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REPORT ON THE WESTERN SILVER MINE,
ZEEHAN.

[TWO PLANS.]

Zeehan, 27th September, 1902.

SIR,

I HAVE the honour to forward you the following Report on the Western Silver Mine, Zeehan, the result of an examination of the mine workings made by me during September and October last year, immediately before the mine closed down. It was originally intended to hold over this Report until the other mines of the district had been examined, so that as much evidence as possible might be brought to bear on the question of the distribution of the ore in the lodes. As, however, my examination of the surrounding districts has occupied much more time than was originally intended, it has been thought undesirable to further postpone the publication of the Report.

The sections held by the company comprise the following:—754-87M, 755-87M, 756-87M, and 892-87M, with a total area of 160 acres; also Sections 67-93M, 69-93M, and 3463-93M, with a total area of 140 acres. The principal mine workings are situated on Section 755-87M (the main workings), on Section 756-87M (Simson's workings), and on Section 892 (north workings on No. 2 lode). Sections 67-93M, 69-93M, and 3463-93M are held for timber, and are connected with the mine by means of a 2-foot gauge railway.

The prevailing rocks of the district consist of Silurian slates, limestones, and sandstones, interbedded with tuffs and flows of vesicular melaphyre (ancient and highly altered basalts). The latter are known locally as "white" country, and in the early days of the field were believed to have a very favourable influence on the metallic contents of the lodes. This theory is now much discounted, as many of the richest shoots of ore which have been mined were totally unconnected with these rocks. At the Western Mine the whole country is very much contorted and disturbed, and the strike and dip of the strata vary very greatly in different

parts. This is partly caused by local disturbances which have been produced by the lode-fissures, and partly by contortion of the whole strata, affecting large areas. When these disturbances are met with underground, it is a most difficult matter to decide whether they are local and produced by a bending of the strata in the vicinity of the fissures, or whether they form part of a great folding affecting the whole series. The only clue which is of any value in the interpretation of the disturbances is the presence of several beds of tuff and melaphyre, which may be traced through most of the levels of the mine.

On Section 755, the largest of these beds runs in a north-north-westerly direction. Near the centre of the section it is from 300 to 400 feet in thickness, but tapers off both north and south. Near the western margin of this lenticular bed there is a comparatively thin seam of slate interbedded with the tuffs, which may be traced through a number of the mine-levels. About 300 feet to the west of this main mass there are two other beds of tuff from 6 to 12 feet in width, which may be identified in all the levels from No. 3 to No. 8; from No. 3 level upwards they are very much broken up, and cannot be definitely located.

Further west again, there is another (larger) band of tuff, which is cut in two places in the mine, and is also exposed in one or two places on the surface. The exact location of this band is still somewhat problematical. By tracing these bands of "white" country from level to level the general direction of the planes of stratification may be determined. The lodes are fissure-veins, containing argentiferous galena as the valuable constituent. A little iron and copper pyrites are present in the galena in the lower levels, but, so far as I can learn, these minerals were practically absent in upper levels. A little zinc-blende is found occasionally, but never in considerable quantities. Carbonate of iron is the principal vein-stone, with occasionally a little carbonate of lime and quartz. The veins seldom have well-defined walls; indeed, it appears to be a general rule that, where the lodes have good walls, they are unproductive. The footwall is the better defined of the two, but often both are practically absent. In some cases, the typical banded structure denoting deposition of mineral matter in an open fissure may be observed; but I am inclined to think that much of the lode-matter has been deposited as a replacement of the wallrock in the vicinity of the fissures. Often the galena occurs in the form of leaves or lenticular bunches in the lode-channel, the rest of which

is filled with slate. As a general rule, where the lodes are unproductive, they are absolutely barren—not even carbonate of iron being present—but sometimes a small seam of carbonate of iron has been followed.

Plate I. gives a plan of the mine workings at No. 2 level, 110 feet below the brace of the main shaft. On this plan the main geological features are sketched. Only one of the two small beds of tuff to the west of the main lenticular bed is shown, as they are very much broken up at this level. The general dip of the strata is towards the east at angles of 65° to 80°.

The mine workings are very extensive. The shaft is 681 feet deep, and there are nine levels at the following distances from the surface:—No. 1, 45 feet; No. 2, 110 feet; No. 3, 170 feet; No. 4, 230 feet; No. 5, 290 feet; No. 6, 360 feet; No. 7, 430 feet; No. 8, 500 feet; No. 9, 600 feet. Altogether, there are over nine miles of drives and crosscuts in the mine. There are not less than eleven lodes, from which ore in payable quantities has been obtained. Many of these are, however, small lodes, which have been only worked in the upper levels. Their positions are indicated on the plan (Plate I.), but the numbers used by me in naming the lodes are not the same as those which were in use at the mine. The latter were unsuitable for the purposes of the present Report. Plate II. gives longitudinal projections of the lodes, showing the amount of stoping which has been done on each, and by reference to it the following description of the lodes will be more readily followed.

No. 1 Lode.—This is generally known as the Main lode, and has been by far the most productive lode in the mine. It is not certain that it is one continuous lode, and, indeed, it has generally been regarded as two lodes, the portion to the west of the shaft being known as the Main lode and that to the east as Jackson's lode. I propose to call these No. 1 lode north and No. 1 lode south respectively. The strike and dip of the lode varies very considerably along its course. For the first 400 feet from the northern boundary, the strike is from 15° to 25° east of north, and the dip about 76° to the south-east. It then takes a bend to the east, and for 250 or 300 feet it strikes from 35° to 55° E. of N., dipping to the N.W. at an angle of 85°. Finally, it takes a second bend to the north, striking 35° to 40° east of north, and dipping again to the south-east at an angle of about 80°. The lode appears to be made up of several branches, and these have often contained valuable shoots of

ore. This fact has made the lode particularly difficult to follow in depth, as when the lode is cut it is impossible to determine at once whether the main lode-channel has been intersected or only a branch. Often the branches have been very highly productive—sometimes more so than the main channel itself.

