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(185)

## REPORT ON THE TIN ORE DEPOSITS OF NORTH DUNDAS.

[Two Plans.]

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*Zeehan, 8th March, 1902.*

SIR,

IN pursuance of your instructions, I have almost completed my examination of the North-East Dundas District, and have now the honour to present the following Report on the Tin Ore Deposits of North Dundas. A further report on the other mines of the district will be forwarded in a few weeks' time. Neither of these reports will enter fully into the details of the geology of the district, for, although a considerable proportion of my time has been occupied in collecting general geological information, and in compiling a geological sketch map of the district, it is thought advisable to delay the publication of this matter until my examination of the other important mining centres has been completed, when a more comprehensive account of the geology of the West Coast will be possible than would be the case if each district were described separately.

Most of the deposits of tin ore are situated in about the centre of the North-East Dundas District. The sedimentary rock consists mostly of slates or shales, which are, for the most part, considerably altered and indurated by contact with igneous rocks. The latter consist of quartz-tourmaline porphyry, gabbro, and serpentine; the latter being an alteration product of peridotite, with which it is often associated. These rocks occur in masses and dykes, often of considerable size, and are distributed widely throughout the district. In the vicinity of the tourmaline porphyry the slates have often been converted into a tourmaline-bearing rock, and this is also the case to some extent with regard to the gabbro, proving that the latter is older than the tourmaline porphyry. The tourmaline porphyry sometimes forms dykes in the serpentine and gabbro.

### *The Penzance Tin Mining Company, No Liability.*

This company holds Sections 5093-93M and 5094-93M, having a total area of 131 acres. Very little work of any kind has been done on these sections. They are situated on

the north-eastern slope of the Commonwealth Hill. On the western section the country is principally composed of quartz-tourmaline porphyry, while on the eastern section most of the country is gabbro and serpentine, with some indurated slate in the north-western, and some tourmaline-quartz porphyry in the south-western portions. No tin deposits have as yet been discovered on the sections, though there are good reasons for believing that they exist. North and adjoining the western section (5093-93M), is J. S. Karlson's 5-acre lease (5063-93M), which is being worked for alluvial tin. The tin is found in the beds of two small creeks, which have their source within the Penzance Company's ground, so that it is certain that the source of the tin is within these sections. Most of Karlson's tin is very coarse, and a considerable proportion consists of large nuggets from 5 to 14 lbs. in weight, which are rich enough to break up and bag without further treatment. Many of these nuggets are found attached to fragments or blocks of tourmaline porphyry, and in some cases the complete section of the original tin vein is preserved in the nuggets. One very large nugget, which has also certainly been derived from a tin vein in these sections, was found several years ago, when the track from the Confidence Saddle to the Commonwealth Mine was being made. This nugget, which weighs about 19 cwts., was purchased by the Tasmanian Government, and is now in the Museum, Hobart. Judging from these nuggets, the tin veins must vary from an inch or two up to 18 or 20 inches in thickness, and their contents must be exceptionally rich in tin.

The two sections are at present covered by dense bush, and before anything effective can be done in the way of prospecting, this will have to be burned off. Some of the ground appears to be covered by a rather deep talus of porphyry blocks, and this portion will be very difficult to prospect. However, when the bush is burnt off, it will then be possible to see where the ground is not covered by this talus, and this portion should first be thoroughly prospected by careful loaming and trenching. If this portion does not prove to contain tin veins, then they must be looked for below the talus of porphyry blocks. This can only be done by deep costeans, and possibly may require tunnelling. The prospecting should be confined to the porphyry and slate country. Tin is not at all likely to occur in the gabbro or serpentine.

I believe that the possibilities of finding payable tin veins on the Penzance Company's ground, and especially on the

western section, are really good. A considerable amount of alluvial tin has already been won, which has undoubtedly been derived from veins in this ground, and probably a little intelligent prospecting would be successful in locating them. The veins will probably prove to be patchy, but, certainly, they will be rich.

