station is the township of Mole Creek, the terminus of the Chudleigh branch of the Western Line, 60¼ miles from Launceston. From Mole Creek a good road, practical for vehicles of all kinds, leads to the little village of Liena, on the River Mersey, 898 feet above sea-level. (See Map 1.)

From Liena Bridge the track ascends the eastern slope of the divide between the Mersey and Forth Rivers for about 2½ miles, to Gad's Hill (2,361 feet), where it branches into three different routes. The southern route, Innes' track, was the only way of access to the Barn Bluff copper propositions till the new track had been cut. It is a most circuitous route; from Gad's Hill it follows the top of the divide between the Mersey and the Forth for about 20 miles in southerly direction. Then it takes a south-westerly turn, passes Lake Ayr to the south, descends into the valley of the Forth, and skirting the foot of Mount Pelion (West), again ascends to the plateau, running in a north-westerly direction to Barn Bluff. West of Lake Windermere the track branches off to the east, reaching the main copper outcrops at a distance of 46 miles from Liena.

This route, besides its length, has many disadvantages, the chief of which is that during winter the greatest part is covered with snow. At many places it is boggy, and at others it passes over swampy ground. It is difficult to understand why such a circuitous, impracticable route has been selected, when there was a much easier and shorter way close at hand.

This new route follows Innes' track for about a mile from Gad's Hill, but instead of keeping on the plateau it descends into the valley of the Forth, which it reaches near the junction of the Lemonthyme Creek and the River Forth; it then follows the direction of the Forth Valley on the southern bank of that stream, rising for a distance of eight miles from 1,077 feet to 1,158 feet; that is to say, 81 feet only. The country is practically level all along the distance from the point where the track reaches the valley of the Forth till it again ascends on its left (western) bank. Here the ascent is rather a stiff one; within a mile it rises from 1,158 to 2,815 feet; that is to say 1,657 feet, passing on the southern side of Commonwealth Creek, up the steep slope fitly termed Razorback. After about two more miles, in the level glacial valley, the main outcrop of the Derwent Copper Proposition is reached, the total distance from Liena being only 22½ miles.

From the Derwent Copper Proposition another 1½ to 2 miles over comparatively easy country brings us to the Cradle Mountain Copper Proposition, and after crossing Swallow Creek the Lake Windermere proposition is reached after another mile.

The whole route has a great many advantages over Innes' track, the foremost of which is, of course, its shortness and the level grade along the valley of the Forth.

It is, however, evident that a route which in its entire length follows the River Forth from Razorback to Lorinna forms the natural way of access to the mining propositions held by the Derwent Prospecting Association, as it has advantages which neither Innes' nor even the present route possess.

The total length of this route from the foot of Razorback to Lorinna is 18 miles, according to the sketch map of Barn Bluff. The first 8 or 9 miles from Razorback to Lemonthyme Creek have an easy grade of 8 to 9 feet per mile, and there are no difficulties whatsoever in constructing an aerial tramway. Even an ordinary tramway, driven by electricity, should cost very little, inasmuch as any amount of water is available for motive power. Unfortunately, I had no opportunity of travelling over the second part of the route from Lemonthyme to

Lorinna, but I am credibly informed by people who are acquainted with the country that is exactly the same as in the upper part of the route.

A permanent road from Lorinna to Sheffield is under construction by Government; according to the map the distance between Lorinna and Sheffield is 15 miles, and thence to Railton, a station on the Launceston-Burnie line, 5 miles.

The total distance from the foot of Razorback to the nearest railway station is 38 miles, viz.:

18 miles in the valley of the Forth to Lorinna;
20 miles over good road from Lorinna to Railton Station.

The total distance from Mole Creek Station to Razorback is about 32-33 miles, and though actually shorter, this route presents two serious disadvantages, which fully outweigh the advantages gained by shortness over the other route. These are the crossing of the divide between Forth and Mersey, and of a second divide between the Mersey and Mole Creek. This would mean that every pound of copper had to be raised 1,284 feet from the valley of the Forth to the top of Gad's Hill; thence the descent to Liena is 1,463 feet, and then it had to be raised again 434 feet to the top of the divide above mentioned (1,332 feet above sea-level), whence a steady grade leads to Mole Creek station, 785 feet above sea-level.

Though water-power is available in the Forth as well as in the Mersey, I am afraid that the costs of hauling up a total height of 1,718 feet would be far greater than the advantage gained by the shorter distance.

The same applies, of course, to Innes' track, with that difference that the cost would be still higher, considering that the distance is about double, and that the hauling up from the Forth Valley to the top of the divide between Forth and Mersey had to be done just the same.

The nearest railway is, of course, the Emu Bay Railway, which in a straight line is about 20-25 miles to the west of the copper outcrops here described. I am not in the position to say anything definite about this route, but from what I have seen of the country near Barn Bluff, I greatly doubt whether this would be the cheapest route. The physical difficulties to be overcome are in my opinion so great as to make this route prohibitive. Mr. C. P. Smith, who knows the country well, states that the track to Tullah, which would be the nearest station on the Emu Bay Railway line, is difficult and exceedingly dangerous in winter time. Mr. E. C. James, of Hobart, who also knows this country well, has fully confirmed the above.

In my opinion the route Razorback along the valley of the Forth to Lorinna, and thence to Sheffield, Railton, is, though somewhat longer than Razorback, Gad's Hill, Liena, Mole Creek, preferable to that route, because there are no hills to cross, and the physical difficulties for at least 28-29 miles are very insignificant, and for the remainder of 9-10 miles they are probably so.

III.—GEOLOGICAL FEATURES.

A—Formations.

The general geological features of the country under examination are very simple, inasmuch as, besides the copper-bearing rocks, only archaean schists and glacial debris occur, but the structural features, particularly the relationship of the ore bodies to the country rock and the faults which intersect the former are very complicated and still somewhat obscure.

The archaean schists form the base for all the younger formations resting upon them, and they practically constitute the plateau. They generally represent quarzitic schists of whitish or greyish colour, which are strongly foliated. Here and there more nodular beds will be observed, that is to say, beds in which the quartz has concentrated in nodular form, strongly resembling certain gneissic rocks.

The strike of this schists is very constant, varying from 80 deg. west of north to 90 deg. west of north; that is to say, it is almost due east-west. Though the strike is very constant, the dip changes a good deal, but it is mostly either south or north, and usually at fairly high angle. To me it seems that previous to the deposit of the permian beds the archaean schists have undergone an enormous folding, resulting in the production of a series of anticlines and synclines, whose axis is directed almost due east-west.

The folded archaean schists were subsequently eroded and planed down; this process certainly took place previous to the deposit of the permian conglomerates and carboniferous rocks, which unconformably rest on the uptilted archaean rocks at Barn Bluff, Mount Pelion, and other hills where they are still preserved. It must, however, be mentioned that no trace of this formation is preserved in that part of the country where the ore bodies occur, but it is certain that permian strata formerly covered the whole country in a continuous layer. The permian beds were again covered by a thick sheet of volcanic rock—Diabas—which caps all the prominent mountains like Barn Bluff, Cradle Mountain, Mount Pelion, etc. In my opinion these now isolated masses of diabas form part of a continuous sheet that once covered the whole country, but has now been divided by the erosion into numerous isolated peaks.

The erosion that has been going on since the outburst producing these vast volcanic sheets has been enormous, because it can be proved that it not only destroyed the greatest part of the diabas sheet, but also removed the underlying permian beds almost completely, eating deep into the base of archaean schists. This erosion has not only laid bare the volcanic vents through which the diabas rose to the surface, but, what is still more important, it revealed the ore bodies, which otherwise would have remained hidden under a thickness of about 2,000 feet of permian rocks and diabas.

It is very probable that a good deal of this erosion is due to the large ice masses that once covered the whole country, and which left extensive traces of their action in the shape of moraines and glacial debris behind. It is, however, tolerably certain that at the time when glacial action was at its height the outcrops of the ore bodies were already laid bare, because boulders of ore are found among the glacial debris in the Commonwealth Creek gully, as well as near Lake Windermere.

B—Faults.

But not only have the archaean schists been folded, they have also been considerably dislocated by faults. There appears a system of faults having a general strike from 15 deg. west of north to almost 45 deg. west of north, that is to say, from nearly due north-south to north-east-south-west.

Foremost among these faults is the great north-south fault, which cuts off the ore body of the Derwent Copper Mining Proposition to the west. This fault has commonly been described as the north-south or chloritic belt. It strikes about 15 deg. east of north, though in places it seems to be almost north-east by south-west. The width of this fault is between 200 and 300 feet, and the dip appears to be south-west, though at places it seems to be perpendicular even going east. It crosses the upper end of the Commonwealth Creek gully, and on its southern slope it forms that prominent pinnacle formerly called the Big Knob, but now termed Ward's Pinnacle. (See photo. pl. 3.)

The quarzitic schists can be seen butting against the eastern side of the fault. The strata immediately resting against the fault are bent upwards, as can be well seen in the photograph, and this seems to indicate that the downthrow is east of the fault.

The rocks filling up this fault are somewhat mixed, and unless a more extended—in particular, microscopical—examination can be carried out it is impossible to say anything about their origin. There is unquestionably a sort of quarzitic schist, of dark green colour, which may be due to the presence of chlorite, but there is also a good deal of aktinolite of a particularly fine fibrous appearance, and there is also white quarzite, as well as soft greyish mineral, perhaps steatite. Besides these rocks there occur bands of a darkish green rock, having almost a volcanic appearance, which are strongly metalliferous. In fact, it may be said that almost throughout the whole width of the fault the rocks are more or less metalliferous. In some parts the ore is more concentrated, forming solid lodes; in others it is more scattered; but it seems that hardly any rock is absolutely devoid of ore.

All the lodes have the same strike as the fault, that is to say, about 15 to 25 deg. west of north. The extension of this fault is not fully known yet; it seems, however, certain that it does not extend in a northern direction for any length, but in a southern direction it has been traced for several miles. It is impossible to say whether it has been cut off in the north by another fault or not, and it is also impossible to say how far the lodes extend towards the south. To prove the latter would involve the removal of a large amount of overburden. and therefore considerable expense.

The character of the ore is quite distinct and different from any of the other ore bodies. Macroscopically it appears to be chiefly iron pyrites, but the assays have proved that it is practically a very low-grade silver ore. As the character of the ore will be fully discussed in a subsequent chapter, it is unnecessary to say more about it at present.

The second north-south fault of importance, called Hawson's vein, occurs in the Cradle Mountain section. This is a small fault, ranging from 4 inches to 2 feet in width, having a strike 15 deg. west of north and a dip 77 deg. towards east.

This lode is filled up with quartz as gangue and a very high-grade copper pyrites, containing a considerable quantity of silver. No traces of aktinolite or any other similar mineral can be found in this lode, and its mineral character is distinctly different from that of the great fault on the Derwent section.

The extension of this lode is also not fully known; it has been traced for about 200 to 250 feet in length, and its northern continuation must either cut off the aktinolite ore body of this section or vice versa. The probability, according to geological evidence, is in favour of the former view, but until more is known about the geology of this part it is impossible to form a definite opinion. The same applies to its southern continuation.

In addition to these main faults the jointing has the same strike, which proves that the north-south faults and the jointing are due to the same mechanical action.

A small basalt-dyke occurs on the southern slope in the bed of a little stream called Cook's Creek. The strike of this dyke is 45 west of north, which proves conclusively that it must belong to that same system of faults as above described, with that difference only that the fault was filled up by volcanic magma.

C—The Ore Bodies.

Two types of ore bodies can be distinguished, viz.:

(a) True fissure veins having a north by south strike.

(b) Stockwerks, having an east by west strike.

(a) Fissure Veins.—I have above described the north-south faults, and stated that at least two of them are metalliferous. The character of these two veins is, however, quite different. The vein on the Derwent section is of vast proportions, but a very low-grade silver ore, containing only a very small percentage of copper; the vein on the Cradle Mountain section is of small dimensions only, but it carries a very high-grade copper ore, with a high percentage of silver. Whether there is any genetic relation between these two classes of veins I am unable to say at present; the very different character of the ore, which, in addition to different metalliferous character, is basic, or at least mostly basic, in the Derwent section and acid in the Cradle Mountain section, seems to indicate that there is no direct relationship between the two types. On the other hand, the same strike proves a structural affinity.

(b) Stockwerks.—Quite different from the former are the great ore bodies which occur particularly on the Derwent and Windermere sections, and also on the Cradle Mountain sections.

The strike of these ore bodies is almost due east-west; the dip, however, varies. On the Derwent and Windermere section it is perpendicular; on the Cradle Mountain section the dip of the northern ore body is 77 deg. towards north, while the southern ore body is partly horizontal. The concordance in the strike of the quarzitic schists and the great ore bodies is evident, and it is also more than probable that this harmony is not accidental, but intimately connected with the genesis of the ore bodies. It is also certain that these east-west ore bodies are structurally, and probably also genetically, different from the north-south veins, but before discussing these questions it will be useful to give a general description, taking that of the Derwent section as a typical instance.

This immense ore body or stockwerk is made up by a series of alternate bands of solid ore, varying in thickness from 4 to 12 feet, aktinolite heavily impregnated with ore and quarzites showing traces of ore. It is not always easy to separate the lodes of more solid ore from the aktinolite ore, and they in their turn seem again to pass into the more quarzitic layers. The whole body bears signs of intense crushing, but this has not destroyed the direction of strike or the dip, which is, as already stated, perpendicular.

As the quality of the ore will be discussed in a subsequent chapter, I need only mention the general features. The ore consists chiefly of

Iron Pyrites, $Fe\ S_2$ {Iron, 46.6 per cent. / Sulphur, 53.4 per cent.}

Copper Pyrites (Chalcopyrite) $Cu_2\ S\ Fe_2\ S_3$.
(Copper, 34.5 per cent.
Iron, 30.5 per cent.
Sulphur, 35.0 per cent.)

Pyrrhotite $Fn\ Sn$ plus 1 { Average Composition,
Iron, 61.6 per cent.
Sulphur, 38.4 per cent. }

Of smaller importance are—

Bornite, $Cu_2\ Fe\ S_2$
Arsenopyrite, $Fe\ S_2\ Fe\ As_2$.

The gold is probably associated with the iron pyrites and the silver probably occurs in the form of proustite, $Ag_3\ As\ S_3$.

As far as can be ascertained macroscopically, the two first-named minerals replace each other, and are mixed up in various degrees in the different parts of one and the same band. How far the pyrrhotite again replaces either iron or copper pyrites is not quite certain, but the ore undergoes all stages from almost absolutely pure copper pyrites to solid pyrrhotite in one and the same band.

As already stated, even the bands of aktinolite and quarzite intervening between the bands of solid ore are impregnated to a greater or smaller degree with ore. The whole body can therefore be considered as one mass of low-grade ore containing numerous bands in which the ore contents are more concentrated in solid lodes.

The quality of the ore will be discussed in another chapter; it is sufficient to say that it represents a low-grade copper ore with rather a high admixture of silver and a small percentage of gold. Taken as a whole, 1000 tons of ore contain

172 tons of copper,
2,522.9 ounces of silver,
8 ounces 6 dwt. 16 grains of gold;

Or if only the richer bands are considered—

206 tons of copper,
2,877 ounces of silver,
10 ounces of gold.

It is obvious from what has above been said about the constitution of the ore body that if we take the lower percentage of the whole ore body, or, at the very lowest, 75 per cent. of the total bulk, is represented by ore of this grade, but if we take the higher grade, about 50 per cent. of the total bulk may be taken to represent ore of this class.

As previously stated, the whole ore body shows signs of intensive crushing, which has, however, not destroyed the direction of strike and dip, and it is evident that the stockwerks are in some way connected with the north-south fault. Their true relationship is not quite clear yet, but that there is some sort of connection between stockwerks and faults is almost certain.