No. 1 lode was very highly productive in the upper levels. From No. 2 level to the surface there was a continuous shoot of first-class metal for a distance of 700 feet. The width of the ore varied very considerably, going up to as much as 8 and even 12 feet; several branches were also stoped out above No. 2 level. The lode passes through both slate and "white" country; and there does not appear to have been any marked difference in the contents of the lodes in the two rocks. There were two very rich patches between No. 2 and No. 1 levels. Measured along the lode, these were situated about 220 and 480 feet from the southern boundary of the section. In the first case, the lode was in slate country, and in the second case "white" country was present on the northern wall. Where the lode passed through the main mass of "white" country, it was good, but no better than the average of the slate country.

No. 1 lode is cut off to the north by what is known as No. 1 slide. This slide strikes 48° to the W. of N., and dips about 40° to the north-east. At No. 2 level it will be seen that the drive continues beyond the slide, and that stoping has been done beyond it. I believe that this is a small branch-lode. The strike is north and south, and the change comes in just beyond No. 1 slide. It is unlikely to be a continuation of No. 1 lode. Below No. 2 level the ore has always cut out when the slide was reached. Between No. 2 and No. 3 levels the lode was good, but poorer than between No. 2 and No. 1 levels. One patch of blank ground was left standing. Between No. 3 and No. 4 levels the lode was very poor where it passed through slate country. On No. 1 lode, south, only one small patch of stoping was done, and that hardly paid for mining. I think it would be advisable to do some cross-cutting at No. 4 level, as it is possible the ore may have made in a branch alongside the lode which has been driven on. In one place, about 250 feet from the south boundary, a branch-lode was driven on for 30 feet in a north-easterly direction, and in the end of this drive there are indications of another branch running parallel to the lode-channel, or track, which was first driven on. This is probably the same as a branch which was productive above No. 3 level, and

which junctioned with the main lode between No. 2 and No. 1 levels. No. 1 lode north is in "white" country, and was stoped out as far as No. 1 slide. It is described as having been very good in patches, and payable all through.

At No. 5 level a lot of barren ground was driven through west of the shaft, as in No. 4 level, but near the southern boundary a good block of ground was stoped out, which produced 402 tons of first-class ore and 7839 tons of seconds. This block is immediately below the ground which was stoped above No. 4 level, and showed a very decided improvement. Two other small patches of stoping were done in slate country from No. 5 level, neither of which proved payable. The smaller of these patches (leading stopes only) contained some native silver, and small patches were in consequence very rich; but the stope did not pay as a whole. In the "white" country to the east of the shaft, No. 1 lode north was patchy, and poorer than in the level above. At No. 6 level the lode was poor all through. The shoot near the southern boundary continues down, but proved to be patchy, and not nearly so good as between No. 5 and No. 4 levels. There is more ground stoped, but the amount of metal produced was less, viz., 164 tons of first and 3580 tons of seconds. A couple of hundred feet north of this shoot the lode contains a little ore. It is said to be just about payable. To the east of the shaft the "white" country is hard, and the lode practically barren. A winze sunk from No. 5 level passed through splashes of ore, and about midway between the levels the lode split up. Below No. 6 level there has been nothing found in the "white" country, and the lode is not well-defined. At No. 7 level two, nearly parallel, shoots of ore were discovered about 420 feet from the southern boundary. The lode has here split up into two branches, which come together a little above No. 6 level, the junction of the two pitching north; both of these shoots have been nearly stoped out, but there is still a little ore below No. 6 level. From about half-way between the levels the two branches were taken out in one very wide stope. It is difficult to say which is the main lode in this portion of the mine. The ore taken from these stopes proved to be very payable, and paid for the whole of the developmental work at this level. At No. 8 level there are also two branches, but they are both further east than the corresponding branches in the level above, so that, if they are the same, the lode has altered its dip between the two levels. The western branch, which was first driven on, proved to be all but barren, a little stoping being done in one place, which proved to be un-

remunerative. A crosscut was then put in to the east, and the other branch cut. This was first driven on south, in order to get under the good ore at No. 7 level, but with disappointing results. It was then driven on north, and very soon it widened out to a good-sized carbonate of iron lode, containing a little rich antimonial silver-copper ore, probably freibergite. Galena then came in, and the lode gradually improved, and became a good lode of second-class ore, with bunches of firsts. This drive was continued for about 120 feet north of the crosscut before the mine closed down. In the face of the drive the lode is 6 feet wide, with from 3 to 5 feet of good seconds and nearly 6 inches of firsts. A few shifts before the mine closed down, it appeared as though this branch was going to junction with the western branch, but in the last shift or two it appeared to be turning away again, so that it may extend for a considerable distance further. In the crosscut, 120 feet further north, I noticed a couple of small seams of carbonate of iron, carrying a little galena. It is possible that these may be the continuation of the eastern branch. So far as has been proved, there is a shoot of payable ore from 80 to 100 feet in length at this level. It is as yet uncertain whether this shoot is the same as that found at No. 7 level; if it is, it must pitch very flat towards the north. A winze put down from No. 7 to No. 8 level proved that the good ore lived down for 30 feet below No. 7, but the pitch of the shoot was not determined.

This discovery of a good payable lode at No. 8 level is a very important one, and had it been discovered when the first level was driven, it is possible that the mine would not have closed down.

At No. 9 level the lode has not yet been reached. A crosscut was being put in south, and must be close to the line of lode; but if, as appears to be the case at No. 8 level, the lode has changed its dip, it is possible that the crosscut may have some distance further to go before the lode is cut.

No. 1 lode is the only one on which much work has been done, and in which payable ore has been found in the lower levels. It is to be regretted that accurate records of the behaviour of the lode in the upper levels have not been kept. The old stopes are, of course, now filled up, and cannot be examined, and it is impossible to obtain definite information concerning them.

In the lower levels it has been shown that the lode is split up into two branches, which may be called the eastern and the western branch respectively. I think it is possible that both of these branches also exist in the upper levels,

although in three of them the eastern branch (if it does exist) has not been located. I think it is possible that the eastern branch which is productive at No. 8 and No. 7 levels may be the same as the eastern branch which was productive from No. 3 level upwards. The junction of this branch in the upper levels pitched to the north, which may account for the fact that the branch in No. 7 is considerably further north than the branch in No. 3, and that in No. 8 it is further north than in No. 7. That the junction of this eastern branch might easily have been missed is proved by the fact that it actually was missed in No. 8 level, as the drive along the western branch in one place passed within 2 feet of the good ore in the eastern branch without the latter being discovered. I think it would be well worth while putting in crosscuts at No. 6, No. 5, and No. 4 levels to test this theory.