*The Mount Lyell Copper Estates Co., Limited.*

This company has been engaged for some time in prospecting two sections, which are situated west and adjoining the Penzance Company's ground. Nos. 3754-93M and 3870-93M, charted in the name of W. Connor. The country consists principally of indurated and metamorphosed slate, which is broken through by a number of dykes of tourmaline-quartz porphyry. These dykes are branches from the main mass of porphyry which is situated on the Penzance Company's western section. They vary from a few inches up to 2 or 3 chains in width, and their general course is east and west. Often the slate is highly impregnated with tourmaline, pyrites, and magnetite, and the latter mineral occurs in veins in the indurated slates. In the south-western portion of the northern section and the north-western portion of the southern section there is an outcrop of gabbro, containing some tourmaline. The latter has certainly been derived from the tourmaline-quartz porphyry. In the south-eastern portion of the southern section the country is serpentine. The most important workings are situated in the south-eastern portion of the northern section (No. 3754-93M). Just south of one of the larger dykes of tourmaline porphyry there is a large gossan blow, which first attracted attention. In the rubble from this blow good prospects of tin were obtained, and it was decided to test the formation in depth. The outcrop is situated on the brow and side of a very steep hill, and its course is somewhat irregular. It is intersected by a fault or plane of movement which strikes at an angle of 60° W. of N., and dips steeply to the north-east. This was at first taken to be the wall of the lode, and a tunnel was put in from a lower level to cut it. The tunnel started from the dyke of tourmaline porphyry already mentioned, and was driven on a course of S. 13° E. (pocket compass reading). In the approach of the tunnel the southern wall of the dyke is exposed, and in the vicinity of the contact the country, which is decomposed and contains much gossanous matter, contains numerous blebs of tin oxide. The tunnel passed through this decomposed country for a

distance of 35 feet, when hard indurated slate was met with. The course of the tunnel was not altered, but continued for another 85 feet, through hard slate, containing a little pyrites, tourmaline, and a very small percentage of tin oxide. A plane of movement was intersected which it is thought may be the same as that seen on the surface, but, if this is the case, its strike has altered considerably; otherwise, it is about in the right position. This was driven on for about 30 feet in an easterly direction without any further development taking place. As nothing which could be regarded as the continuation of the Big Blow was discovered at this point, attention was directed to the formation which had been passed through in the approach and the first 55 feet of the tunnel. A cross-cut was put in, 55 feet from the entrance of the tunnel on a course of N. 72° E. (approximately), and passed through a decomposed country and gossan formation for a distance of 30 feet, when the hanging wall was met with. This consists of hard indurated slate highly impregnated with tourmaline and magnetite. This gossan formation carries tin in seams through it, and is now believed to be the true lode, though it is poor in tin at this point. The strike, as far as can be estimated at present, is about 20° west of north, and the dip 50° to 60° to the east. This strike and dip, allowing for the slope of the hill, accounts fairly well for the position and irregular shape of the outcrop at the surface, and I think there is now little doubt that the true position of the lode has been located. Since this work was done, discoveries have been made on the surface which have given further support to this theory. A trench was made along the brow of the hill, and in the supposed line of lode a rich tin-bearing formation was cut. It consists of tourmalinised slate with a good deal of vein-quartz, and some of it is very rich in tin, visible crystals being quite plentiful. Mr. T. Brannan, the Mining Manager, tells me that a bulk sample from 3 feet 6 inches of lode matter returned 7% of metallic tin. This formation has been again cut in a trench about a chain further north, and the strike proved to be the same as that of the formation cut in the entrance of the tunnel. This lode is certainly worth further testing, and I was surprised to learn that the company had temporarily suspended operations. The lode could be quickly tested by continuing the most southerly of the eastern crosscuts from the main tunnel. This should intersect the lode within 10 or 15 feet, and it should then be driven on south in order to get below the rich ore which has been cut on the surface.