The stockwerks exhibit another characteristic feature; some of the quartzitic bands appear as if they had been metamorphosed and the aktinolite bands have the appearance of a volcanic rock. If we take this feature together with the strike, which is the same as that of the archaean schists, the following theory regarding the origin of these ore bodies suggests itself:—

These ore bodies may be considered as metamorphosed portions of the archaean schists. They were metamorphosed by basic volcanic rocks which were pressed up along the north-south faults, and which at those places where the schists had been more or less crushed by pressure penetrated also into the schists. As some of the magmatic eruptions may have been metalliferous, their contents were transferred partly to the metamorphosed rocks, partly they remained in the rocks resulting from the cooling of the magma (aktinolite).

It will be seen that though this theory assumes a connection between the faults, the ore bodies, the country rock (schist), and volcanic eruptions, it does not necessarily follow that the combination of three of these factors must result in the production of ore bodies. Neither does it follow that the same volcanic eruption which resulted in the production of the stockwerks also filled up the fissure veins. It is far more probable that stockwerks and fissure veins represent different stages of one and the same period of volcanic activity.

Though the north-south veins may to some extent be considered as ore channels, it does not necessarily follow that the magma pressed up in these fissures also permeated and metamorphosed the archaean schists. To me it seems more probable that in the first instance local eruptions took place, which pressed the metalliferous magma into the archaean schists wherever these were weakened by crushing. Subsequently further disturbances resulted in the production of the north-south faults, which in their turn cut off parts of the previously-formed ore bodies. Further volcanic activity resulted in the filling up of the north-south veins, and, according to the nature of the magma and its metalliferous contents, the more basic ore of the Derwent section or the more acid ore of the Cradle Mountain section was formed.

It will be seen that this mechanical volcanic theory widely differs from Dr. Peters' swamp theory, and fully confirms Prof. Gregory's view about the origin of the Mount Lyell ore bodies. It differs, however, from the theory of that scientist inasmuch as it assumes that the stockwerks characterised by the east-west strike are chronologically different from the north-south veins.

If this theory be correct two economically important conclusions may be drawn from it.

The first is that the ore bodies, fissure veins (north-south), and stockwerks (east-west) must continue for a great depth, being ore-bearing all along.

The second is that it is useless to search for a cut-off east-west stockwerks in the north-south vein, notwithstanding the ore contents of the latter, but that the searcn should rather be made on the other side of the north-south fault. The direction must naturally be decided by the laws ruling these structural dislocations.

Of course the first conclusion must be taken with that restriction that it will hold good only if the ore body is not cut off in the depth by a great thrust plane, as is the case with the Mount Lyell ore body. But if no such thrust plane exists the ore body must extend to almost unlimited depth.

IV.—DETAILED DESCRIPTION OF THE MINING PROPOSITIONS.

A—The Derwent Copper Mining Proposition.

1. Size and Situation.

The Derwent Copper Mining Proposition includes two sections of 80 acres each, or 160 acres in the aggregate. They are situated about 4½ miles south-east of Barn Bluff, at the western or upper end of an old glacial valley, which may be called Commonwealth Creek Valley. This valley runs almost due east-west, and is about 2½ to 3 miles in length, but not more than half-a-mile wide.

The bottom of the valley is in the average about 2,850 feet above sea-level, while the altitude of the plateau on the northern and southern side is about 3,400 feet in the average. The eastern end of the valley opens into the valley of the Forth, and there is within a mile of horizontal distance a sudden drop from 2,815 to 1,158 feet, giving a perpendicular difference in height of 1,657 feet. At the western end a spur rising about 200-250 feet above the level of the valley butts out from the surrounding plateau. On the northern side of this spur is a small streamlet called Cook's Creek, on the southern side the larger Commonwealth Creek. Both creeks join a few chains east of the end of the spur, and, flowing in eastern direction, eventually branch into the River Forth, after having rushed with tremendous force down the steep precipice of Razorback.

The outcrops of the lodes, the open cuts, trenches, and the tunnel are situated at the eastern extremity of this spur. (See photo. pl. 2.)

2. History.

It appears that in 1891 C. P. Smith and J. Swallow discovered this splendid property, and after some prospecting pegged out two claims of 80 acres each. A small company—the "Barn Bluff Copper, Gold, and Silver Company"—took over the property, and spent about £350 in laying the lodes bare by shallow trenches. An Adelaide company—"The Barn Bluff Option Development Company, Ltd."—took an option on the property, and actively commenced work in January, 1901. Huts were constructed, a small compressor plant, driven by a Pelton wheel, which was supplied with water from the Commonwealth Creek, was erected. A tunnel, called No. 1 tunnel, was commenced, and the surface of the spur energetically prospected by means of numerous trenches and cuts.

Everything seemed to be prosperous; but, as is so often the fate of pioneer companies, it failed, and all work was completely stopped. It is not my business to enquire into the reasons why the Barn Bluff Option Development Company failed in their enterprise; it is sufficient to say that, in my opinion, the worthlessness of the ore body was not the reason.

All work was stopped on April 4th, 1903, after No. 1 tunnel had been driven to a total length of 448 feet, No. 2 and No. 3 tunnels for about 25 to 30 feet, and 18 open cuts had proved the ore body for a distance of 9 chains (say 600 feet) in length and 7 chains (say 460 feet) in width.

No further developmental work has since been carried out, and when I visited the proposition on April 28th, 1907, that is to say, four years after the Barn Bluff Option Development Company had ceased to work, most of the faces exposing the lodes had already become completely oxidised. In the tunnel dust and slime had effectually obliterated the more solid lodes, and it required a good deal of fresh blasting to clean some of the faces. I may mention here that all samples have been taken from material obtained by fresh blasting.

3. Geological features.

As the geological features have exhaustively been dealt with in a previous chapter, I may be permitted to pass them over in a few words. The Commonwealth Creek valley is scooped out from the archaean schists, which completely encircle it. The whole valley is covered with glacial debris, particularly near the upper (western) ends. Large boulders of ore, which have greatly been altered by weathering, may be seen here and there among the debris, and prove conclusively that the ice has attacked the outcrop of the ore body and probably removed a large quantity.

I attribute the comparative thinness of the gossan to this fact. The boulders of ore among the glacial debris have always a core of unaltered ore and a thin shell of gossan, so to speak. It is certain that these boulders have been removed from the ore body during the glacial period, which we may assume to correspond with the Diluvial period, and it is also equally certain that the same glacier has not only removed the gossan that may have existed previous to its arrival, but also attacked the unaltered ore. To what degree this amount of abrasion has been carried out I am unable to say, but if we only assume that the ore body extended to the level of the surrounding plateau, which it must have done formerly, a quantity almost twice as large as the ore body still in existence must have been removed by the ice.

As the large number of years which have lapsed since the boulders of ore were detached from the outcrop have only resulted in producing a comparatively thin shell of gossan, it is quite intelligible why the actual outcrop, which is far more protected against weathering than isolated boulders, shows either none or only a very thin gossan.

I dwelt at some length on this subject, because there is a general belief that unless an ore body has a thick gossan, and unless there are various secondary minerals resulting from the superficial oxidation of the sulphides, the ore body is of no value. This general belief holds good only as long as the gossan has not been removed during an earlier geological period. In the case of the copper outcrops near Barn Bluff, where ample evidence proves an enormous glacial erosion, it is absolutely certain that the previously existing gossan was removed by the ice, and the time since its removal was too short for a new gossan to form.*

This theory, which is almost a certainty, is of some importance in judging the value of the ore body. It supposes that the rich carbonates and oxides have been removed by the

* This view assumes that the outcrop has been in existence for a lengthy period previous to the formation of the ice sheets. If all the erosion above referred to is the work of the ice only, the ore bodies probably never reached the surface after the deposit of the Permian beds, and in that case a thick gossan was probably never formed.

glacier, and as the time was too short since the glacial period for the formation of a new cap of carbonates and oxides, we may assume that the quality of the ore as proved by the assays taken from samples derived from the outcrop does not represent a richer superficial zone which is followed by poorer ore at greater depth, but actually represents the true value of the ore, and that the quality thus proved will continue to an unknown depth without getting poorer.

The ore body has been described at length in a previous chapter, and I can here dispose of it in a few words. It forms the end of the spur above mentioned, measuring about 12 by 8 chains, and having an average height of 200 feet. The question of bulk will be discussed at length in a subsequent chapter, so I will pass it over here.

At the western side, the aktinolite ore body, as it may be termed, has been cut off by a great north-south fault, which is also metalliferous, but shows a remarkable difference from the ore of the aktinolite ore body. As a chlorite schist forms part of the material filling up the fault it is referred to as the chloritic belt.

The aktinolite ore body consists of alternate layers of more solid ore, aktinolite heavily impregnated with ore and quartzite more or less impregnated with ore. The bands have a strike east-west and a perpendicular dip.

The chlorite belt consists of chlorite schist, aktinolite, white quartz, all more or less impregnated with ore, having a strike almost due north by south, but a somewhat varying dip.

Both the aktinolite ore body and the chlorite belt have been laid bare by numerous open cuts, and have also been proved by a longer and two shorter tunnels.

IV.—THE AKTINOLITE ORE BODY.

A. Description of the Open Cuts and Trenches.

The open cuts and trenches here described extend all over the spur, and they are practically the same that have previously been examined by Waller. Not much can be said about these cuts; they vary considerably in width and depth, and some of them are mere surface scratchings, while a good deal of work has been spent on others. To facilitate any comparison with Waller's report I give his numbers in brackets, because I adopted a somewhat different numbering.

Open Cut No. 1 (D).

A trench cut in north-southern direction, thus cutting right across the lode, which is well exposed on the western face. The height of the face is about 8 feet, the width about 12 to 15 feet. The lode exposed measures 6 feet in width, and shows solid ore throughout. It has a strike almost due east-west and a perpendicular dip. On either side of the lode dark aktinolite rock, slightly charged with copper, is exposed, and on the northern side a band of dark green quartzite, with slight traces of copper, is seen. Waller remarks that the ore, though solid, is poor in copper. This has been fully confirmed by the assays. I took two samples, which gave the following results:—

No. 1.

Copper, 0.21 per cent.
Silver, 16 dwt.
Gold, nil.

No. 2.

Copper, 0.53 per cent.
Silver, 19 dwt. 4 gr.
Gold, 16 gr.

	Average.		Value.* £	s.	d.
Copper ...	0.37 per cent.	...	0	7	4.8
Silver ...	17 dwts. 14 grs.	...	0	2	4.79
Gold ...	8 grs.	...	0	1	4.99
			£0	11	2.58

The above assays prove that the lode is rather poor in copper, though it appears that it is one of those that contain a perceptible quantity of gold, inasmuch as 60 tons of ore contain one ounce of gold.

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* The prices have been calculated at the following rates—

	£	s.	d.
Copper,	£100	0	0 per ton.
Silver...	0	2	6½ per oz.
Gold ...	4	17	0 per oz.

Since the above was written, the price of copper has slightly declin d to £98 per ton. It will however, be seen that this is of small importance in judging the value of the ore body. Unless the price of copper goes down to £50 per ton, which is, however, very impropable, the extraction and treatment of the ore will always pay. though the profits are naturally smaller. If the price of copper should decline to £50, numerous mines. including probably some of the greatest copper producers, would have to close.

The assays seem to indicate that the contents in copper and gold vary considerably, inasmuch as sample No. 2 shows more than double the percentage of copper than sample No. 1, in addition to 16 gr. of gold, which is absent in sample No. 1. The percentage of silver is pretty near the same in the two assays.

Open Cut No. 2 (E).

This is a very shallow open cut, to the south of No. 1. The lode is not well exposed, and no sample has been taken, but it shows that the ore, probably mostly iron pyrites, is fairly solid.

Open Cut No. 3 (F).

This is a short trench which exposes a very solid lode of copper pyrites, iron pyrites, and pyrrhotite, about 4 feet in thickness. The rock on either side is very much crushed, but the strike of the lode could be determined as east-west. It seems that it has a southerly dip, though this may only be local. The assay of sample No. 3 gave the following results:—

No. 3.

Copper, 0.10 per cent.
Silver, 10 dwt.
Gold, nil.

This is unquestionably a very poor ore, and in general appearance, as in chemical contents, seems closely related to the ore from No. 1 cut, though it is unquestionable that it represents a different lode.

Open Cut No. 4.

This is the most northerly cut, which is, at the same time, almost at the extreme western end, close to the boundary of the aktinolitic schist. It being a shallow surface scratching only, no samples were taken.

Open Cuts Nos. 5 and 6.

The same as said before applies to these cuts, which are apparently not mentioned by Waller.

Open Cut No. 7 (A). (See photo. pl. 5.)

This cut is about 20 feet above No. 2 tunnel, which has been driven on the lode exposed by this cut. A fine lode of copper pyrites, arsenical pyrites, and iron pyrites, measuring 4 feet in width, on either side of which beds of greenish quartzite are exposed.

The lode has a strike exactly east-west, the dip is vertical, and it is exposed for about 8 to 9 feet in height by the cut. Two samples were taken, one from the bottom (No. 6), and another a little higher up (No. 4). The assays are as follow:—

No. 4.

Copper, 0.38 per cent.
Silver, 16 dwt. 8 gr.
Gold, trace.

No. 6.

Copper, 2.71 per cent.
Silver, 1 oz. 12 dwt. 16 gr.
Gold, 20 gr.

There is unquestionably a great difference between these two assays of ore coming from the same lode. Whilst the assay of No. 4 closely resembles those of Nos. 1, 2, and 3, that is to say, lodes which are pretty close to the lode exposed by No. 7 cut, the assay No. 6 is ever so much richer, inasmuch as it shows the highest contents of gold of all the ore so far assayed from this aktinolite schist, besides a high percentage of copper. The difference between these two samples coming from one and the same lode is even greater than the difference between samples Nos. 1 and 2, which also came from one and the same lode. In my opinion this seems to indicate that the metalliferous contents of one and the same lode vary greatly.

Waller states that the copper contents improve in the bottom of the cut, and that a sample yielded as much as 9½ per cent. of copper. The first statement seems to be borne out by the above assays, and if the second—that is to say, the copper contents—is also correct it only emphasises the fact stated above, viz., that the contents of one and the same lode vary considerably. According to this statement the average percentage of copper of this lode would be 4.14 per cent., while the extremes would be 0.38 per cent., 2.71 per cent., 9.50 per cent. If we follow the lode further down to the tunnel the following assay was obtained.

Assay No. 17.

			Value. £ s. d.
Copper	... 8.32 per cent.	...	8 6 4.2
Silver	... 3 oz. 18 dwts. 9 grs.	...	0 9 10.88
Gold	... Trace	...	——
	Total	...	£8 16 3.08

Though in this case the copper and silver contents are considerably higher than those of sample No. 6, it is poorer in gold, and this seems still more to emphasise the fact pointed out above, that the contents of a lode vary greatly within a short compass. This will best be illustrated by comparing the assays side by side.

	No. 4. From top of Cut.	No. 6. From bottom of Cut.	No. 17. From Tunnel.	Previous Assay. From bottom of Cut.	Average.
Copper	0.38 per cent.	2.71 per cent.	8.32 per cent.	9 5 per cent.	5.18 per cent.
Silver ..	16dwts. 8grs.	1oz. 12dwts. 16grs.	3oz. 18dwts. 9grs.	—	1 oz. 11dwts 20grs.
Gold ...	Trace.	20grs.	Trace.	—	5grs.

The average value per ton of ore from this lode can therefore be computed as follows:—

	£	s.	d.
Copper	£5	3	7.2
Silver	0	4	0.54
Gold	0	0	10.619
	£5	8	6.359

Open Cut No. 8 (B).

This cut is about 20 feet wide, exposing a lode of solid iron pyrites, with arsenical pyrites and copper pyrites distributed through it. The lode is striking east-west, and the dip perpendicular; no samples were taken from this lode, as it appeared to be exactly the same as that exposed by the tunnel and in No. 7 cut.

Open Cut No. 9 (C).

About 10 feet wide, but rather shallow; the face exhibits mostly dark aktinolite rock, with bunches of iron pyrites and copper pyrites; the cut runs north-south, and an east-west strike can be distinctly seen. For about a width of 5 feet the ore contents form a lode having rather irregular walls. A sample gave the following results:—

Assay No. 5.

Copper, 0.40 per cent.
Silver, 16 dwt.
Gold, trace.

The above assay gives a very good idea of the metalliferous contents of the aktinolitic schist between the lodes of solid ore.