No. 2 Lode.—This lode strikes 13° W. of N., and dips 82° to the E. It is very constant, both in dip and strike. It appears to branch off from No. 1 lode a little to the east of the main shaft. This lode is said to have been very productive for a distance of 400 or 500 feet north of its junction with No. 1 lode, but beyond this, although what is supposed to be the lode has been driven on in three levels for a total distance of over 3000 feet, no large bodies of payable ore were found. Two slides were met with, the first of which corresponds as to strike and dip with No. 1 slide, which cuts off the ore in No. 1 lode, and the second is probably No. 2 slide, though it is not quite in line. Above No. 2 level the lode appears to have crossed No. 1 slide, as the stopes go on as far as No. 2 slide, but here the ore appears to have cut out. The levels were continued as though the slides had not faulted the lode at all. This is very curious, as another lode (No. 10) is certainly faulted, both by No. 1 slide and by No. 2 slide, and it is also almost certain that No. 1 lode north has been faulted by No. 1 slide. These drives are timbered for the most part, and the roof of the level cannot be examined; but where they are not timbered it is often a matter of difficulty to discover what has been followed. I am informed, however, by Mr. Sale, a former officer of the company, that at No. 2 level there was generally a fairly well defined seam of carbonate of iron to follow. He also tells me that one patch of fair-grade ore was stoped above No. 2 level, some 400 feet north of No. 2 slide. No records of this are available at the mine. It is difficult to form an opinion without being able to pro-

perly examine the lode, and without knowing the behaviour of the lode in the vicinity of the slide; but, so far as the facts have been presented to me, they appear to point to the fact that the lode has been faulted by No. 2 slide, and that it would be worth while cross-cutting for it on the north side of the slide at No. 2 level. To the south of the slides the lode is in "white" country down to No. 3 level. Between No. 3 and No. 4 levels the "white" country dips away from the lode to the east, so that the lode passes into slate in depth. As will be seen by reference to Plate II., the lode has been stoped almost continuously above No. 3 level. Above No. 4 there is a large piece of unstoped ground, and above No. 5 level very little stoping has been done at all. At No. 5 level the drive follows the contact of the "white" country, and is certainly to the east of the lode for a considerable distance. I think it is probable that No. 4 level is also off the lode for some distance, and I think it would be advisable to crosscut west, and pick it up at both these levels. Apart from the fact that it may contain payable ore, it is very important to trace the lode down from level to level; otherwise, it is impossible to tell when the lode is cut in the lower levels.

At No. 6 level the lode is apparently barren; but as it was not driven along at No. 5 level above this drive, and as no connection with the upper levels has been made, it is not certain that it is on the lode at all.

No. 3 Lode.—This lode strikes 24° W. of N., and the dip is nearly vertical. It junctions with No. 4 lode in depth. A good deal of ore has been won from this lode. In the north end, above No. 2 level, it is said to have been very good, gradually getting poorer going south, but all well payable. Between No. 3 and No. 2 levels the lode was fairly good, and between No. 4 and No. 3 levels, good. The ore cut out going north, and the lode was not followed for any great distance.

No. 4 Lode.—This lode comes next in point of productiveness to No. 1 and No. 2. The average strike is 44° W. of N., and the dip is 55° to N.E. A very rich but somewhat short shoot of ore was mined on this lode down to No. 6 level. As will be seen from the longitudinal projection on Plate II., the main shoot follows the junction of a branch lode very accurately. Below No. 4 level this junction was not found, and the shoot gradually became poorer, till it finally cut out at No. 6 level. The branch lode was of

little importance in itself. Close to the junction it contained up to a foot of first-class ore, but this invariably cut out within 15 feet of No. 4 lode. In the main shoot there was up to 3 or 4 feet of first-class ore, and 15 feet of seconds. Several other patches of ore were discovered in this lode, but none of them were remarkably rich. There are still a couple of small patches of ore underfoot in No. 5 level, but these will hardly pay to take out at the present price of the metals. At No. 3 and No. 4 levels, No. 4 lode splits up into two branches near its contact with No. 1 lode. In the upper levels its continuation to the south of No. 1 lode has not been found, but at No. 6 level what is believed to be No. 4 lode has been cut and driven on for some distance. Between No. 6 and No. 5 levels No. 9 lode drops into No. 4, and a little stoping has been done below the junction. There is still a little ore to be won at this point.

No. 5 Lode.—Strike, 5° E. of N.; dip, 75° to the E. This lode has not proved of much value. A little stoping has been done above No. 2 level, and there are some poor seconds still standing, which may pay to take out when the metals are at a better price. At present the lode is not payable.

No. 6 Lode.—Strike, 18° E. of N.; dip, 82° to the E. This lode junctions with No. 4 lode to the north, and with No. 1 lode to the south. It was never very rich, and is practically unpayable below No. 2 level. Near No. 1 lode there is a patch of poor seconds, which will only pay to take out when the metals are at a good price.

No. 7 Lode.—Strike, 15° E. of N.; dip, 82° to E. This is another small lode between No. 1 and No. 4 lodes. It proved payable, but not highly so. There are still some seconds to be won below No. 3 level.

No. 8 Lode.—Strike, 12° E. of N.; dip, to the E. This is another small lode, nearly parallel with No. 5 and No. 6. It was good between No. 3 and No. 2 levels, but the northern end of the stopes was poor.

No. 9 Lode.—Strike, 38° W. of N.; average dip, 82° to the E. This lode was productive from No. 5 level up to No. 1 level, but above No. 1 it appears to have cut out. Part of the lode is in "white" country, part at the contact of the "white" country and slate, and part wholly in slate. At

No. 3 level a well-defined wall was followed in a south-easterly direction for a long distance, and a couple of crosscuts put in, with the hope of intersecting the Montana No. 6 lode, but without success. It is doubtful if the drive is on No. 9 lode, but it is certainly on a decided plane of movement. As already stated, this lode junctions with No. 4 lode between No. 5 and No. 6 levels.