There are several other lode formations on the property carrying a little tin, but the lode which has been described is much the most important, and I think that, for the present, work should be confined to opening up this.

*The Cornwall Tin Mining Company, No Liability.*

Section 5101-93M, 80 acres. This mine is situated on the northern slope of the Commonwealth Hill, and the mine workings are close to the northern boundary, and almost at the base of the hill.

There is a large pyritic tin-bearing formation exposed here in several trenches and open cuts, both on the Cornwall Company's section and on the old Commonwealth section, which is north and adjoining. All of these exposures are within a radius of about 100 feet, but it is not yet quite certain that they are on the same deposit. The exposures are, however, of the same nature, and if not portions of one and the same body, they are certainly very intimately connected with one another. It will probably require some more underground work before their relations can be finally determined.

On the hillside, about 50 feet from the northern boundary of the section, a large pyritic and gossan formation has been exposed in a trench. From this trench a prospecting tunnel has been driven on a course of S. 43° E. for a distance of 43 feet. This passes through highly decomposed country for about 20 feet, and then through a stanniferous gossan formation. Some of the latter is very rich in tin; two dishes, which were washed for me, yielding about 1½ lbs. to the dish. Some of the best of this gossan has been already mined. The dirt had to be wheeled for a considerable distance to water, and must have been rich to pay for this treatment. The end of the tunnel is in dense pyrrhotite, but the deposit has not been further tested at this point. Twenty feet north of the entrance of this tunnel an open face has been excavated in a decomposed pyrites formation carrying tin; to the west of the pyrites is a band of gossan carrying small seams of tin, and on the dump pieces of tin oxide up to 3 inches in diameter may be found.

About 20 feet vertically below the prospecting tunnel, which has been already described, a second tunnel has been recently driven, in which important developments have taken place. The tunnel was commenced on a course of S. 34° E., and, at about 40 feet from the entrance, a vein of decomposed axinite was cut. This is evidently the same as an axinite vein which had been trenched along on the Commonwealth

section for a distance of 120 feet. The nearest point in this trench is 185 feet from the point where the axinite vein was cut in the tunnel. Its strike is  $15^{\circ}$  W. of N., dipping 1 in 5 to the west, the vein carries arsenical pyrites, some pyrrhotite, and copper pyrites, but, apparently, no tin. It was passed through by the tunnel, which was continued on the same course for a further distance of 40 feet, making 80 feet from the entrance. Here, a slide was met with striking  $35^{\circ}$  E. of N., and dipping to the south-east. The course of the tunnel was altered to S.  $10^{\circ}$  W., and after being extended for 20 feet in this direction the axinite vein was again cut. When the axinite was broken through, it was found that the hanging (western) wall was composed of stanniferous pyrites. It was therefore decided to again alter the course of the tunnel, and to follow the axinite vein. In doing so the hanging wall was broken down, and the foot wall left standing. The axinite vein has been followed up for a distance of 52 feet on a bearing of S.  $15^{\circ}$  E. After a very few feet of driving, the foot-wall, as well as the hanging wall, came into stanniferous pyrites, and has continued up to the end of the drive in this mineral. The pyrites of the foot-wall, however, gave place to a hard indurated shale or hornstone at a distance of 45 feet from the point where it was first struck. The quality of the pyrites forming the foot-wall of the axinite vein is not known, for it has not been broken into, but all the hanging wall stone which was taken out has been stacked at the mouth of the tunnel, and can be examined in daylight. It is seen to be composed of fine bands of pyrites, pyrrhotite, and indurated slate, with seams of tin oxide through it. I could not get a good observation of the strike of the seams of ore in the tunnel, but I am told by Mr. Borley, the Mine Manager, that, when the tunnel was being driven, it was observed to be about  $50^{\circ}$  E. of N., and the dip to the south. The banded nature of the ore is very remarkable. The tin oxide occurs in seams from  $\frac{1}{8}$  of an inch up to several inches in thickness, and is sometimes practically solid; generally, however, it is distributed in small grains throughout the pyrites. The tin oxide is not visible in all the stone, and possibly some of it may not be stanniferous, but in a pyritic ore like this much of the tin is certain to be invisible. I did not attempt to take any sample, because, to take a reliable sample of a big heap of hard roughly-broken ore like this would have involved much more time and labour than were at my disposal. Mr. Borley, the Mine Manager, has had a number of samples