Open Cut No. 10 (G).

This cut is north of No. 1 tunnel, about 40 feet above it and about 25 feet wide, having a face 10-15 feet high. Altogether three lodes are exposed in this cut, separated by bands of dark green quarzitic rock, which shows, however, traces of copper pyrites, mostly filling up the cracks and fissures.

Beginning at the northern end of the cut, a band of dark green quartzite rock, measuring about 3 feet in width, is exposed; then follows a lode (a) of solid ore 5 feet in width, from which assay No. 9 was taken; then comes a band of quartzite, with traces of copper pyrites, 12 feet wide; then Lode (b) of apparently very rich ore (Assay No. 8), mostly consisting of carbonates, measuring, however, only 2 inches in width; then follows another band of quartzite, and at last Lode (c), measuring 6 inches in width (Assay No. 7). As this cut is practically the northern continuation of the next one, it will be best to discuss the character of the ore together.

A strip of country about 6 feet in width separates this cut from the following.

Open Cut No. 11 (H). (See photo. pl. 4.)

This cut is about 21 feet wide, and the face is 15 feet high. Two lodes, separated by dark green quartzite, with traces of copper pyrites, are exposed by this cut. At the northern side a lode (d) 8 feet in thickness, from which Assays 11 and 12 have been taken, is well exposed. Lode (e), exposed at the south side (left hand of photograph) is 4 feet in thickness (Assay No. 10). The strike of the lodes is almost due east-west and the dip vertical.

Both cuts form practically one exposure of the formation, giving a very good illustration of the occurrence of the ore in bands separated by beds of quartzite or aktinolitic rock, which, though not considered as ore, still show traces of copper pyrites, mostly occurring in the fissures.

If we assume the total width of the two cuts, including the rock not exposed, to be about 50 feet, the following bands are exposed. Beginning from the northern end of Cut No. 10, the sequence is:—

	ft.	in.
Dark green quartzite, with traces of copper pyrites and iron pyrites	3	0
(a) Lode of iron pyrites, copper pyrites, and pyrrhotite, solid ore (Assay No. 9)	5	0
Dark green very hard quartzite, with traces of ore	12	0
(b) Lode of very rich ore, mostly carbonates (Assay No. 8)	0	2
Dark green quartzite, mixed with aktinolite rock	3	0
(c) Lode of copper pyrites and iron pyrites, with some traces of carbonates (Assay No. 7) ...	0	6
Country rock covered by debris, about	6	0
(d) Lode of solid copper pyrites, with a little copper pyrites (Assays Nos. 11 and 12)	8	0
Dark green quartzite, with traces of sulphide ore and bands of aktinolite	12	0
(e) Lode of solid copper pyrites and iron pyrites (Assay No. 10)	4	0

We have therefore an aggregate thickness of
17 feet 8 inches (say 18 feet) of ore;
36 feet of country rock.

In other words, for a distance of about 54 feet, measured across the strike of the rocks, the metalliferous lodes represent 33 1-3 per cent. and the country rock 66 1-3 per cent., or in round figures, the proportion between ore and country rock would be one-third to two-thirds. This may be a rough estimate only, and in places it seems that the proportion is much higher.

Turning to the assays, the following results were obtained, taking the assays again in the same sequence as the lodes, that is to say, from north to south:—

No. 10 CUT.

	Lode A. No. 9.	Lode B. No. 8.	Lode C. No. 7.
Copper ...	2.72 per cent.	7.30 per cent.	1.21 per cent.
Silver ...	2 ozs. 9dwts.	13 ozs. 1 dwt. 8 grs.	1 oz. 10 dwt.
Gold ...	18 grs.	Trace	Trace

No. 11 CUT.

	Lode A. No. 11.	Lode A. No. 12.	Lode C. No. 10.
Copper ...	1.52 per cent.	5.10 per cent.	0.20 per cent.
Silver ...	2 ozs. 5 dwts. 17 grs.	10 ozs. 2 dwts. 12 grs.	16 dwts. 8 grs.
Gold ...	Trace	18 grs.	Nil.

The most striking feature of the above assays is their great difference, not only among the lodes themselves, but between the assays of one and the same lode, and no more striking instance could be given than a comparison of Assays No. 11 and No. 12, which proves conlusively, as already pointed out, that the ore contents of one and the same lode vary considerably, and to such an extent that unless bulk assays can be made it is difficult to judge as to their real value. It would be just as wrong to assume that the lode is a low-grade one as to judge it by the higher percentages. I therefore think that if we take the average of the above figures the estimate as to the value of the ore will be fairly correct.

The average figures would be:—

	Average of No. 10 Cut.	Average of No. 11 Cut.	Total Average.
Copper ...	3.74 per cent.	2.27 per cent.	3.01 per cent
Silver ...	5 oz 13 dwts 11 grs	4 oz. 8 dwts. 4 grs.	5 oz. 0 dwts. 19 grs.
Gold ...	6 grs.	6 grs.	6 grs.

Value.

Copper ...	£3	14	9.6	£2	5	4.8	£3	0	1.2
Silver ...	0	14	5.02	0	11	2.45	0	12	9.7
Gold ...	0	1	0.7428	0	1	0.7428	0	1	0.7428
	£4	10	3.3628	£2	17	7.9928	£3	13	11.6428

The remarkable feature of the above assays is the comparative richness of the ore in silver and gold. The percentage of copper is also much larger than in any of the previous lodes, and naturally this tells on the values.

If we calculate the value of the ore contained in the block of country proved by the Open Cuts Nos. 10 and 11, we can assume that the block measures in round figures—

$$50 \times 500 \times 100 = 2{,}500{,}000 \text{ cubic feet.}$$
220,000 tons.

If we take one-half of this as payable ore we have 100,000 tons of ore worth £3 13s 11.6428d per ton, or £406,780 in the whole.

If the total of ore contained in the Aktinolite body would be considered to represent the above value, it would be a splendid property indeed, but the evidence of the previous lodes apparently shows that though the above figures may hold good for perhaps the southern part, the ore exhibited in the northern part is of lower grade, and this must naturally lower the average.

Open Cut No. 12 (K).

A small cut, about 20 feet above Nos. 10 and 11; it exposes a band of aktinolite strongly impregnated with whitish pyrites. The band is 4 feet in thickness, and at either side there is a band of quartzite showing traces of ore. A sample assayed per ton:—

Assay No. 18.

Copper, nil.
Silver, 15 dwt.
Gold, nil.

The above may be taken as a fair average of the value of the country rock or poorer bands alternating with the richer lodes.

Open Cut No. 13 (L).

A shallow open cut, about 7 feet in width. Aktinolite bearing iron and copper pyrites is here exposed, but no sample was taken.

Open Cut No. 14 (R).

A small lode, mostly of iron pyrites, having a strike east-west, is exposed by a shallow open cut about 66 feet east of the boundary, between aktinolite and chlorite ore body. It is probably one of the lodes that has been cut by the tunnel at a lower level, but no assay was taken from the outcrop.

V.—DESCRIPTION OF No. 1 TUNNEL.

This tunnel was started on the eastern end of the spur, about 30-40 feet above the level of the valley, with the object of intercepting the ore bodies contained in the chloritic belt, this being considered the main ore channel. The lodes of the aktinolite ore body were to be opened out by crosscuts later on, after the tunnel had reached the north-south ore bodies.

The distance in which the tunnel would have cut the chloritic schists can be estimated at 7 to 8 chains (say 460 to 500 feet) from the entrance.

According to the geological features as exhibited on the surface, this view was a sound one, and if it has failed the blame rather falls on those who deviated from this view. It may, perhaps, be argued that the same object, that is to say, the testing of the north-south ore bodies, could have been attained by exposing them by superficial cuts and trenches. This would, however, have meant the removal of such large quantities of overburden that a tunnel was unquestionably preferable.

The tunnel was accordingly started between the open cuts Nos. 10 and 11, about 40 feet down hill. The accompanying photograph (photo. pl. 4) gives a good view of the entrance of the tunnel, and the opening in the scrub immediately above the tunnel indicates the situation of No. 11 open cut.

As the lodes of the aktinolite ore body have a strike nearly east-west, it was considered best to drive the tunnel as near as possible in the same direction, and the first part, measuring 250 feet in length, has therefore a bearing 13 deg. to 15 deg. south of west. The direction was afterwards slightly altered towards north and an almost westerly course—5 deg. south of west followed for about 13 feet. This was, however, not deemed sufficient, and the course was still further shifted towards north (about 37 deg.), and for 72 feet a direction 25 deg. north of west was followed.

Then the direction was radically altered by continuing the drive at almost a right-angle for 32 feet, the bearing being 28 east of north. However, it seems that this new turn did not prove satisfactory, and by a somersault of 135 deg. the tunnel was brought back to the original direction—13 deg. south of west—and this line was continued for 31 feet. Another turn of 32 deg. towards north was then taken, and a direction of 15 deg. north of west was continued for 50 feet, after which all operations ceased.

The erratic windings of the tunnel will be seen on the accompanying sketch map (see map 2), plotted out from observations taken by me with the assistance of Messrs. Curran and Ward. I may be permitted to dwell a little longer on this subject, because I think that there is a widespread notion that the ore body has thoroughly been tested by the tunnel, and that it failed to prove the existence of any considerable mass of ore.

The original notion of driving a tunnel to intercept the north-south ore bodies may have been right or wrong. If considered right, the only course open was to continue the direction 13 deg. to 15 deg. south of west till the object in view was attained; if considered wrong, the only possible course was to take a turn of 90 deg. towards north in order to prove the ore bodies that were exposed on the surface north of the tunnel by a crosscut. The manager who directed operations after the original bearing had been abandoned seems to have had a hazy idea of this, but instead of taking a bold course, and continuing his drive at a right angle to the original direction, he wheeled feebly towards north for about 37 deg. After a time some notion that he was wrong seems to have dawned upon him, and he then turned round, driving his tunnel in a north-eastern direction, that is to say, at a right-angle to the direction hitherto followed. Had he persevered in this new line there would have been reasons to justify his new action, but instead of that he completely turned round again after having driven for 32 feet only and brought the tunnel back to its original course, with that difference only that it was shifted about 74 feet towards north. But even this does not seem to have satisfied him, and he returned again to the old direction which he had followed after leaving the original south-by-west direction, with that difference only that at the beginning of the drive he was 10 feet to the north, and at the end almost in the exact line of continuation of his first drive.

There can be no question that this erratic way of driving after the original direction had been abandoned shows lack of judgment, which would be ludicrous if it had not also a serious side. We may fairly assume that the purpose of the tunnel was to prove the country. Now, the first 250 feet had proved a block of country measuring 240 feet in length by 74 feet in width. Had the plan of the tunnel been plotted out when it was decided to abandon the original direction it would have been noticed that the new direction, which was continued for 72 feet, did not prove anything that had not already been exhibited in the last 80 feet of the original drive. But worse was to come—the somersault of 32 feet towards east cut through the same formation that in the first part of the tunnel had been cut through between 68 feet and 180 feet from the entrance.

In other words, the total length of 104 feet since the original direction had been abandoned cut only through rocks that had already been traversed by the original drive between 68 feet and 250 feet from the entrance.

This in itself is bad enough, but, as already stated, the mistake could have been rectified had the drive been continued in the new direction, but instead of doing so, section XI. went back again through exactly the same beds that had been cut just now, and then again turning towards north, section XII., re-cut the very same strata that had already been traversed by sections X. and XI., only a little further towards west, and at a more acute angle. In other words, after a drive of 81 feet the tunnel stands exactly in the same strata as had been between 350 and 367 feet in section X.

To sum up, the last 185 feet of the tunnel have not proved anything that had not already been proved by the first part of the tunnel, and, as far as proving the country goes, the tunnel might just as well have been stopped at 265 feet from the entrance than continued to 448 feet.

The tunnel, though having a total length of 448 feet, has actually proved an area measuring 380 x 74 feet only, or 28,120 square feet, and as the last part of the tunnel has not proved anything that had not already been proved by the first part, except that the beds extended about 130 feet further west, a fact which might pretty well have been assumed without driving 185 feet, we can therefore say that the tunnel has really only proved an area measuring 250 x 74 feet.

Now let us examine how much of the country could have been proved by a tunnel of 448 feet in length, provided the work had been done methodically and systematically. In the first instance, let us assume that the old south-of-west direction had been continued. As it will be seen from the map, the tunnel would probably not have reached the north-south belt, but terminated about 40 feet east of it. On the other hand, it would have always cut through new beds, and the area proved would measure 430 x 132 feet, or 56,760 square feet; that is to say, exactly double the area could have been proved at the same outlay of money.

But assuming that it had been decided to discontinue the south-of-west course, the only way indicated by the strike would have been to cut at a right angle to the previous direction. Assuming again that this crosscut would have been continued in a north-western direction for 185 feet, bringing the total length of the tunnel to 448 feet, the area thus proved would represent a trapezoid measuring 250 x 185 x 319 x 272 feet, or 62,715 square feet.

These figures are more striking still when we calculate the bulk that is and that could have been proved by the tunnel. Taking the height above the level of the tunnel in a round figure as 200 feet, the following quantities will result:—

1. Actually proved ... 28,120 sq. ft.* = 560,000 cub. ft. = ½ mill tons.
2. Had the original direction been continued—
   56,720 sq. ft. = 11,200,000 cub. ft. = 1 mill tons.
3. Proved by crosscut 62,715 sq ft. = 12,400,000 cub ft. = $1\frac{1}{20}$ mill tons.

If we apply the figures as obtained from the geological observations in the tunnel (see below), and assume that 50 per cent. of the above quantity is ore below 1 per cent. Cu. and 50 per cent. only above, the quantity of ore in round figures would be:—1. Actually proved, 250,000 tons. 2. 500,000 tons. 3. 550,000 tons.

If we now turn to the financial side of this question, it can be calculated that the 185 feet above referred to cost the old Barn Bluff Company £786 5s, or, in other words, practically two-fifths of the total working capital, and all this money was absolutely wasted, inasmuch as far as the value of the proposition was concerned nothing was proved.

The above figures require no further comment, but they illustrate once more the mischief that can be done in the initial stages of a mining proposition by want of good judgment.

If we now turn to the geological evidence afforded by the tunnel, I wish to say that the notes made must necessarily be of a preliminary character, and are subject to revision afterwards. The chief reason for this is the impossibility to make accurate observations without extensive clearing of the faces. Since the tunnel has been cut the faces rapidly covered with dust, and a thick slimy coat effectually conceals everything. It was not until several shots had been fired that some of the main lodes could be located, but it would have required much

* Disregarding the last three figures.

more time and a considerable amount of expense to thoroughly clear the face from the entrance to the end of the tunnel. Besides this difficulty, which is experienced almost in every mine when no proper record of the ore bodies has been kept, I experienced another difficulty as a result of the strike of the formation.

The first part of the tunnel has been driven in almost westerly direction, bearing slightly towards south. This direction nearly agrees with the strike, which is almost east-west. All strata, whether metalliferous or not, are therefore cut at a very acute angle. It is therefore almost impossible to fix the exact position where a richer ore body has been cut and where it terminates. As the bearing of the tunnel as well as the strike naturally oscillates a little, the difficulty of locating the exact positions of ore bodies is increased. Under these circumstances it cannot be expected that the accompanying geological sketch map is absolutely accurate, but, on the whole, I think that it represents the geological conditions in a fairly accurate way, and if it has erred it is rather on the side of under-estimating the thickness of the lodes than exaggerating them.

The identification of the lodes cut by the first part of the tunnel with those that were cut after the south-of-west direction had been abandoned must, of course, be considered as an assumption only. But having plotted out the position of the ore bodies observed, and noticing that those in the first part of the tunnel practically coincide with those in the last part if continued in their direction of strike, this assumption takes the shape of a probability which almost amounts to certainty. We may therefore assume that the tunnel affords very good evidence of the geological features of at least a part of the ore body measuring 380 x 74 feet, and if we combine this together with the evidence given by the superficial trenches and cuts we may arrive at a fair estimate of the value of the ore body.