No. 10 Lode.—Strike, 28° E. of N.; dip, 63° to E. Up to the time when the mine closed down, this lode had only been found between the two main slides, being cut off to the north by No. 2 slide, and to the south by No. 1 slide. It has been cut and driven on at No. 5 level, No. 4 level, and No. 3 level, and in each of these levels it contains very payable ore. The lode is not a big one, being about 2 feet in width, but it contains a good proportion of firsts. The crosscut at No. 2 level just missed the lode, and it has not yet been picked up. Its calculated position at this level is marked on the plan (Plate I.). It will be seen that by driving south-east along No. 2 slide, it may be readily picked up. Between No. 5 and No. 4 levels about one-third of the lode between the two slides has been stoped out. This produced 13 tons of firsts and 216 tons of good seconds. The rise between No. 5 and No. 4 produced 4 tons of firsts and 85 tons of seconds. Between No. 4 and No. 3 levels about one-fourth part of the lode has been stoped out between the slides, and this produced 23 tons of firsts and 216 tons of good seconds. At No. 3 level the lode was cut between the slides by a crosscut from No. 11 lode. Neither of the slides have been cut at this level. In the north drive the lode looks well, and shows about 8 inches of first-class ore. South of the crosscut the drive got off the lode, which was poor where first cut. Above this level the lode is not developed. Since the mine closed down, a party of tributors have been working on a lode about 700 feet to the south-west of these workings. This lode has approximately the same strike and dip as No. 10 lode, and is almost exactly in line with it. I visited this claim on the 9th September, 1902, and found that an underlay shaft had been sunk to a depth of about 45 feet. The lode is in decomposed "white" country, and carries from 2 up to 6 or 8 inches of first-class ore the whole way down. The party holds a tribute on the lode for a distance of 300 feet along its course, and for a depth of 50 feet below the surface. I am informed that the metal assays 120 ozs. of silver per ton and 70 per cent. of lead. I have very little doubt that this lode is the continuation of No. 10

lode, south of No. 1 slide, and I think it was also cut in No. 3 level in the drive along No. 9 lode. A small lode was cut here, carrying some ore, and a little stoping was done on it; but it did not prove payable, so work was discontinued. This is the only drive in the mine which tests this portion of the section. I consider this discovery is a most important one, and may lead on to the development of a very productive lode.

No. 11 Lode.—Strike, 8° E. of N.; dip, 60° to the E. This lode was most productive on the north side of No. 2 slide. The stoping which has been done produced 85 tons of firsts and 3144 tons of low-grade seconds, won between No. 3 level and No. 2 level. No. 2 slide appears to run along with the lode. After the lode meets the slide it becomes very poor for 50 or 60 feet, but then improves somewhat. At the south end of the drive in No. 3 level there are some payable seconds exposed. This lode dips into the Montana ground just below No. 3 level.

Simson's Workings.—I regret that I was only able to examine the upper level in these workings, as the pump had been stopped for some time before my visit, and this portion of the mine was under water. I understand from the manager that there is a very wide block of ground ready for stoping out. This contains a network of small veins of galena, and is believed to be payable, though it is by no means rich. Lately a slip of ground occurred in this portion of the mine, which put the company to considerable expense. It has, however, been picked up, and made secure, and is now ready for stoping. I think it is probable that Simson's workings are in some way connected with No. 1 lode, north. This lode was, I believe, faulted by No. 1 slide, and has never been found to the north of it. In No. 5 level a crosscut has been driven towards Simson's workings, and in a branch from this crosscut a carbonate of iron lode was cut, which I think may very possibly prove to be the continuation of the lode to the north of the slide. In Simson's workings the whole country is very much disturbed, and the lode may have split up into a number of branches.

It will be evident from the above account that the mine is a very complicated one. There are a great number of lodes, and although a great deal of work has been done, it cannot be claimed that their relations are yet fully understood. In a number of cases, where the lodes are barren, it

is at least doubtful if the drives are really on the lode; and in the several instances mentioned I think the question should be settled once and for all by putting in crosscuts, and by connecting the levels with winzes. I think also that an effort should be made to understand the two main slides. Up to the present it has always been assumed that the lodes pass straight through the slides, and on most of the levels some little track or seam has been followed beyond the slide for some distance. I doubt very much if No. 1 lode has been seen at all to the north of the slide, and I think this point should be settled. Perhaps the behaviour of the two slides may be best learned by operating on No. 10 lode. This will be naturally the first work undertaken when the mine is re-opened, as No. 10 lode can be reached from the crosscut at No. 2 level by driving along the west wall of No. 2 slide within a few feet, provided it maintains its strike and dip. When the lode is cut, it should be driven on south-west till No. 1 slide is cut. This should be passed through, and the continuation of the lode picked up on the other side. This will probably be done by driving south-east on the footwall of the slide. Considering the productiveness of this lode from No. 5 to No. 3 levels, this work should be the means of opening up a very considerable body of payable ground; and if I am right in assuming that the party of tributors are working on the same lode to the south, it is evident that there is a great additional inducement to thoroughly explore this lode. The continuation of the lode should also be sought to the north of No. 2 slide by driving north-west along the hanging-wall of the slide. The developments obtained at No. 2 level should, of course, be followed up at No. 3, No. 4, and No. 5 levels, where the lode is already known to be productive. Below No. 5 level the northern portion of the lode dips out of the Western ground into the Montana; but if it is productive to the south of No. 1 slide, this part of the lode may be worked from No. 6 level.

Besides the development in No. 1 lode south, between No. 8 and No. 7 levels, I believe that No. 10 lode is the only one that can be depended upon to furnish any considerable amount of ore until lower levels are reached. It is true that I have recommended certain exploratory work in the upper levels, and that I think there is a reasonable chance that payable ore may be discovered; but these possible discoveries cannot be depended on to assist in the development of the mine. I believe that the ore that can be won from No. 10 lode and from No. 1 lode south, between No. 8 and

No. 7 levels, will bear a considerable proportion of the cost of developing the mine for some time. But it would be useless to re-open the mine without providing a large amount of capital for developmental work. The future of the mine ultimately depends upon developments in the lower levels, and unless a large amount of sinking and systematic exploration can be carried on in the deeper levels, it would be useless to re-open the mine. We have now to consider whether the prospects of discovering payable ore-bodies in depth are sufficient to warrant the expenditure of capital necessary for their development. To answer this question, it will be necessary to consider the origin of the lodes, and the possible causes of enrichment in the upper levels.