I may further mention that twice, at section V., between 180 and 225 feet, and again at section IX., 367 and 398 feet from the entrance, the needle of the compass was greatly affected. It oscillated at first, and eventually refused to move, which, in my opinion, proves the existence of some sort of magnetic influence, resulting perhaps from the occurrence of a large ore body close to the places where the disturbances were noticed.

I divided the length of the tunnel into twelve sections, numbered I. to XII., partly because of the length of the measuring

rope at my disposal. A natural division would distinguish five sections of very unequal length, viz.:—

First Section, 263 feet in length. Bearing 253 deg. W.

For about 25 feet from the entrance hard quartzitic rock, slightly impregnated with sulphides, prevails. At about 45 feet a small fault, striking 70 deg. east of north, with a southerly dip, is met with.

At 55 feet dark fibrous aktinolite, which soon passes into a band heavily impregnated with iron pyrites, measuring at least 12 feet in thickness, is found. Assay No. 13 was taken from this lode. It is probable that this lode is the continuation of lode (a) exposed in No. 11 cut, though it is impossible for the present to say this with certainty. This lode is followed by quartzite slightly impregnated with sulphides, and then another band of fairly solid ore, measuring about 5 feet, is met with.

At 90 feet aktinolite slightly impregnated with sulphides occurs, gradually passing into a more solid lode of 4 feet in thickness. This is followed by quartzite and aktinolite, and 132 feet from the entrance a large aktinolite band, measuring about 8 feet in thickness, and closely resembling the band met near the entrance, is cut through. Assay No. 14 was taken from this lode.

The next part of the tunnel was not well cleared. There are certainly two distinct lodes, measuring about 2 feet and 1 foot each, and it is probable that I may have overlooked one or the other band. As far as can be seen, it consists mostly of aktinolite, more or less impregnated with sulphides. Bands of quartzite alternate with the former, and at about 225 feet a lode of dark aktinolite, strongly impregnated with sulphides, has been cut.

Second Section, 72 feet in length. Bearing 295 W.

At the beginning of this section quartzitic rock occurs, which is followed later on by aktinolite impregnated with sulphides. At 283 feet sample No. 15 was taken in order to obtain an assay of this kind of rock.

Third Section, 32 feet in length. Bearing 208 W.

A series of bands of dark aktinolite impregnated with sulphides, alternating with bands of quartzite, has been cut through; as far as can be seen, the sequence appears to be the same as in the first part of the first section. The drive ends in a band of aktinolite strongly impregnated with sulphides, which is most probably the continuation of one of the lodes previously met.

Fourth Section, 31 feet in length. Bearing 253 deg. W.

The band met at the former section is again met with; then follows quartzite.

Fifth Section, 50 feet in length. Bearing 285 deg. W.

The same as before, near the end of the tunnel. Sample No. 15 was taken from the country rock.

The sequence of the bands is therefore exactly the same as observed on the surface, and the same evidence of tremendous crushing as exhibited by the open cuts can be observed in the tunnel.

There were altogether four assays taken from the lodes cut by the tunnel, that is to say, one assay for every hundred feet in the average. I do not consider this as exhaustive, and perhaps a much larger number would be required to arrive at a fair estimate of the value of the ore. But keeping in mind what I have said above with regard to the difficulties experienced, we must rest content for the present. The assays are as follow:—

	No. 13.	No. 14.	No. 15.	No. 16
Copper.	0.22 per cent.	0.10 per cent.	Nil	Nil.
Silver...	2 oz. 4 dwts. 10 grs.	1 oz. 6 dwts 3 grs.	13 dwts. 1 gr.	16 dwts 8 grs.
Gold ...	Trace.	Trace.	Nil.	Nil.

Average.

Copper, 0.16 per cent.	£0	3	2.4
Silver, 1 oz. 4 dwt. 23 gr.	0	4	0.73
Gold, trace		—	
	£0	7	3.13

There is no denying the fact that the ore as contained in these lodes is of very low grade, and if representing the actual value it could not be considered as payable. We must, however, make allowance for the small number of assays, which probably do not represent the actual value of the ore. (See also Chapter V.)

This fact becomes plainer still if we examine the assays separately. It is unquestionable that Assay No. 13 comes from the same lode which has been laid bare by the open cut No. 11, and which, as we have seen, has yielded one of the richest samples. In fact, the average of lode (d) was

Copper, 3.31 per cent.
Silver, 6 oz. 4 dwt. 2 gr.
Gold, 9 gr.

while about 40 feet lower down the ore shows the very small percentage of 0.22 per cent. of copper, as per Assay No. 13.

As I have previously stated, the tunnel has been started between cuts No. 10 and 11, and the probability that the ore as cut at about 45 feet from the entrance does not represent lode (d) of cut No. 10 is not impossible. On the other hand, assays from other lodes have conclusively proved that the contents of one and the same lode vary considerably. It is therefore not improbable that Assay No. 13 represents such a poorer class of ore, and if this be the case the average contents of lode (d) would be—

Copper, 1.76 per cent.
Silver, 4 oz. 4 dwt. 6 gr.
Gold, 4½ gr.

The samples Nos. 14 and 15 were taken from lodes that were not exposed by surface outcrops, and it is only when we turn to sample No. 16 that we can assume that this comes from the most southern lode (e) exposed in No. 11 cut.

In this instance the similarity of the assays is rather striking, as will be seen by the following figures:—

	Assay No. 10. From Lode (e) as exposed in Open Cut No 11.	Assay No. 16. From a Lode at the end of the Tunnel, probably identical with Lode (e).
Copper ...	0.20 per cent.	Nil.
Silver ...	16 dwts. 8 grs.	16 dwts. 8 grs.
Gold ...	Nil.	Nil.

The contents in silver are exactly the same in both assays, but the value of this is rather discounted by the fact that lodes of different places, viz.:—

Assay No. 1 (open cut No. 1), 16 dwt.
Assay No. 4 (open cut No. 7), 16 dwt. 8 gr.
Assay No. 5 (open cut No. 9), 16 dwt.

show almost exactly the same contents of silver. In fact, out of 16 assays altogether, five, that is to say, one-third, show the above contents. In my opinion this rather tends to prove that the general contents of the ore bodies throughout the aktinolitic schists is somewhere about 16 dwt. than the view that lodes having this amount of silver must be identical.

Though therefore from a geological point of view there is a great probability that the lode at 440 feet in the tunnel from which assay No. 16 was obtained is identical with lode (a) of open cut No. 11, a view which is strongly supported by results of the assay, the coincidence of the two assays cannot be taken as conclusive to express the true value of the lode, because the assays of other lodes have sufficiently proved the great variability of the ore contents.

The total thickness of the six lodes cut by the tunnel is approximately 32 feet, which is about half of the total thickness of country proved by tunnel, viz., 74 feet.

If we again compute the tonnage of ore as proved by the tunnel we arrive at an estimate of 250,000 tons, one-half of which, say 125,000 tons, would represent low-grade ore, while the remainder would represent quartzite and aktinolite schist, with traces of copper ore. But as the above amount does represent the total quantity of ore as contained in this block up to the boundary between the two ore bodies, the total quantity is likely much greater.

VI.—VALUE OF THE ORE CONTAINED IN THE AKTINOLITE ORE BODY.

We are now in the position to sum up the results as set forth in the foregoing pages, and to arrive at a fair estimate of the value of the aktinolitic ore body. We will for this purpose divide the total ore mass into three sections, viz.:—

The Northern Section, including all the lodes north of No. 1 tunnel, and exposed by the open cuts Nos. 1, 2, 3, 4, 5, 6, assays Nos. 10 and 17, and tunnel No. 2.

Central Section, as represented by open cut No. 10 and assays Nos. 7, 8, 9, open cut No. 11, and assays Nos. 10, 11, 12.

The Southern Section, as represented by the lodes cut by No. 1 tunnel and the country on the southern side of the aktinolitic body.

I.—Northern Section.

There are altogether nine open cuts and trenches in this section, and the aggregate width of the lodes contained therein can be estimated at about 60-65 feet. It is difficult to say whether this estimate is correct, because in some of the cuts no measurements could be taken; but, on the whole, I believe that it is rather under the mark.

The Northern Section measures about 132 feet (two chains) in width, but this does not include the extreme northern slope, which is covered by glacial debris. We see therefore that the proportion of ore bodies to the total is about half.

The Northern Section measures 132 x 500 x 100 feet, which gives a bulk of 6,600,000 cubic feet, representing 600,000 tons of ore in a round figure. On the basis of the above estimate 300,000 tons would represent low-grade ore, while the remainder would be considered as metalliferous fluxes.

The average assay of the above ore would be

Copper, 2.76 per cent	£2	15	2.4
Silver, 1 oz. 6 dwt. 22 gr.	0	3	5.05
Gold, 4.7 gr.	0	0	9.97
Total	£2	19	5.42

On closer examination it will, however, be seen that this average is again made up by three parts of very different grade. The first part includes the lodes as exposed in open cuts Nos. 1, 2, and 3, the average contents of which are—

Copper, 0.28 per cent.	£0	5	7.2
Silver, 15 dwt. 1 gr.	0	1	11.35
Gold, 5 gr.	0	0	10.619
	£0	8	5.169

The second part represents the lodes as exposed by open cut No. 7 and the tunnel No. 4, the average contents of which are—

Copper, 5.18 per cent.	£5	3	7.2
Silver, 1 oz. 11 dwt. 20 gr.	0	4	0.54
Gold, 5 gr.	0	0	10.619
Total	£5	8	6.359

The third part is represented by the lodes exposed in open cuts No. 8 and No. 9, and shows an assay of—

	£	s	d
Copper, 0.40 per cent.	£0	8	0
Silver, 16 dwt.	0	2	0.4
Gold, trace		—	
Total	£0	10	0.4

It is unquestionable that the lower grade ore of under £1 per ton prevails, and the above average may, perhaps, be too high, but it will be difficult to decide this question, because, as already pointed out, the contents of one and the same lode vary greatly, and it is therefore not quite certain whether the assay values of the first and third part really represent the actual value of the lodes or not. On the other hand, these assays bear a striking similarity to the average as obtained from the assays of the tunnel, and there is, therefore, a probability that they really represent the general value of the lower-grade ore. If we were to reduce the average by taking two parts of the first and third to one part of the second, this may perhaps represent the proportion of the ore as exposed, and the average value per ton would work out at £1 6s 5.89d.

The total value of the ore in the Northern Section would therefore be in round figures £662,000, taking a very low estimate.

II.—Central Section.

The Central Section represents that block of country which is proved by the fine open cuts Nos. 10 and 11, the contents of which have been estimated at 100,000 tons, worth £406,780. It is, however, quite correct to assume that the central section is much wider than 50 feet only inasmuch as a few surface scratchings have exposed the existence of ore bodies to the north of the open cut No. 10. If we assume the width of this section to be only 132 feet (two chains), I think we will be well within the mark. This section would therefore measure 132 x 528 feet, and the value in round figures would be 130 x 500 x 100, equal to 6,500,000 cubic feet, which would in round figures give 600,000 tons, out of which 300,000 tons would be workable ore, worth £1,109,552 at the rate of £3 13s 11.6428d per ton.

III.—Southern Section.

This section includes all the rock to the south of Nos. 10 and 11 cuts, which has been fairly tested by No. 1 tunnel and open cuts Nos. 13 and 14. It measures about 330 feet (five chains) in width, and its bulk would be in round figures 330 x 500 x 100, equal to 16,500,000 cubic feet, or 1½ million tons. According to the evidence of the tunnel, we ought to assume that one-half would be represented by workable ore, say 750,000 tons, which, at the rate of 7s 3.13d, would be worth £290,400. In the following table I have compiled the above figures:—

	Cubic Feet Million	Tons @ 11 Cubic Feet Million	Workable Ore, 50 per cent. Tons.	Fluxes and Gangue. Tons.	Average Value per Ton.	Total Value of Ore.
I. Northern Section...	13.2	1.2	600,000	600,000	£2 19 5.42 £1 6 5.89	£662,000
II. Central Section...	6.5	0.6	300,000	300,000	£3 13 11.64	£1,109,552
III. Southern Section...	16.5	1.5	750,000	750,000	£0 7 3.13	£290,400
Total ...	36.2	3.3	1,650,000	1,650,000	£1 15 10.88	£2,061,952

The above figures require a few more words of explanation; if the actual average of the ore of the Northern Section, as ascertained by the assays, were taken the total average would work out at £2 6s 10.73d per ton, instead of £1 15s 10.88d, and then the total would, of course, increase considerably.

It will, further, be seen that if the average value per ton of ore as ascertained from 15 assays were taken the value of the ore contained in the Southern Section would be considerably increased.

I believe that the above figures give a very fair estimate of the value of the ore as contained in the aktinolitic ore body of the Derwent Copper Proposition, and it remains only to be seen how far this estimate agrees with an estimate taken in bulk.

In order to calculate the volume of the ore body it will be best to divide it into six sections, each representing a triangular prisma of 132 feet in height. The base of each prisma is represented by the height of the spur and the length from the north-south belt, measured in horizontal direction. The area of the base is therefore

$$a = 200/2 \times 528 = 52{,}800 \text{ square feet,}$$

The volume v.

$$v = 52{,}800 \times 132 = 6{,}969{,}000 \text{ cubic feet.}$$

The total cubical volume of the aktinolitic ore body amounts therefore to

41,517,600 cubic feet,

which is somewhat more than the estimate in the above table. The above would represent

3,774,327 tons of ore,

or, say, in round figures,

3.7 million tons of ore.

If we again assume that 50 per cent. of the ore is workable, while the remainder represents ore that can only be considered as metalliferous fluxes, we arrive at an estimate of

1.85 million tons of ore.

Now, if we take the total average of the 18 assays from the aktinolitic ore body, this works out at

	£	s.	d.
Copper, 1.72 per cent.	£1	14	4.8
Silver, 2 oz. 10 dwt. 11 gr.	0	6	4.95
Gold, 4 gr.	0	0	8.49
Total	£2	1	6.24

This amount is larger than the average as worked out by sections, but somewhat smaller if the average is calculated as above stated. We may, however, disregard this small discrepancy, and take the above figures as representing the total average.

According to this figure 1,000 tons of ore would be worth £2,076, and 1.85 million tons would be worth

£3,841,600.

Perhaps this estimate may be somewhat too high, but it is probably correct to assume that the aktinolite ore body contains between 1.65 and 1.85 million tons of ore, worth between 2 million and 3.8 million pounds.

I may therefore conclude this by drawing attention to the summary of assays from the aktinolitic ore body as contained in the above table. It will be seen that if the assays Nos. 15, 16, and 18 were omitted the average contents would work out at a much higher figure, viz.:—

	£	s.	d.
Copper, 2.06 per cent.	£2	1	2.4
Silver, 2 oz. 17 dwt. 13 gr.	0	7	3.75
Gold, 4.8 gr.	0	0	10.19
Total	£2	9	4.342

At this rate the value of the ore body would work out at a higher figure still, viz., from £4,072,200 to £4,565,800, or, in round figures from 4 million pounds to 4½ million pounds. according to the quantity of bulk.

I have again condensed these figures in the following table:

Estimated Quantity of Ore Body.	Average Contents per ton	Average Value per ton.	Total Value of Ore Body.
1 65 million tons...	Copper, 1.11 per cent. Silver, 14 dwt. 18 grs. Gold, 3 grs.	£1 15 10.88	£2,061,952
	Copper, 1.72 per cent. Silver, 2 oz. 10 dwt. 11 grs. Gold, 4 grs.	2 1 6.24	3,425,400
	Copper, 2.06 per cent. ilver, 2 oz. 17 dwt. 13 grs. Gold, 4.8 grs.	2 9 4.34	4,072,200
1.85 million tons...	Copper 1.11 per cent. Silver, 14 dwt. 18 grs. Gold, 3 grs.	1 15 10 88	2,072,000
	Copper, 1.72 per cent. Silver, 2 oz. 10 dwt. 11 grs. Gold, 4 grs.	2 1 6.24	3,841,600
	Copper, 2.06 per cent. Silver, 2 oz. 17 dwt. 13 grs. Gold, 4.8 grs.	2 9 4.34	4 565,800

The above table proves conclusively the value of the aktinolite ore body, and it shows that at the lowest estimate it is worth £2,000,000, while the highest estimate, which is, at the same time, a moderate one, proves it to be worth 4½ million pounds. There is, of course, a wide difference between these two estimates, and this needs a few words of explanation, though this is practically already stated in the previous estimates.