The origin of the lodes.—The Zeehan lodes are not confined to any one kind of rock. In the Western Mine several of the lodes occur both in the "white" country and in the slate, and are productive in both. In the Montana Mine one of the most productive lodes is in a hard micaceous quartzite. In the Argent Mine, also, some of the lodes are productive in quartzite. In the south end of the field the lodes are in limestone or calcareous slates. It is true that the character of the lodes often changes when passing from one rock to the other, and that certain kinds of slate, for example, are regarded as kindly, while others are looked upon as unfavourable. The silver contents of the galena also, varies in different parts of the field, and possibly also, to some extent, when the lodes pass through different rocks. Taking, however, the different kinds of rocks which occur in the district, it can hardly be said that one is appreciably more favourable than another. In other words, the lodes are essentially *independent of the country-rock* in which they occur. This fact leads to the conclusion that the ore has been derived from some external source; and as we cannot imagine that the fissures have been filled from the surface, we are forced to assume a deep underground source for the metals. In my Report on the ore deposits of the North Dundas district, I have pointed out that the Zeehan type of lode also occurs in that district, and that there are strong reasons for believing that they are connected genetically with other types of deposits in that district which have been produced by granitic "after-actions." The occurrence of lodes containing galena, stannite, and a little wolframite in the Zeehan district is also very strong corroborative evidence that the Zeehan lodes are connected with the granite. I believe, therefore, that we are justified in fixing the age of

the Zeehan lodes at a little later than that of the granite eruption, which is known to be younger than the Zeehan rocks (Upper Middle Silurian), and older than those of the Permo-Carboniferous age, *i.e.*, either Upper Silurian or Devonian age. The fact that galena lodes have not, so far, been found in the rocks of the Permo-Carboniferous age is further evidence that they were already formed when these rocks were deposited. We arrive, therefore, at the following two important conclusions:—(1) That the ore was deposited by ascending solutions travelling along the lode-fissures; (2) that the age of the lodes is older than that of the Permo-Carboniferous system. The great importance of these conclusions lies in the fact that they exclude the possibility of the present surface having been a determining factor in the original deposition of the ore. The geological and topographical features of the district abundantly demonstrate that it has been subject to an immense amount of denudation since the Permo-Carboniferous period, so that at the time when the ores were deposited the rocks at the present surface were probably some thousands of feet below the surface at that period. We have, therefore, every reason to believe that when the ores were first deposited there was no tendency for the ore to become concentrated near the present surface. How, then, is the fact to be accounted for that, in so many instances in the Western and other Zeehan mines, the lodes show such a marked impoverishment in depth? I believe this impoverishment is in part real and in part apparent, and is to be accounted for in two ways. Firstly, the ore is not distributed evenly along the lodes; it occurs in shoots and patches. It is probable that the principal factors which have determined the formation of these shoots are the presence of open spaces and channels along the fissures, and the presence of rocks which, either on account of their porosity or solubility, or both, are specially favourable for replacement. Up to the present time no general law has been discovered which assists us in finding new shoots of ore, and, as far as we know, their distribution is quite irregular. This being the case, we may regard the lodes as fissures in the crust of the earth, containing irregular shoots and patches of payable ore. The present surface is an arbitrary plane, passing through these fissures in a more or less horizontal direction. Where this plane intersects a shoot of ore, the lode is discovered, the shoot is worked, and eventually is found to cut out in depth. This follows naturally from the irregular nature of the deposits, and does not by itself prove that the lodes are on the

average more productive near the surface than in depth. Secondly, the shoots in the upper levels have been enriched by concentration of the ore near the surface through the action of the surface water. I believe this concentration is due to two causes, namely, (a) the leaching away of the iron carbonate, and (b) the re-deposition of galena. The first of these causes I believe to be the most important. In the upper portion of all Zeehan lodes the proportion of first-class ore is much greater than the same lodes contain below water-level. When water-level is reached, the galena is always mixed with more or less carbonate of iron, and the proportion of second-class ore increases. That the change in many instances is due to the leaching away of the carbonate of iron in the upper portions of the lode is proved by the fact that the galena often retains the impressions of the crystals of carbonate of iron. It will be readily seen how this process might convert a large body of second-class ore into a smaller body of firsts. The re-deposition of galena by the action of surface waters depends upon the presence of the sulphides of other metals which have less affinity for sulphur than lead has. The only mineral present in any considerable quantity which fulfils this condition is iron pyrites, which occurs in small quantities with the galena in the lower levels, but in the upper levels of the Western Mine is stated to have been absent. It is probable that the absence of pyrites in the upper levels is due to the fact that it has been replaced by galena. The oxidising waters attack the galena near the surface, converting the lead and silver into sulphates, or carbonates; and in this form carry them downwards till they come in contact with the iron pyrites. Then a chemical reaction takes place, lead and silver sulphide are deposited, and iron sulphate or carbonate goes on in solution. I believe that this reaction is, in part, the cause of the concentration of the galena in the upper portions of the lodes. This theory, however, must not be carried too far. There is nowhere a great deal of pyrites in these lodes, and unless it or some other precipitant is present, it is impossible for secondary deposition of galena to take place.

We must now inquire what bearing these theoretical considerations have on the question of the distribution of ore in the Western Mine. Taking No. 1 lode as an example, there was here in the upper levels a continuous shoot of first-class metal for a distance of 700 feet along the course of the lode. This shoot was rich down to No. 2 level (110 feet below the surface). Between No. 3 and No. 2 levels it was

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still good, but showed signs of impoverishment, and practically cut out at No. 3 level (170 feet below the surface). Below No. 3 the lode has been driven on at five other levels to a depth of 500 feet, and although in each level payable ore has been found, the shoots have all been short, and their average metal contents have been much lower than that of the big shoot in the upper levels. Applying now the theoretical conclusions arrived at above, it is evident that the present surface has intersected a very large shoot of ore. This shoot has been enriched in part by the leaching away of the carbonate of iron, and in part by the re-deposition of galena; and, as this enrichment is due to surface action, we cannot expect that the shoots which are met with in depth will be as rich as this one. The question remains, is there any reason why they should be smaller? I believe there is no reason except that of the irregular distribution of the shoots in the lode.

As I have already stated elsewhere, where the lodes are unproductive they are usually quite unmineralised. The track of the lode continues, but the lode-channel is filled with crushed or broken country. Occasionally a little carbonate of iron or quartz is present, but quite as often these are absent. I can imagine no surface action which would convert a barren, practically closed channel like this into an ore-bearing vein, such as those which are commonly mined in the Zeehan district. If, then, the size of the shoots has not been increased by surface action, it follows that we may take the length of the shoots of ore in the upper levels as a sample of what we may hope to find in the lower levels. From the great size and richness of the shoots of ore in the upper levels of the Western Mine, it is impossible to withstand the conclusion that the lower levels have been driven in a poor zone, in which the shoots of ore are below the average in size and richness. By persevering steadily with developmental work, the pendulum must swing back, and sooner or later another highly productive zone will be entered. I believe this is the only conclusion which can be arrived at, after a careful consideration of the facts at our disposal.

From the 28th half-yearly report of the Western Silver Mining Company, presented at the meeting held on the 28th of May, 1902, I have obtained the following memoranda *re* the output of the mine:—

	MINE WEIGHT.		SALE CONTENTS.		PROCEEDS.	
	Bags.	tons cwts.	Silver.	Lead.	£	s. d.
			ozs.	tons cwts.		
Local Sales.	71,901	3128 11	307,173	1518 8	39,111	2 2
Shipments...	749,033	35,054 16	3,370,164	19,150 19	454,428	18 0
TOTAL.....	820,934	38,183 7	3,677,337	20,669 7	£493,540	0 2
Less cost of ore purchased for mill					923	4 6
Total receipts.....					492,616	15 8
Less cost of ore bags, twine, &c.					14,252	10 8
Total net proceeds at mine					<u>£478,364</u>	<u>5 0</u>

From the above, the average contents of the ore sold in silver and lead, and the proceeds per ton, works out as follows:—

	Silver. Ozs. per ton.	Lead. Per cent.	Proceeds. Per ton. £ s. d.
Local Sales.....	98·19	48·53	12 10 3
Shipments.....	97·69	55·51	13 3 5

From the same report I note that the sum of £102,000 has been paid in dividends by the company, and that the amount actually subscribed by shareholders for developing the mine amounts to £16,599 13s. It will, therefore, be seen that in the past the mine has been a very profitable investment; and it is to be regretted that, during the period of prosperity, the work of equipping the mine with the necessary machinery, and of developing the lodes in the deep levels, was not undertaken.

However, when it was finally realised that a poor zone had to be passed through, the directors of the mine faced the situation boldly. The old pumping-engine, which was incompetent to cope with the water, was replaced by a first-class compound tandem Corliss engine, fitted with surface condensers; additional boiler accommodation was also provided, and a new brick-stack erected. This plant was all put up in a most substantial manner, and is a lasting proof of the confidence which the directors and the late mine manager placed in the mine. Its erection, however, although an unavoidable necessity, so reduced the available capital of

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the company that when the serious drop in the prices of silver and lead occurred, developmental work could not be proceeded with, and the mine had to be closed down. This plant is in good order, and is as good as new. The mine is also equipped with a Lührig concentrator, with a capacity of 60 tons per eight hours. This is an old plant, but much of it has lately been renewed, and, with a small additional expenditure, could be put into first-class order. I believe the plant is well suited to the class of ore which has to be treated.

In conclusion, I must express my deep obligations to Mr. C. F. Heathcote, the late mining manager, who took the greatest pains to enable me to see everything that was to be seen, and to give me all the information he could about the mine. I am also indebted to Mr. John Craze, the manager of the Montana Mine, for general information on many points.

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

GEORGE A. WALLER,
Assistant Government Geologist.

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

PLATE I.