I have explained how I arrived at the lowest value of £1 15s 10.88d per ton, which is considerably lower than the average value of 18 assays. On the other hand, we see that this average value is considerably influenced by the low assays Nos. 15, 16, 18. These assays, though coming from lodes in the tunnel, practically represent nothing but the very low-grade bands between the more metalliferous lodes. If all ore of that grade were included in the bulk estimate the proportion of workable and poorer ore would be two to one; that is to say, two-thirds of the bulk could be considered as ore having an average composition of copper, 1.72 per cent. Naturally, instead of 1.65 to 1.85 million tons of ore there would be from 2.2 to 2.5 million tons available, and this would again considerably increase the total value.

It would be superfluous to discuss this question further, but it proves, in my opinion, that if we take the average of 18 assays as representing the average contents of the ore, and if we assume that 50 per cent. of the bulk only represents ore of that composition, disregarding entirely the other half, which is also metalliferous, and could be advantageously used as fluxes, we arrive at the sum of 3 4-10th million pounds to 3 8-10th million pounds as representing the value of the ore body, an estimate which, in my opinion, is hardly exaggerated.

The only question which remains to be decided is, of course, all important: Would it pay to treat ore of such a low grade as contained in the aktinolite ore body?

We are luckily in the position to answer this question consulsively and in the affirmative. According to the latest report published by the Mount Lyell Company the average assay of ore from the Mount Lyell mine is—

	£	s	d
Copper, 0.95 per cent.	£0	19	0
Silver, 0.91 oz.	0	2	5.755
Gold, 0.073 oz.	0	6	2.333
Total	£1	7	8.088

And only by adding the richer ore from North Mount Lyell, having an aggregate of 6.07 per cent. of copper, and some by-products of the Crotty Smelting Works, the average contents of the 1 4-10 million tons of ore that have been treated since August, 1903, are brought up to

	£	s	d
Copper, 2.36 per cent.	£2	7	2.4
Silver, 1.89 oz.	0	7	4.145
Gold, 0.054 oz.	0	4	7.048
Total	£2	19	1.593

If we take the lowest average contents of the aktinolite ore body, viz.,

Copper, 1.11 per cent.
Silver, 0.924 oz.
Gold, 0.0062 oz.

we see that even this compares favourably with the Mount Lyell ore as far as the contents of copper and silver are concerned, but if we take the average of 18 assays, viz.,

Copper, 1.72 per cent.
Silver, 2.5228 oz.
Gold, 0.0083 oz.

we find that this compares very favourably with the average ore treated by the Mount Lyell works, but considerably exceeds the value of ore extracted from the famous Mount Lyell ore body by having almost twice the percentage of copper and over double the quantity of silver.

If, last of all, we compare the average of the 15 assays above mentioned, viz.,

Copper, 2.06 per cent.
Silver, 2.877 oz.
Gold, 0.0096 oz.

we see that this ore is almost of the same quality as far as the percentage of copper is concerned, but of a much higher value in silver than the ore treated by the Mount Lyell Company, which was only by adding the rich ore from the North Lyell and some rich by-products brought up to the above standard. The only difference in value is represented by the contents of gold; 1000 tons of ore treated by the Mount Lyell Company yield 54 ounces of gold, while 1000 tons of the aktinolite ore body would yield 9.6 oz. of gold only.

The figures are more striking still if we compare the value per ton of ore from Mount Lyell with that obtained from the aktinolite ore body. For easy reference I put the figures again side by side in the following table:—

Mt. Lyell Ore, per ton.	Ore Treated by Mt. Lyell Co., per ton.	Actinolite Ore Body, per ton. Lowest Value.	Average Value.	Highest Value.
£1 7s 8.088d.	£2 19s. 1 593d.	£1 15s 10.88d.	£2 1s. 6.24d.	£2 9s. 4 34d.

We therefore see that even at the lowest value the ore from the aktinolite ore body is worth 8s 2d more than the Mount Lyell ore, notwithstanding the higher percentage of gold which distinguishes that ore. But even if the average ore be treated by the Mount Lyell Company, by adding the rich ore from North Lyell and the very rich by-products from the smelting works, this ore is worth only 10s more per ton than the ore from the aktinolite ore body. Of course this will mount up to a considerable sum when large masses are treated, but, on the whole, we can say the ore from the aktinolite ore body is more valuable than the ore from the famous Mount Lyell mine, and it even compares very favourably with the ore treated by that company.

I may be permitted to add a few words to this. On the Cradle Mountain section a thick lode of aktinolite ore is exposed, which assayed—

Copper, 6.30 per cent.
Silver, 7 oz. 16 dwt. 19 gr.
Gold, 22 gr.

If this ore be added to the ore from the Derwent Copper Proposition the average assay of that ore would range from—

Copper, 1.96 per cent. to 2.33 per cent.
Silver, 2 oz. 16 dwt. 1 gr. to 3 oz. 3 dwt. 18 gr.
Gold, 5 gr. to 6 gr.

according to whether the lower or higher average is taken. The last figure would work out at £2 15s 9.16d per ton; that is to say, practically only 4s less than the average ore treated by the Mount Lyell Company.

Little remains to be added to this. The expenses of the Mount Lyell Company are per ton of ore:—

Mining operations	£0	5	10.12
Smelting operations	0	7	5.32
Converting operations	0	1	1.53
Total	£0	14	4.97

During the previous half-year the expenses were a little higher—15s 10.45d. Taking 15s per ton of ore as an average, even the lowest estimate of the ore value from the aktinolite ore body would leave a profit of £1 per ton, or 1.65 to 1.85 million pounds altogether. The general average would leave a profit of £1 6s, the higher of £1 14s per ton, and the total profit would range from £2,000,000 to £3,000,000, according to the quantity of ore available.

V.—THE CHLORITE BELT.

A.—DESCRIPTION OF THE OPEN CUTS.

A general outline of the geological features of the "Chlorite Belt" has been previously given; it now remains to describe in detail the outcrops of lodes that have been observed. It may be stated at once that much less prospecting work has been done in this part of the proposition than on the aktinolite ore body. The cuts are mostly mere surface scratchings, and that lode which is apparently the richest could not be examined because it was covered partly by debris, partly by the high water of the Commonwealth Creek.

In order to avoid confusion of the cuts in this part of the proposition with those in the aktinolite ore body I distinguished them by capital letters.

Open Cut A (S).

A short tunnel has been driven from the open cut on this lode, which has a width of about 5 to 6 feet. The lode crosses the creek and disappears on the southern slope beneath the glacial debris. An assay of a sample of ore yielded—

Assay No. 19.

Copper, 0.10 per cent.
Silver, 19 dwt. 4 gr.
Gold, trace.

Open Cut B.

This is an open cut about 100 feet above A, and a little further to the west. The lode measures 5 feet in width, and is apparently a chloritic schist, thickly impregnated with copper pyrites and iron pyrites. The rock is very crushed, indicating that the lode has been subjected to a heavy pressure. The assay of a sample yielded—

Assay No. 20.

Copper, 0.11 per cent.
Silver, 17 dwt.
Gold, trace

Open Cut C.

This is a little further to the west of B, and exposes a lode 4 feet in width of greenish aktinolite, richly impregnated with iron pyrites, and apparently only a little copper pyrites. The strike is north-south, the dip apparently west. Sample No. 21 was taken from this lode, and it yielded—

Assay No. 21.

Copper, 0.13 per cent.
Silver, 1 oz. 12 dwt. 15 gr.
Gold, trace.

Open Cut D.

This is a small trench which opens out a thick lode not less than 8 feet in width, of greenish rock impregnated with copper and iron pyrites. The strike is north-south. On assay it yielded—

Assay No. 22.

Copper, 0.12 per cent.
Silver, 2 oz. 4 dwt. 10 gr.
Gold, trace.

Open Cut E.

Right on the top of the hill, exposing a lode of rather solid ore, about 4 feet in width. It is most probably the northern continuation of the lode exposed in the bed of the creek and by open cut A. On assay it yielded—

Assay No. 23.

Copper, 0.10 per cent.
Silver, 1 oz. 6 dwt. 3 gr.
Gold, nil.

Open Cut F.

A surface scratching, exposing a fine lode of fibrous aktinolite richly impregnated with iron pyrites. This lode had only recently been discovered. On assay it yielded—

Assay No. 24.

Copper, nil.
Silver, 1 oz. 19 dwt. 4 gr.
Gold, nil.

The average of the above five assays is:—

	£	s.	d.
Copper, 0.093 per cent.	£0	1	10.32
Silver, 1 oz. 9 dwt. 18 gr.	0	3	9.37
Gold, nil		—	
Total	£0	5	7.69

This is such a low grade of ore that it would never pay to work it profitably, but its metalliferous contents might be extracted by using this ore as a flux in conjunction with the more acid ores of the aktinolite ore body.

The bulk of the chloritic belt can be estimated at about 32,000,000 cubic feet, measuring 200 x 800 x 200 feet roughly. This would give about three million tons by weight, of which at least two-thirds have the above composition, and if this ore is considered as fluxes only, for which purpose it would be eminently suitable on account of its aktinolite contents, its metalliferous percentage can be added to that of the other ore.

I may state here that the Mount Lyell Company use about 2,000 tons of metal-bearing fluxes every half-year showing the following contents:—

Copper, 1.22 per cent.
Silver, 6 dwt. 2.8 gr.
Gold, trace.

This ore is considerably richer in copper than the ore from the chlorite belt, but, on the other hand, the latter shows a much higher percentage in silver.

VI.—COMPARISON OF THE ORE FROM THE AKTINOLITE ORE BODY AND CHLORITE BELT.

As it has been stated that the north-south belt, the chloritic schist is the real ore channel, and as No. 1 tunnel was driven with the purpose to intercept these ore bodies, it will be interesting to investigate how far this view is borne out by the results of the assays.

If ore samples from the aktinolite and chlorite schist are macroscopically examined there does not appear to be a great mineralogical difference, except that the latter bear unquestionably the appearance of an ore of lower grade than the former. On the other hand, the chemical constitution of the two classes of ore is very different.

We can divide the ore from the aktinolite schist, according to the copper contents, into three classes, viz., poor ore with less than 1 per cent. of copper; low-grade ore with less than 5 per cent. of copper; rich ore, with more than 5 per cent. of copper; and we will consider each class separately.

1st Class—Poor Ore, with less than 1 per cent. of Copper.

The following assays fall under this class:—

Assay No.	Copper.	Silver.	Gold.
1. ...	0.21 per cent. ...	16 dwts. ...	Nil
2. ...	0.53 per cent. ...	19 dwts. 4 grs. ...	16 grs.
3. ...	0.10 per cent. ...	10 dwts. ...	Nil
4 ...	0.38 per cent. ...	16 dwts. 8 grs. ...	Trace
5. ...	0.40 per cent. ...	16 dwts. ...	Trace
10. ...	0.20 per cent. ...	16 dwts. 8 grs. ...	Nil
13. ...	0.22 per cent. ...	2 oz. 4 dwts. 8 grs. ...	Trace
14. ...	0.10 per cent. ...	1 oz. 4 dwts. 10 grs. ...	Trace
15. ...	Nil ...	13 dwts. 1 gr. ...	Nil
16. ...	Nil ...	16 dwts. 8 grs. ...	Nil
18 ...	Nil ...	19 dwts. 4 grs. ...	Nil

This class of ore can again be conveniently divided into two sub-classes, one showing no copper, but a certain amount of silver, and the other in which copper is present.

The lowest class of ore shows an average of

14 dwt. 19 gr. of silver

only, and it is obvious that this cannot be considered as workable ore. The geological occurrence of this class, which was obtained from the tunnel, proves conclusively that this is practically nothing else but the country rock between the richer lodes. The petrographical position of this ore is not quite certain; it is mostly a dark green rock, which almost looks like a volcanic rock, richly impregnated with iron pyrites. Matted aktinolite forms apparently the chief part, and for this reason this class of ore should make a good flux when added to the more acid ore. If, as it is in my opinion pretty certain, this class of ore is representative of the beds that exist between the richer lodes, it will be seen that that part of the aktinolitic schist which was not considered as workable ore would still add its metalliferous contents when used as flux, and the actual value of the ore body would be perceptibly higher than it is assumed to be. The next higher class of ore (8 assays) shows in the average—

Copper, 0.27 per cent.
Silver, 1 oz. 0 dwt. 13 gr.
Gold, 2 gr.

This ore could not well be considered as workable ore either, but it must be remembered that part of the assays making up this average were obtained from lodes which have also yielded some higher grade ore.

The above average comes pretty near to the average obtained from the chloritic schist, but it shows a higher percentage of copper and smaller contents in silver. If we examine the above assays we see that in six out of the eight assays the contents in silver are under one ounce, while two only contain more than one ounce. On the other hand, two out of six samples from the chlorite schist contain less than one ounce of silver, while four contain more than one ounce. That is to say, 66.6 per cent. of ore from the chloritic belt will contain more than one ounce of silver, while only 25 per cent. of the low-grade ore from the aktinolite schist will contain more than one ounce of silver.

This is unquestionably a marked difference, which is still more emphasised when the contents of copper are examined; all the assays from the chlorite schist show a percentage of under 0.13 of copper; in the ore from the aktinolite schist only two samples show a similar percentage. In other words, while 100 per cent. of the ore assayed from the chlorite schist have 0.13 per cent. of copper and less, only 25 per cent. of the samples from the aktinolite schist show the same percentage.

These two features seem to prove that the ore contained in the chlorite schist is of a different character from that of the aktinolite schist. The ore from the chloritic schist might be termed as a low-grade silver ore, with a small percentage of copper, while that from the aktinolite schist can be termed as a low-grade copper ore with rather a high percentage of silver.

II.—Low-grade Ore, with less than 5 per cent. of Copper.

The following assays fall under this heading:—

Assay No.	Copper.	Silver.	Gold.
7.	1.21 per cent.	1 oz. 10 dwts.	—
11.	1.52 per cent.	2 oz. 5 dwts. 17 grs.	—
6.	2.71 per cent.	1 oz. 12 dwts. 16 grs.	20 grs.
9.	2.72 per cent.	2 oz. 9 dwts.	18 grs.

The average of the above assays works out at—

Copper, 2.04 per cent.
Silver, 1 oz. 19 dwt. 16 gr.
Gold, 9.5 gr.

This may be considered as a good low-grade ore, with a fairly high percentage of silver. Comparing this with the average of the poor ore, it will be noticed that though the contents of copper are nearly eight times higher, the contents in silver have not increased in the same proportion, being only about double of that of the poor ore.

III.—Rich Ore with more than 5 per cent.

Assays falling under this heading:—

Assay No.	Copper.	Silver.	Gold.
12.	5.10 per cent.	10 oz. 2 dwts. 12 grs.	18 grs.
8.	7.30 per cent.	13 oz. 1 dwt. 8 grs.	—
17.	8.32 per cent.	3 oz 18 dwts. 9 grs.	—

The average of the above assays works out at—

Copper, 6.91 per cent.
Silver, 9 oz. 0 dwt. 17 gr.
Gold, 6 gr.

This may be considered as very rich ore indeed, and it will be seen that the contents of silver have increased nearly four times, while the percentage of copper has increased a little over three times as compared with the low-grade ore.

The above figures will perhaps best be tabulated in the following way:—

	Ore from the Aktinolite Schist. Rich Ore.	Low Grade Ore.	Poor Ore.	Country Rock.	Ore from the Chlorite Schist.
Copper	6.91 per cent.	2.04 per cent.	0.27 per cent.	—	0.093 per cent.
Silver	6 oz. 0 dwts. 17 grs.	1 oz. 19 dwts. 16 grs.	1 oz. 0 dwts. 13 grs.	14 dwts. 19 grs.	1 oz 9 dwts. 18 grs.
Gold ...	6 grs.	9.5 grs.	2 grs.	—	—

It must, however, be well understood that the five classes above distinguished do by no means represent particular lodes that show one of the above contents right through. In fact, just the opposite is the case, as observations have proved that one and the same lode contains very rich ore at one place and very poor ore at another. For the present it is impossible to say in what proportion the three classes of ore are contained in the lodes representing the workable ore. For all practical purposes

it is safest to go by the general average, which, not including the country rock, works out at—

Copper, 2.06 per cent.
Silver, 2 oz. 17 dwt. 13 gr.
Gold, 4.8 gr.