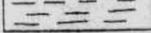
GEOLOGICAL SKETCH PLAN N°2 LEVEL WESTERN MINE

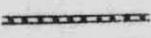
SCALE OF FEET

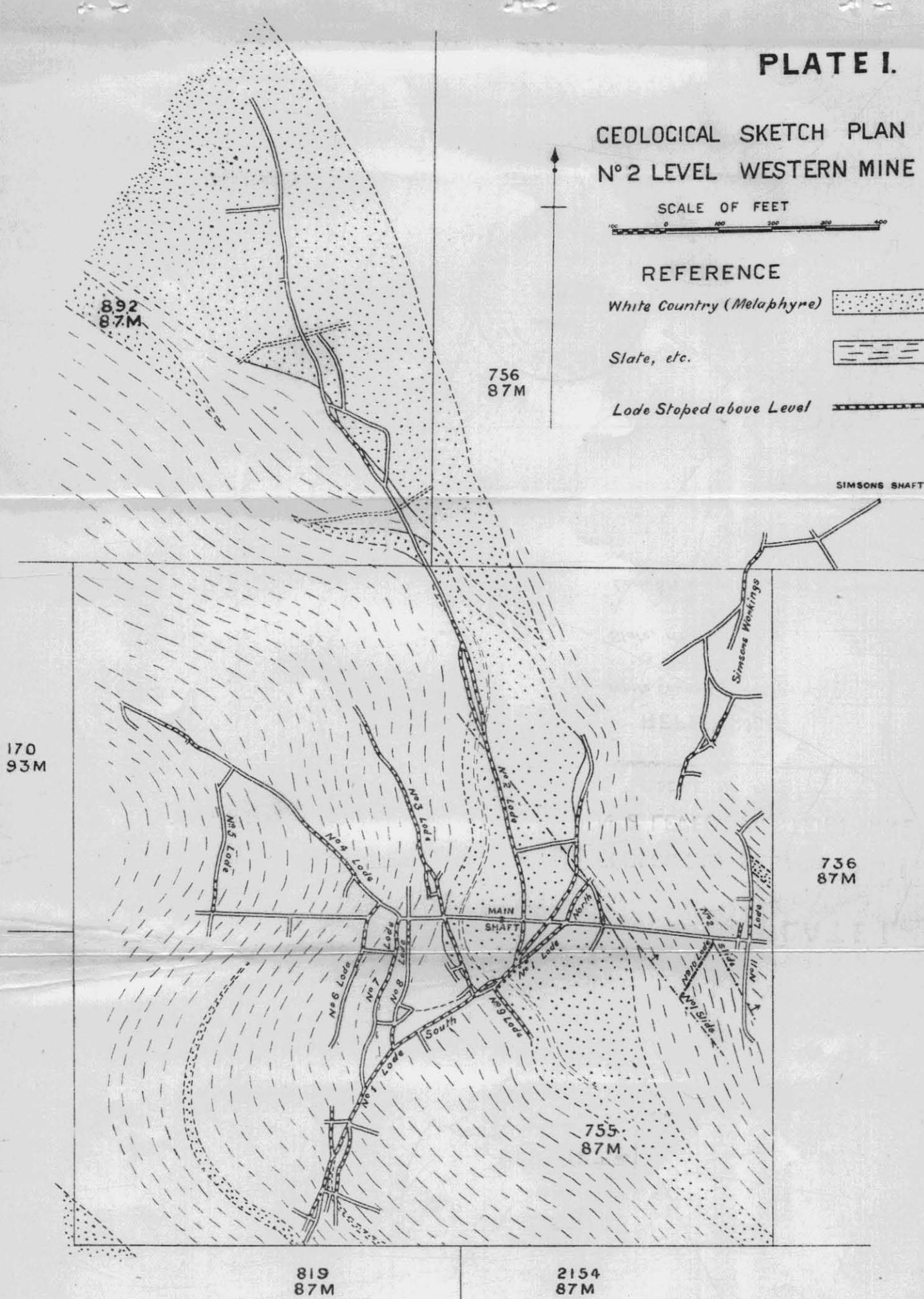


REFERENCE

White Country (Melaphyre) 

Slate, etc. 

Lode Stopped above Level 



892
87M

756
87M

170
93M

SIMMONS SHAFT

736
87M

755
87M

819
87M

2154
87M

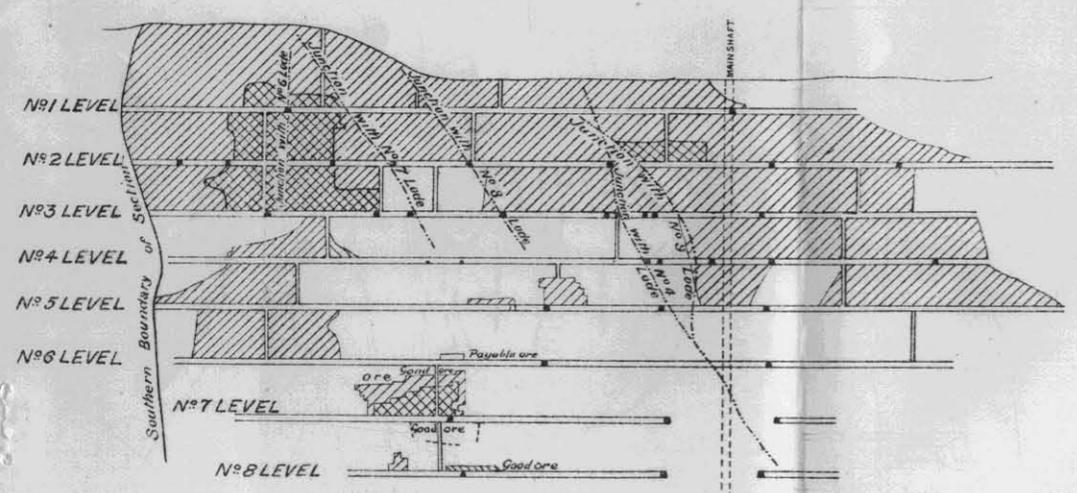
5 cm

(R)

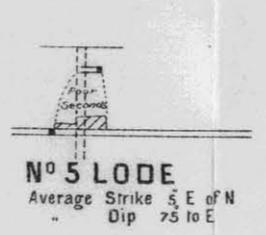
1920

LONGITUDINAL PROJECTIONS OF LODES AT WESTERN MINE

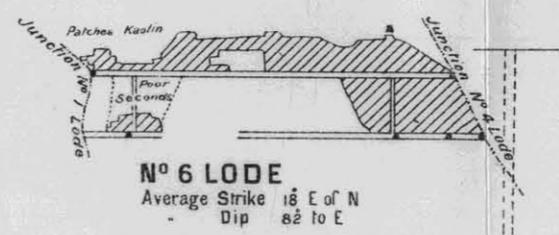
PLATE II.



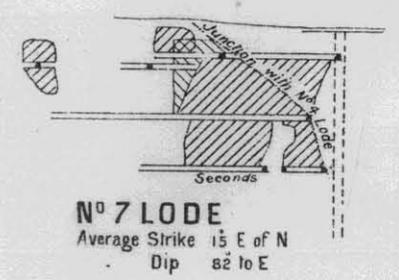
N°1 LODE Average Strike 40° E of N Dip from 83° to NW to 75° to SE



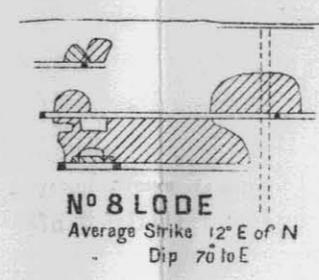
N°5 LODE
Average Strike 5° E of N
Dip 75 to E



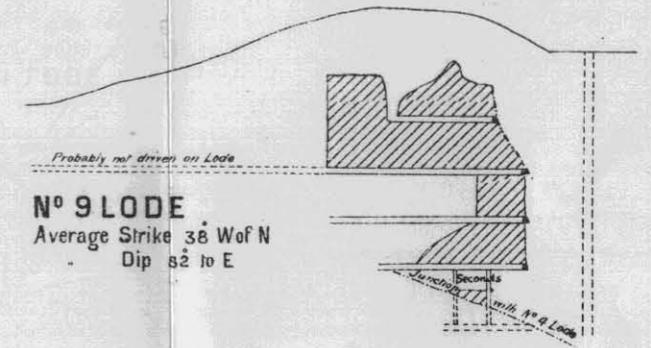
N°6 LODE
Average Strike 16° E of N
Dip 82 to E