But if certain mineralogical indications are not deceptive, it seems that the different lodes vary considerably as to the proportion the above three classes participate in making up the metalliferous contents. A few examples will illustrate this. The lode exposed by open cut No. 7 seems to be composed of two parts of rich ore, one part of low-grade, and one part of poor ore, while the lode exposed by open cut No. 1 is made up of two parts of poor ore, and lode (d), in No. 11 cut, of one part low-grade ore and one part rich ore.

It must be understood that the samples were not picked, but taken in the ordinary way. Under the 15 samples, excluding the country rock

8, or 53.3 per cent., represent poor ore,
4, or 26.6 per cent., represent low-grade ore.
3, or 20 per cent., represent rich.

Could this small number be taken as a fair test, the following theoretical average composition of the ore would result:—

2 parts of poor ore,
1 part of low-grade ore,
0.75 part of rich ore.

The lode exposed in No. 7 cut would therefore be above the theoretical average, while that of No. 1 is below and that of No. 11 cut again above the average.

It is, under the circumstances, quite probable that some of the assays do not represent the true value of the lode, which ought to be ascertained by at least five assays. It is also quite clear why a poorer specimen of ore is sooner obtained than a rich one, and that there is every probability that the average value of the ore from the aktinolite schist may be higher than is assumed here.

As far as the ore from the chlorite schist is concerned, the assays prove unquestionably that the ore is of a different class from that contained in the aktinolite schist. For the present it is impossible to give any reason for this unless we assume that the genesis of the two classes of ore are different, a question which it is unnecessary to discuss here. On the whole, the assays seem to prove that the ore in the chloritic schist is rather a silver than copper ore, and under these circumstances the probability that some richer lodes may be discovered in this hitherto little explored part is by no means small. However this may be, I do not wish to raise hopes that may not be fulfilled; the present evidence goes only to show that the ore contained in the chloritic belt can be advantageously used as flux, while there is a probability that during the excavation lodes showing a considerable content of silver may be discovered.

B.—THE CRADLE MOUNTAIN COPPER MINING PROPOSITION.

1. SIZE AND SITUATION.

The Cradle Mountain Mining Proposition is for the present only one claim of 80 acres, but it is intended to take up at least one more section of 80 acres should the prospecting operathe north-eastern corner of the section.
the north-eastern corner of the section towards east.

The Cradle Mountain Claim is situated about two miles south-west of the Derwent Mining Proposition and south-southeast from Barn Bluff.

A strong creek, called Curran's Creek, traverses the proposition in a north-southerly direction. Curran's Creek is formed by the junction of two smaller creeks, one of which has been named Swallows Creek, and takes its origin from Lake Windermere; the second branch is the outlet of Lake Curran. The upper part of Swallows Creek gully is formed by a fine glacial valley, with numerous terminal moraines. (See photo. pl. 7.) After the junction of the two creeks they continue their southerly course for some distance, but Curran's Creek takes eventually a turn towards east, and joints the Forth River.

The copper outcrops occur on the eastern slope of Curran's Creek, and energetic prospecting operations have been going on from February, 1907, to April, 1907. Of course it is impossible to expect that the same amount of prospecting can be carried out in two months as has been done on the Derwent proposition, but what has been done reflects every credit on the prospectors. The north-south lode has been followed for about 200 feet in length, and it has been proved by two deep trenches and about half-a-dozen shallow cuts. The northern aktinolitic lode has been laid bare by a deep trench, and the southern aktinolite body has been proved for a considerable distance and thickness.

2. HISTORY.

This section has originally been taken up by Lord, Swallow, and Trick, who did very little prospecting work, however. As far as I understand, they put a few shots into the north-south lode and then stopped further work. The claim was eventually taken up by the Derwent Prospecting Association, together with the two claims adjoining north and south of the present section.

3. GEOLOGICAL FEATURES.

Though on the whole the same, there is, however, considerable difference between the geological characters of the Cradle Mountain and Derwent ore bodies.

The archaean schists crop out on the eastern slope of Curran's Creek, but they are mostly hidden by a thick layer of glacial debris, which affords a rich soil for a luxurious vegetation. The western slope is even more thickly wooded than the eastern, and it appears that it is formed by volcanic rocks, probably diabas.

It is impossible for the present to make out the relations between the ore occurrences, the volcanic rocks, and the archaean schist, but the following facts may be considered as certain:—

(a) There is a lode striking north-south, and bearing a very rich ore (Hawson's vein).

(b) A thick lode of high-grade ore, striking east-west, has been laid bare at the north-eastern corner of the claim.

(c) A large body of aktinolite, striking east-west, which in some parts dips towards north, while at others it seems to lie horizontal, has been proved in the southern part of the claim.

I am unable to state for the present the relation of these three different ore bodies, but I may venture a few conclusions drawn from the general geological features of the country.

It will be observed that the north-south vein is situated close to the eastern boundary of the section. The southern, and probably also the northern, east-west ore bodies are therefore on the western side of this north-south fault, and not on the eastern side, as in the Derwent proposition.

That part of the vein that has been proved is situated between the two east-west ore bodies, and three probabilities are possible, viz.:—

The north-south fault cuts off the east-west ore bodies, and continues in northern as well as southern direction into the adjoining sections.

It does not cut off the east-west ore bodies, but intersects them, with or without perceptible dislocation.

The east-west ore bodies cut off the north-south vein both at its northern and southern extremity.

Now the examination of the Derwent proposition has proved that the east-west ore body is cut off by the north-south fault, and not vice versa. We are therefore entitled to assume that unless the country be proved, the same structural features hold good in the Cradle Mountain proposition. This at once disposes of the third view. We have therefore to investigate whether the east-west ore bodies are cut off or intersected by the north-south lode. If the second view—that is, intersection—were true, it is almost certain to assume that at the point of intersection a considerable enrichment of the ore contents could be expected.

I am, however, afraid that we may not take this favourable view; to judge again from other observations, it is very probable that the north-south lode cuts off the east-west ore bodies at their eastern extremity. This view would be quite in harmony with the features of the aktinolite ore body of the Derwent proposition which has been cut off by the north-south fault.

Mr. C. P. Smith has endeavoured to settle this question and to lay bare the point where the north-south vein and the east-west ore bodies must cross. So far his work has not met with success, but this is chiefly due to lack of time. Had the weather permitted him to push on operations for only a few more weeks, this very important point could have been settled. As it is, we must content ourselves with the assumption that, though it is not impossible that the north-south lode intersects the east-west ore bodies, it is more probable that it cuts them off somewhere near the eastern boundary of the claim.

The country is unquestionably much disturbed, and if the few observations I have been able to make are correctly interpreted, it would seem that the eastern part of the aktinolite ore body forms an anticlinal, the western an unsymmetrical synclinal. Only further prospecting operations can prove how far this view is correct or not.

(a) The North-South Vein (Hawson's Vein).

This vein has crops out near the eastern boundary of the section, where it has been laid bare by two open trenches measuring 33 feet and 25 feet in length, and having a depth of 14 and 18 feet respectively at the face where they cut the vein. The following photo., pl. 7, gives a very good view of one of these trenches.

The vein has a strike of 15 deg. west of north (345 deg. W.) and a dip of 77 deg. towards east. Its thickness varies a good deal; in some of the trenches it is hardly more than four inches in width, at others it is over two feet wide; sometimes it seems to pinch out, while at other places it is developed to its full thickness. Both walls consist of very hard quartzite, which is very crushed. The question naturally arises will this vein continue for any depth and length. The horizontal extension has above been discussed; if it cuts off the east-west bodies it is safe to assume that it will extend all throughout the claim. With regard to extension of depth, it is very difficult to form an opinion. As stated in a previous chapter, an enormous amount of rock has been removed by erosion, and the possibility that only the tail-end of the vein has been preserved must be taken into consideration. On the other side, I do not think this very probable; I rather feel inclined to think that the vein extends for a considerable depth, but this can only be proved by actual operation. The ore contained in this vein is a very pure and solid copper pyrites, with dark quartzite as gangue; in some parts arsenical pyrites seems to occur in considerable quantities, while the silver most probably occurs as proustite.

A considerable number of samples from this lode have been assayed at various times. I took four samples of ore and one sample of arsenical pyrites. In the following table I have arranged these assays according to the percentage of copper:—

		Copper.	Silver,	Gold.
	1. ...	20 per cent	... 17 oz. 6 dwts 6 grs. ...	4 dwts. 21 grs.
	2. ...	18.7 per cent.	...16 oz. 19 dwts. 17 grs....	Trace
	3. ...	17 0 per cent. ...	14 oz. 7 dwts. ...	4 dwts. 21 grs.
	4. ...	16.4 per cent.	... 16 oz. 6 dwts. 16 grs. ...	Trace
	5. ...	16.3 per cent.	... 15 oz. 9 dwts. 9 grs. ...	14 grs.
	6. ...	15 4 per cent. ...	14 oz. 2 dwts. ...	9 grs.
Assay No. 29—	7. ...	13.12 per cent.	... 17 oz. 6 dwts. 6 grs. ...	Trace
	8 ...	13.7 per cent.	...13 oz. 16 dwts. 14 grs....	14 grs.
Assay No. 26—	9. ...	10.20 per cent. ...	19 oz 12 dwts ...	18 grs.
	10. ...	10 5 per cent.	... 1 oz. 15 dwts. 6 grs. ...	15 grs.
	11. ...	9.2 per cent. ...	9 dwts. 19 grs. ...	Trace
	12. ...	9.0 per cent. ...	6 oz. 4 dwts. 3 grs. ...	1 dwt. 23 grs.
Assay No. 27—	13 ...	4.51 per cent.	... 5 oz. 4 dwts. 12 grs. ...	Trace
Assay No. 25—	14 ...	2.55 per cent.	... 3 oz. 8 dwts. 14 grs. ...	Trace

These assays seem to prove that there is some sort of connection between the contents of copper and silver, inasmuch as with the decrease of the percentage of copper the contents of silver become smaller. There are exceptions to this rule—for instance, Nos. 9, 10, and 11—but, on the whole, it seems that the contents of copper and silver stand in a direct proportion to each other. A similar observation, though not quite so conspicuous, has already been noticed in the ore from the aktinolite body of the Derwent proposition, but I am unable to give a satisfactory explanation of this rather peculiar feature, which might perhaps prove of some importance when the ore is turned into marketable metal.

The contents of gold are erratic, and there seems to be no rule by which they are regulated; the remarkable feature is the very high contents of gold in some of the samples.

The contents of copper vary from 2.55 per cent. to 20 per cent.; those of silver from 3 oz. 8 dwt. 12 gr. to as high as 19 oz. 12 dwt.; and those of gold from a trace to 4 dwt. 21 gr. The average works out at—

	Value.		
Copper, 12.61 per cent.	£12	12	2.4
Silver, 11 oz. 12 dwt.	1	9	5.8
Gold, 22 gr.	0	3	10.7
Total	£14	5	6.9

There is no doubt that this is a splendid ore, of high commercial value; the present prospecting operations have proved about 300 to 400 tons of this ore, worth from £4,000 to £5,000 in round figures.

At the present stage it is impossible to form an idea of the quantity of ore carried by this vein. If the view above put forth holds good, it may have a considerable extension in length as well as in depth, but, as already said, this can only be proved by actual operations. Perhaps the best plan would be to sink a winze, following up the vein after its horizontal extension has been proved by more extended surface workings. If the depth can be proved, we would have to consider this vein as a particularly valuable one.

In order to test the value of the arsenical pyrites for gold and silver, I had a sample assayed, which yielded—

Assay No. 25.

Copper, nil.
Silver, 1 oz. 15 dwt. 6 gr.
Gold, nil.

The comparatively high percentage of silver in this otherwise barren ore is remarkable.

(b) The Northern Aktinolite Lode.

At the north-eastern corner, about 12 chains from the corner and one chain from the boundary, a short cut has opened out a fine lode, measuring about 6 feet across.

The ore occurs in two lodes of solid ore, the larger of which measures four feet, the smaller two feet in width, separated by about one foot of aktinolite impregnated with sulphides. The strike of this lode is exactly east-west, the dip 70 deg. towards north. The hanging-wall is formed by aktinolite, the footwall either by quartzite or by aktinolite. A sample yielded an assay—

Assay No. 30.

Copper, 6.30 per cent.
Silver, 7 oz. 16 dwt. 19 gr.
Gold, 22 gr.

Barring the rich ore from Hawson's vein, this lode has, with one or two exceptions from the Derwent proposition, yielded the richest ore. If we could assume that this lode would show such rich ore throughout, it would be a splendid ore body, but it must be kept in mind what I said above about the character of the lodes. It is probable that this sample represents a sample of the richer ore only, and that if more assays were taken the average would perhaps be 2.06 per cent. of copper. However that may be, it is certainly a fine lode.

Unfortunately, the extension is not known yet. If what I have above said about the structural features is correct this lode should be cut off by Hawson's vein in eastern direction not far from the present open cut, but it should continue in western direction for an unknown length.

As the archaean schists have exactly the same strike, this lode must stand in the same relation to them as the aktinolite ore body of the Derwent proposition, and the probability that this lode is only part of an extensive ore body is very great.

Energetic prospecting operations should be carried out along this lode in order to test it more fully, though in my opinion there can be hardly any doubt that there is a large quantity of ore contained in this lode.

(c) The Southern Aktinolite Ore Body.

Further down the slope, towards the creek, there occurs a large body of aktinolite, impregnated with copper pyrites. More in the middle of the section the aktinolite strikes east-west and dips towards south. This dip would indicate that the northern aktinolite lode and part of the southern aktinolite form an anticlinal whose axis is running east-west. It is impossible to say for the present whether this view is correct or not; if correct, the southern continuation of the rich lode above mentioned must be found somewhere towards the middle of the section.

The chief prospecting operations have been carried out a little further downhill, and here the aktinolite assumes a distinctly horizontal bedding. It is impossible to say whether this is due to a superficial disturbance only, or whether it is really structural. If structural, we would have a very unsymmetrical synclinal, and it would be quite probable that the richer lodes would be met with a little further downhill.

Two samples were taken from this ore body, which yielded—

Assay No. 31.

Copper, 0.62 per cent.
Silver, 1 oz. 15 dwt. 6 gr.
Gold, trace.

Assay No. 32.

Copper, 0.10 per cent.
Silver, 1 oz. 3 dwt. 12 gr.
Gold, nil.

This is very low-grade ore, and it would hardly pay to work it profitably; yet it will be seen that sample No. 31 is practically the same as far as copper and silver is concerned as the ore that is at present won by open cutting in the Mount Lyell mine. The following comparison will prove this:—

	Ore won by Open Cutting at Mount Lyell.	Ore from the Southern Aktinolite Ore Body Cradle Mountain Property.
Copper ...	0.60 per cent. ...	0.62 per cent.
Silver	1.92 oz. ...	1.76 oz.
Gold ...	0.044 oz. ...	Trace.

It is evident that if the ore contained in this ore body is treated together with the richer ore from the northern aktinolite lode or in conjunction with the ore from the Derwent proposition, the results will be very satisfactory. But if Hawson's vein has the extension it is supposed to have the working of these three classes of ore must prove very remunerative.

I refrain from working out an average percentage of the three classes, because this would only be reliable if we knew the exact proportion by which each class would be represented if mixed together. It is almost certain to say that for every ton from Hawson's vein there would be three tons from the northern and about 10 tons from the southern aktinolite ore body, and taken at this rate the average would work out at—

Copper, 2.5 per cent.	£2	10	0
Silver, 3 oz. 11 dwt. 4 gr.	0	9	0.2
Gold, 6 grains	0	1	0.7
Total	3	0	0.9

Which comes very near the average of the ore from the aktinolite ore body on the Derwent proposition. Though a very low-grade ore, it is unquestionable that the ore from the southern aktinolite ore body could be profitably treated in conjunction with the ore from the other ore bodies above mentioned.

No estimate can at present be formed as to the quantity of ore contained in the southern aktinolite ore body, but if we assume that there are two million tons that could be simply extracted by quarrying, I think that estimate is far below the mark.

It would be inopportune at the present stage of prospecting operations to form a definite opinion as to the quantity and value of the ore contained in the Cradle Mountain section, because the data as to bulk on which such an estimate could be based are insufficient. The present examinations have proved that there exist three classes of ore, viz.,

(a) Very poor ore, under 1 per cent. of copper.
(b) Rich ore, 6.3 per cent. copper.
(c) Very rich ore, 12.61 per cent. copper.

At the proportion of

1a: 3b: 10c.

this would represent ore considerably above the average ore treated by the Mount Lyell Company.

On the basis of the above proportion, taking the quantity of (c) to be two million tons, there should be

(a) 2 million tons.
(b) 0.6 million tons.
(c) 0.2 million tons.

Total 2.8 million tons.

It is no exaggeration to assume that the quantities required for (b) and (c) exist, but in order to be on the safe side we will suppose that only half of the above quantity exists as workable ore. On this estimate the Cradle Mountain section should contain about 1.4 million tons of ore, worth £3 per ton, or £4.2 million in the aggregate.

The above may be considered as somewhat premature calculations, but I wish to demonstrate by figures which cannot be considered as exaggerated the probable value of the ore as may be contained in this section. The actual observations have proved that there exists an enormous quantity of very poor ore, probably a fair quantity of low-grade ore, certainly a small quantity of very rich ore.

No accurate figures as to the bulk of these three classes of ore can be given, and the above estimate must be rather considered as an attempt based on certain facts observed than an actual one proved by measurement.

C.—THE LAKE WINDERMERE PROSPECTING PROPOSITION.

SIZE AND SITUATION.

Two claims of 80 acres each have been taken up to the west of Claim 1819/93M, held by Mr. C. P. Smith. These sections are situated about one and a half miles to the west of the Cradle Mountain section, almost south of Barn Bluff. (See photo. pl.6.) No prospecting operations have so far been carried out on these sections, and they have merely been taken up because the western continuation of the lodes which crop out on Smith's claim is supposed to cross these claims. Only actual prospecting operations can prove how far this view is correct or not. But large boulders of ore occurring in the glacial debris can only come from an outcrop in these sections which is now hidden by this debris.

The direction in which the diluvial glacier once covering this country moved can distinctly and correctly be fixed, and there is an absolute proof that there were two glaciers, one flowing down Curran's Creek valley, in eastern direction, the other in western direction, passing down a valley not yet named. From the whole configuration of the country it is impossible to assume that the western glacier passed over the outcrops on Smith's section, thus transporting the boulders from that outcrop to their present resting place, as could easily be shown were a map of a large scale showing contour lines available. We can only assume that the outcrop of the lodes must occur between the present resting place of the ore boulders and the crest which divided the two ice streams, and that it is the western glacier which, passing over this outcrop, removed them.

These considerations have decided me to take up these two claims, but before anything more can be said about the value of this property a considerable amount of prospecting operations will have to be carried out.

V.—WATER SUPPLY.

There is any amount of water available for the purposes of motive or electric power, and as the source of the creeks running through the different properties is invariably a permanent glacial lake, there is no fear of the supply ever giving out even during the driest time of the year. Of course careful measurements had to be taken in order to judge accurately the quantity of water available, but it can safely be said that the quantity, together with the high fall, is more than sufficient to produce any power, motive or electric, that would be required for the purposes of even the largest mine in the world. A short enumeration will give at least an idea of this large water supply.

1. The River Mersey.

The River Mersey, which passes at the foot of Razorback, carries at all times of the year a large quantity of water running at a considerable speed.

2. The Commonwealth Creek.

The Commonwealth Creek derives its supply from Lake Macrae (see pl. I.), about 400 feet above the level of the valley, in which the Derwent Copper Proposition is situated. It falls down a fine waterfall (indistinctly seen at the right-hand corner of photo. pl. II.), and passes right through some of the outcrops. A rough measurement gave 2,000 cubic feet of water per minute; with a head of 400 feet this would give 1,287.8 horse-power available right at the foot of the aktinolite ore body.

As already stated, the Commonwealth Creek is afterwards joined by Cook's Creek, and on its eastern course down the valley it takes up numerous little streams, so that its quantity is largely increased when it rushes down 1,610 feet in height over the precipice of Razorback. No measurements were taken, but I think that the above data are sufficient to prove that there is more water available than even the largest mining concern could make use of.

3. The Cradle Mountain Section.

The Cradle Mountain Section is crossed by Curran's Creek, a creek with probably even a larger quantity of water than Commonwealth Creek, near the aktinolite ore body. There is a fine falls quite close to the outcrops, and the probable head of water is between 300 and 400 feet.

VI.—TIMBER SUPPLY.

All the country along the valley of the Forth and the Mersey is thickly studded with the finest timber, which is now wasted, and which could be used for mining purposes at a very small expense.

VII.—SUMMARY.

I have endeavoured to show on the foregoing pages that the Derwent Prospecting Association holds one of the finest copper mining propositions that probably occurs in Tasmania. It is a great mass of low-grade ore that can be easily extracted

by open cuts which occur on the Derwent and Cradle Mountain Copper Propositions. The total quantity of the ore masses which can thus be won is estimated at 1.65 to 1.85 millions, worth from two million to 4.5 million pounds, in the Derwent proposition, and at 1.4 millions, worth 4.2 million pounds (approximate estimate), in the Cradle Mountain proposition, giving in the aggregate from 3 million to 3¼ million tons, worth from £5.2 millions to £8.7 millions, not including the metalliferous fluxes, which if used would add their metalliferous contents to the output. There is a large water supply available all the year round for motive power, and the timber supply would last for many years to come. Though perhaps not over easy of access at the present time, the accessibility could be greatly improved by an aerial or ordinary tram driven by electricity, running down the valley of the Forth to Lorinna, and thence to the nearest railway station.

I may be permitted to end this report with a word of caution. The property is a splendid one, no doubt, but every attempt to work this low-grade ore mass at a small scale and with a small capital must end in failure. If, however, a large working capital—in my opinion not less than £100,000—is available, and if properly managed, the copper propositions near Barn Bluff should soon rank as one of the foremost copper mines in Tasmania, and pay handsome dividends for many years to come.

F. B. JACKSON, M.I.M.M., London.
METALLURGICAL CHEMIST AND METALLURGIST.

MOUNT BISCHOFF WORKS,
LAUNCESTON, 22ND MAY, 1907.

CERTIFICATE OF ASSAY,

For DERWENT PROSPECTING ASSOCIATION, NO LIABILITY.

I beg to hand you assay of samples submitted as under, and find the following to be the result :—

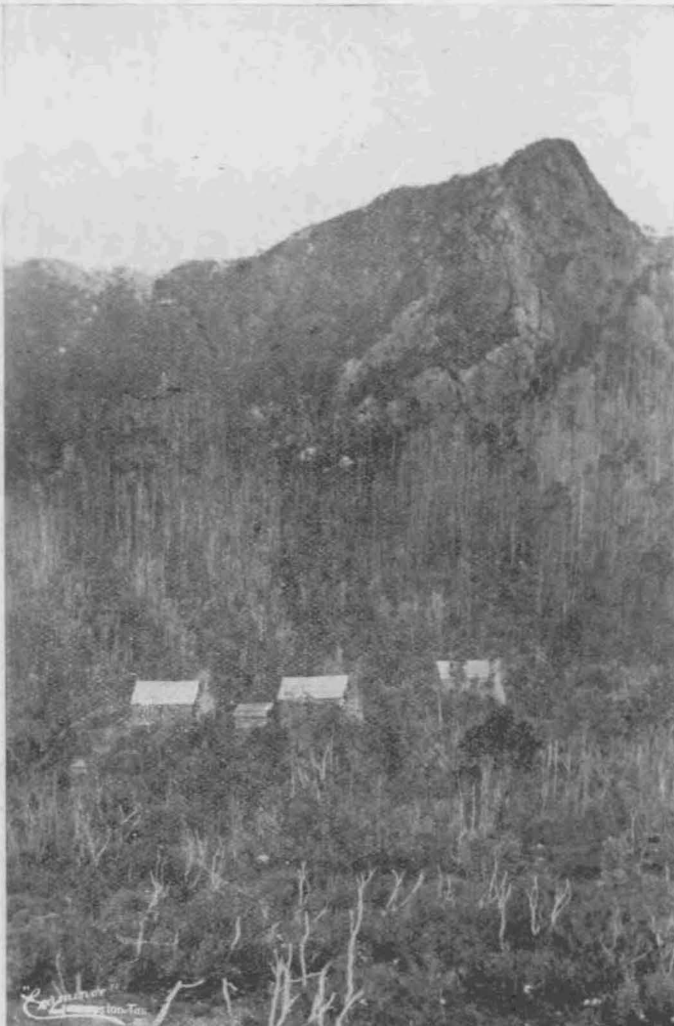
Sample No.	Copper.	Gold.	Silver. Oz.	Silver. dwts.	Silver. grs.
1	0.21 per cent.	Nil.	0	16	0
2	0.53 per cent.	16 grs.	0	19	4
3	0.10 per cent.	Nil.	0	10	0
4	0.38 per cent.	Trace.	0	16	8
5	0.40 per cent.	Trace.	0	16	0
6	2.71 per cent.	20 grs.	1	12	16
7	1.21 per cent.	Trace.	1	10	0
8	7.30 per cent.	Trace.	13	1	8
9	2.72 per cent.	18 grs.	2	9	0
10	0.20 per cent.	Nil.	0	16	8
11	1.52 per cent.	Trace.	2	5	17
12	5.10 per cent.	18 grs.	10	2	12
13	0.22 per cent.	Trace.	2	4	10
14	0.10 per cent.	Trace.	1	6	3
15	Nil.	Nil.	0	13	1
16	Nil.	Nil.	0	16	8
17	8.32 per cent.	Trace.	3	18	9
18	Nil.	Nil.	0	15	0
19	0.10 per cent.	Nil.	0	19	4
20	0.11 per cent.	Trace.	0	17	0
21	0.13 per cent.	Trace.	1	12	15
22	0.12 per cent.	Trace.	2	4	10
23	0.10 per cent.	Nil.	1	6	3
24	Nil.	Nil.	1	19	4
25	Nil.	Trace.	1	15	6
26	10.20 per cent.	18 grs.	19	12	0
27	4.51 per cent.	Trace.	5	4	12
28	2.55 per cent.	Trace.	3	8	14
29	13.12 per cent.	Trace.	17	6	6
30	6.30 per cent.	22 grs.	7	16	19
31	0.62 per cent.	Trace.	1	15	6
32	0.10 per cent.	Nil.	1	3	12

Yours faithfully,
F. B. JACKSON.

PL. I.—PANORAMA OF BARN BLUFF, CRADLE MOUNTAIN AND BROWN MOUNTAIN.
In the foreground Lake Macrae, feeder of the Commonwealth Creek.

PL. 2.—PANORAMA OF THE DERWENT COPPER PROPOSITION.

In the centre, Ward's Pinnacle, against which the Archaen schists are resting on the left side. The thickly wooded hill in the right foreground is the aktinolitic ore body. Ward's Waterfall (Commonwealth Creek) indistinctly seen in the right corner (X). Mulloch heap of No. 1 Tunnel almost in the centre (O). In the left hand corner the huts.



PL. 3.—WARD'S PINNACLE AND THE HUTS.

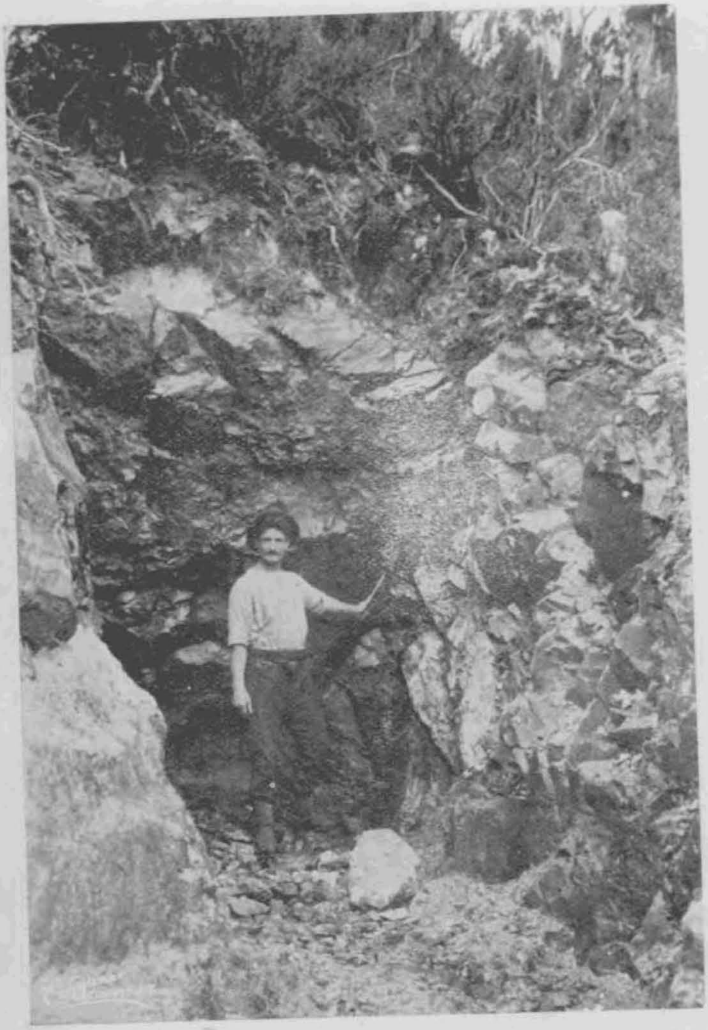
The uptilted Archaean Shists butting against the Chlorite belt are beautifully seen in this photograph.

PL. 4—No. 11 OPEN CUT.
The fine solid lodes on the left and right are well marked.

PL. 5.—ENTRANCE OF NO. 1 TUNNEL.
The glacial debris covering the hill-side is well seen. Above the tunnel is No. 10 open cut (X).

PL. 6,—VIEW OF GLACIAL VALLEY NEAR LAKE WINDERMERE.

Lake Windermere in the background, to the right is Smith's track, to the left Mount Inglis. The low hill to the right of Smith's Knob (X) indicates the situation of the Lake Windermere Prosp. Prop. The deep gully in the left foreground represents Swallow's Creek.



PL. 7.—HAWSON'S VEIN, CRADLE MOUNTAIN COPPER PROPOSITION.