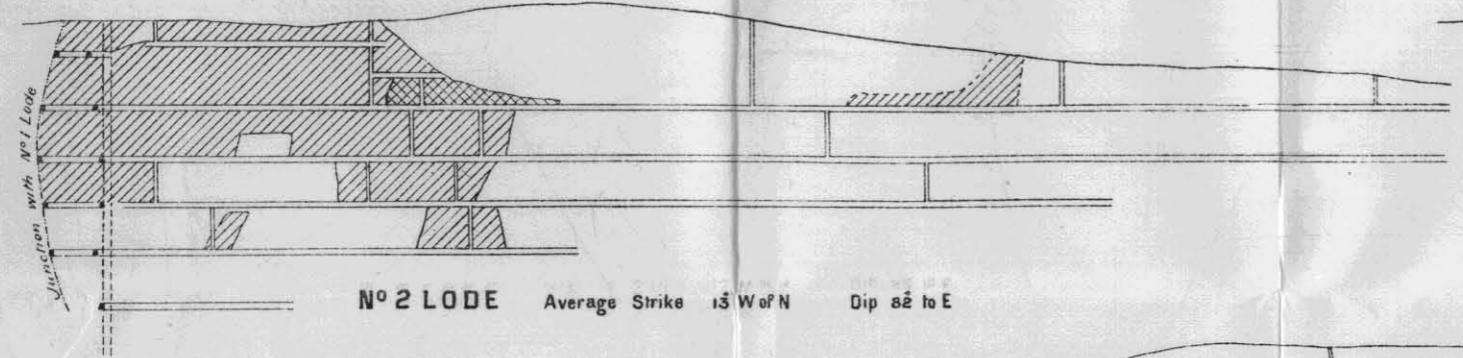
N°7 LODE
Average Strike 15° E of N
Dip 82 to E



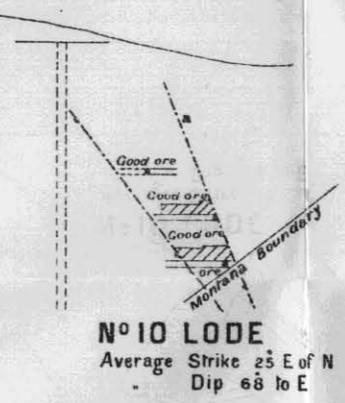
N°8 LODE
Average Strike 12° E of N
Dip 70 to E



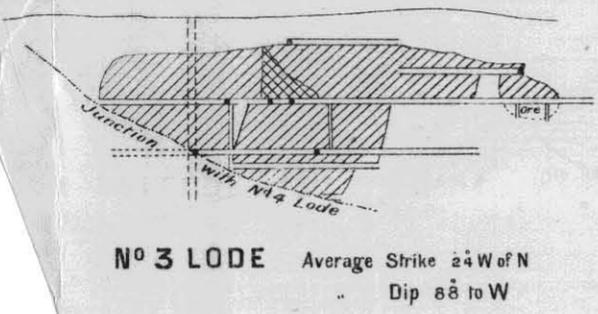
N°9 LODE
Average Strike 38° W of N
Dip 82 to E



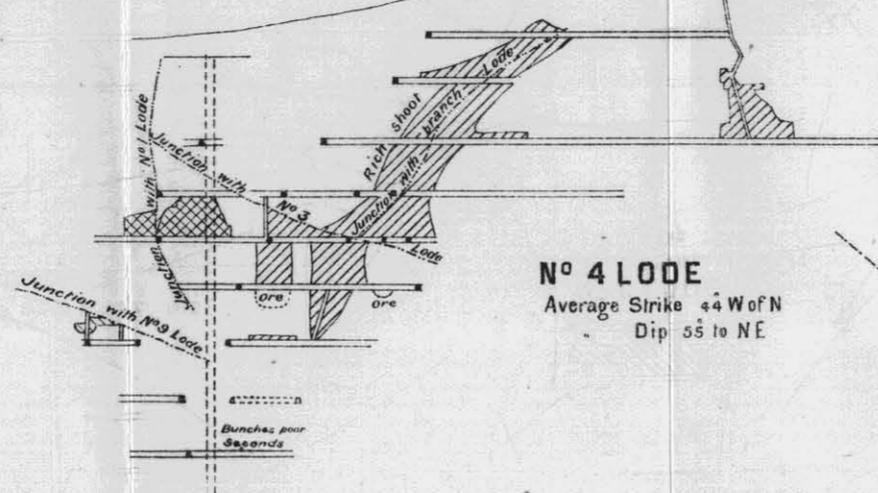
N°2 LODE Average Strike 13° W of N Dip 82 to E



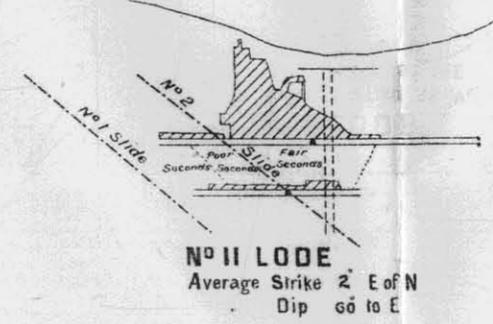
N°10 LODE
Average Strike 25° E of N
Dip 68 to E



N°3 LODE Average Strike 24° W of N
Dip 88 to W



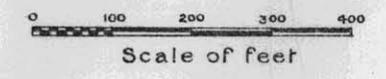
N°4 LODE
Average Strike 44° W of N
Dip 55 to NE



N°11 LODE
Average Strike 2° E of N
Dip 60 to E

REFERENCE

- Stopped ground on main line of lodes
- Stopped ground on branch lodes



A. G. Walker,
Asst. Geol. Geologist
27. 9. 02.