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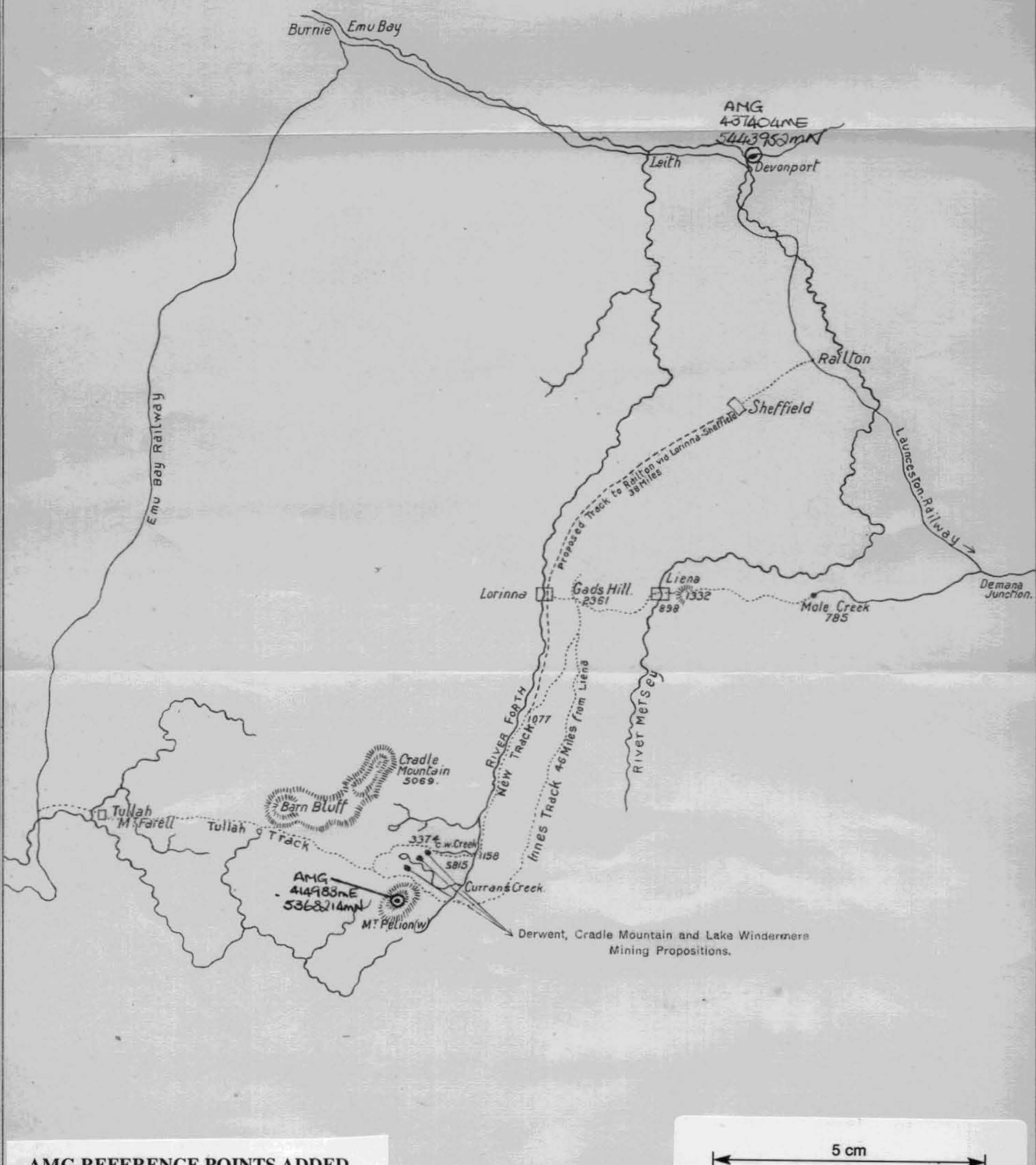
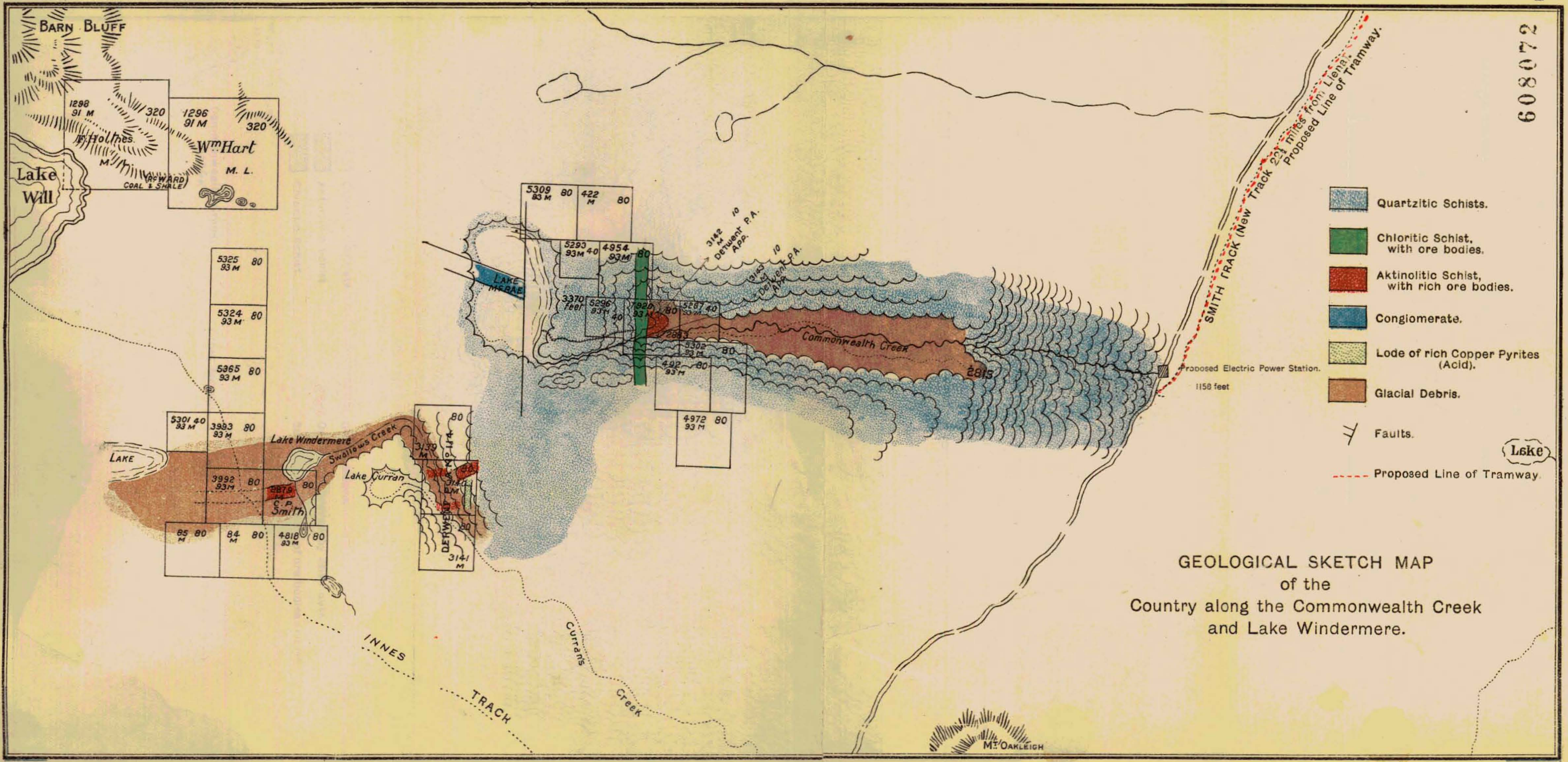
SKETCH MAP

showing the different Routes to Barn Bluff.

SCALE : 1 Inch equals 5 miles.



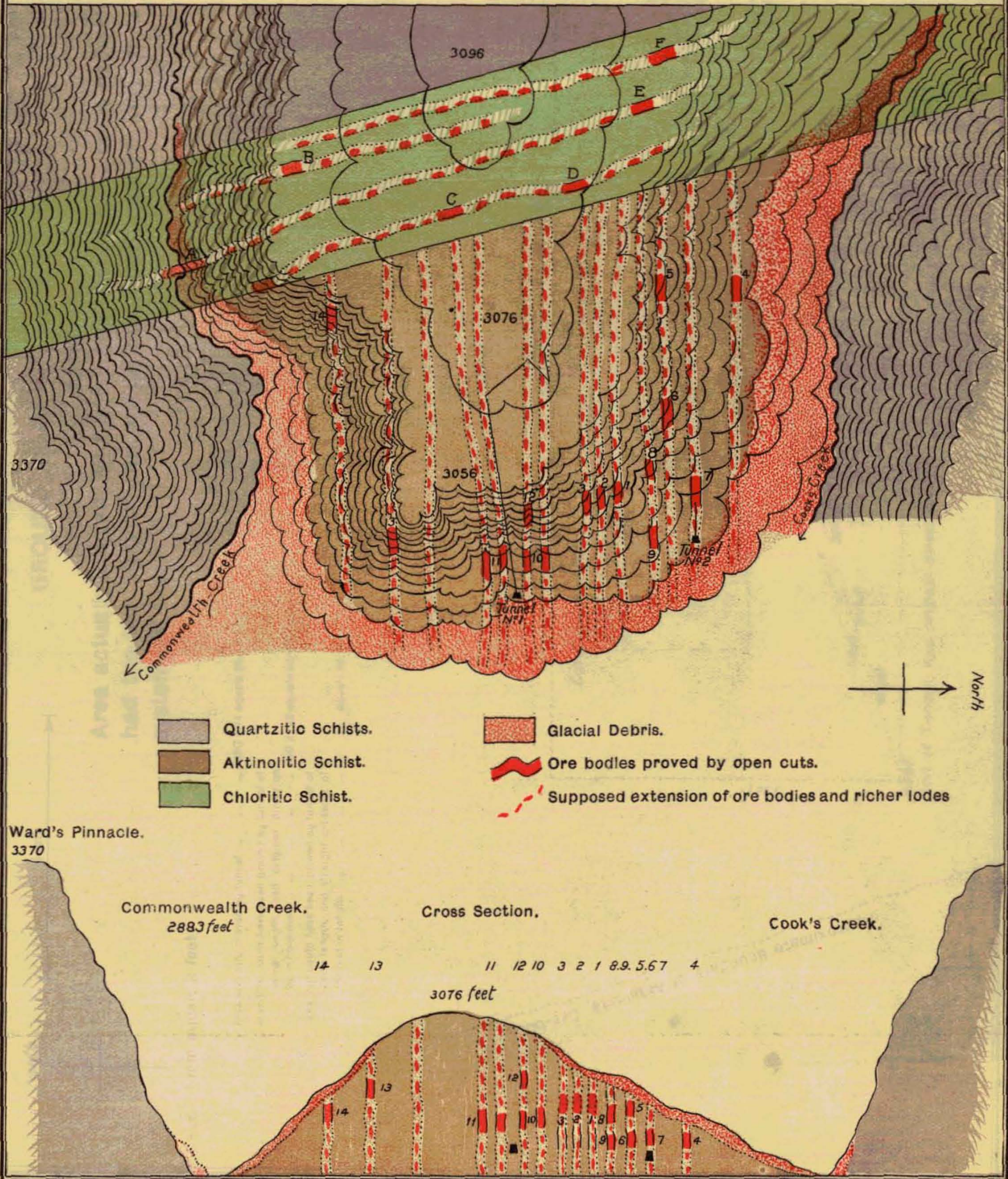
AMG REFERENCE POINTS ADDED


Barn Bluff
Lake Will
F. Holmes
Wm Hart
M. L.
Reward Coal & Shale
Lake McRae
Derwent P.A. App.
Commonwealth Creek
Lake Windermere
Swallows Creek
Lake Curran
Lake
C. P. Smith
Derwent No 174
Innes Track
Curran's Creek
Mt. Oakleigh
Smith Track (New Track 22½ miles from Lienas)
Proposed Line of Tramway.
Proposed Electric Power Station.
1158 feet
3370 feet
2815
Quartzitic Schists.
Chloritic Schist, with ore bodies.
Aktinolitic Schist, with rich ore bodies.
Conglomerate.
Lode of rich Copper Pyrites (Acid).
Glacial Debris.
Faults.
Proposed Line of Tramway.
GEOLOGICAL SKETCH MAP
of the
Country along the Commonwealth Creek
and Lake Windermere.

5 cm

GEOLOGICAL SKETCH MAP
of
Section Derwent Copper Proposition.

SCALE: 10 mm equals 1 chain app. Contour Lines 20 feet app.



GROUND PLAN OF No. 1 TUNNEL,

showing

Area actually proved, and areas that could have been proved had the last part of the operations been carried out in a systematic way.

North

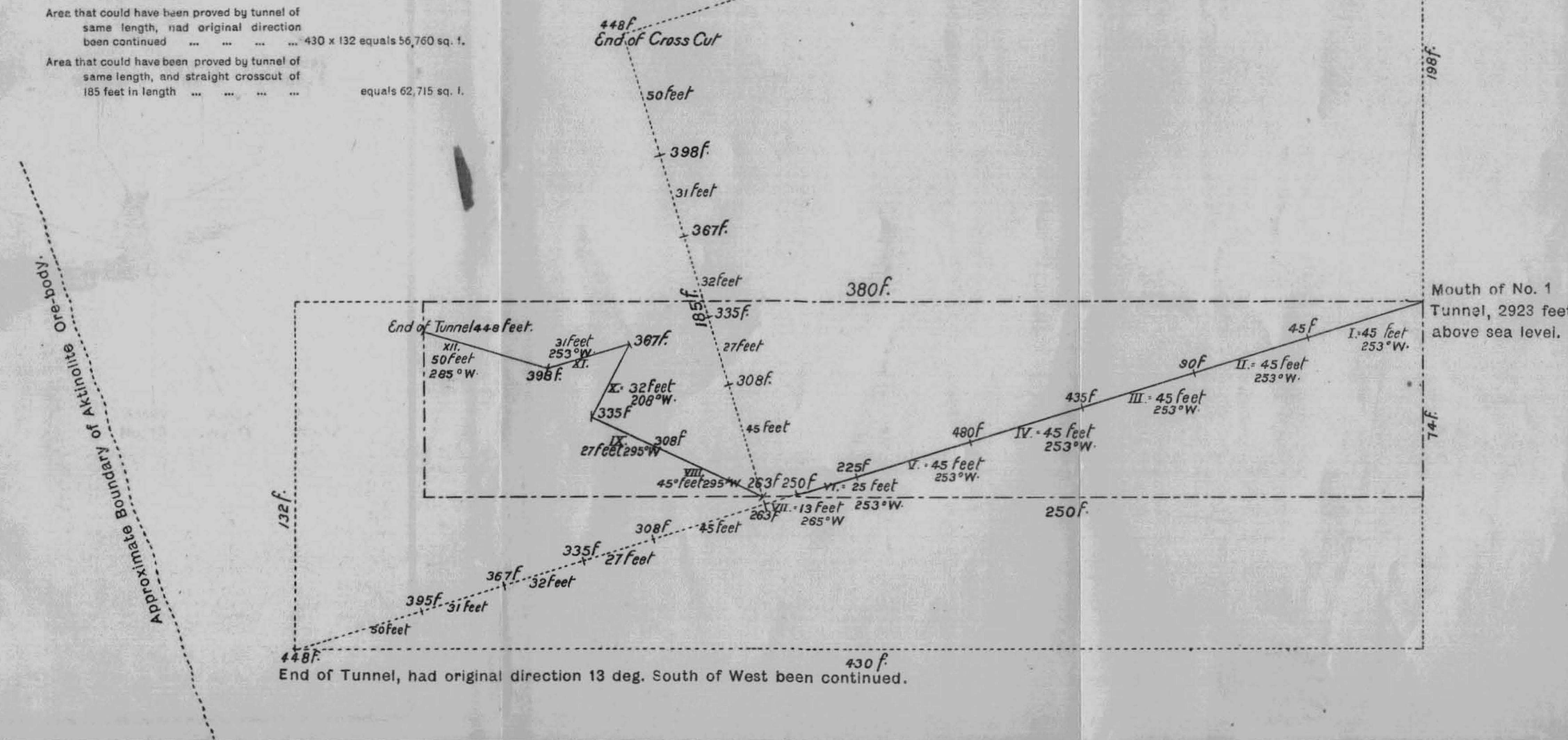
5 cm

SCALE: 1 mm equals 2 feet.

Area actually proved by tunnel ... ... 380 x 74 equals 28,120 sq. f.

Area that could have been proved by tunnel of same length, had original direction been continued ... ... 430 x 132 equals 56,760 sq. f.

Area that could have been proved by tunnel of same length, and straight crosscut of 185 feet in length ... ... equals 62,715 sq. f.



End of Tunnel, had original direction 13 deg. South of West been continued.

GEOLOGICAL SKETCH MAP OF No. 1 TUNNEL, DERWENT COPPER PROPOSITION

North

SCALE : 1 mm equals 2 feet.

5 cm

Total Length of Tunnel, 448 feet.
Country proved by Tunnel, 380 x 74 feet.
Aggregate thickness of richer Lodes, : 32 feet = 50%
Aggregate thickness of poor rock : 36 feet = 50%