tested, and estimates the heap to bulk between 6 and 7% of metallic tin. Certainly, samples might be selected from the heap which would go anything up to 40 or 50%.

Geologically, the deposit is of very great interest. The banded nature of the pyrites, pyrrhotite, tin oxide, and indurated slate at once pronounces the deposit to be formed through metasomatic replacement of a rather finely laminated shale, the whole structure of the original shale being beautifully preserved in the dense ore. It is evident that the bed of shale was impregnated by mineralising waters or vapours, which attacked the more soluble layers and, taking up the material of the shale into solution, deposited the pyrites and tin oxide in its place. It is a well recognised fact that tin deposits are intimately connected with granite intrusions. During the consolidation of the granite, it is believed that emanations of metal-bearing vapours or highly heated waters are given off, of very high chemical activity. The solutions attack and dissolve certain constituents of the rocks, and deposit mineral matter in their place. The solutions contain certain elements known as "mineralising agents," of which fluorine and boron are the commonest. These are believed to play a most important part in the process, and minerals containing these elements are almost always found associated with deposits of tin ores. At the Cornwall Mine we have a boron mineral in the axinite, with which the deposit is associated, while at the Commonwealth Mine the mineral fluorite occurs, though I have not heard of its being discovered in connection with the deposit which is now being dealt with. It will, however, probably be found to occur here also. It is known that granitic rocks (namely, tourmaline-quartz porphyry) occur in the vicinity of the deposits. It is further known that stanniferous and boron emanations have taken place from this rock, for the tin veins in porphyry on the Penzance Company's section are proof of the former; and the tourmalinisation of the slates and gabbro in the vicinity of the porphyry are proof of the latter, tourmaline being another mineral which contains boron. There can therefore be no reasonable doubt as to the main facts of the origin of the deposit; but there is still some doubt as to the path which the vapours or heated waters took in ascending from the granitic hearth. This point is of the greatest importance to the miner, because it is along this path that he must look for the continuation of the deposit. The question is, did the vapours ascend along the planes of sedimentation of the shale, or did they come up along some

fault-fissure and attack such beds of favourable shale as this fissure intersected? At present I am inclined to think that the latter has been the case, though I cannot regard this as being finally settled. The axinite vein along which the tunnel has been driven is certainly the filling of a fault-fissure. Where first cut, the hanging wall of the axinite vein was composed of ore, and the foot-wall of slate. When driven on for a few feet, ore came in on the hanging wall as well as on the foot-wall, while, after 45 feet of driving, the ore gave place to indurated shale on the hanging wall, but the foot-wall remained in ore as far as the tunnel was driven—a further six feet.

This evidence is capable of two interpretations:—

- 1st. The axinite vein might be regarded as a cross course faulting the lode, the hanging wall having been thrown to the north. In this case the fault took place *after* the pyritic tin ore was deposited;
- 2nd. The axinite vein might be regarded as the filling of the fissure which had served as a channel for the mineralising solutions. In this case the faulting must have taken place *before* the tin ore was deposited. The selective action of the solutions for the favourable beds would account for the present position of the ore on either side of the axinite vein.

My reason for thinking that the latter is the more likely is based on the following facts:—Several other axinite veins are known in the district, all of them being associated with bodies of pyrites and pyrrhotite, though it is true all of these have not been proved to be stanniferous. This shows that the axinite is in some way very closely connected with the pyrites bodies; for, although it is possible that accident might bring them together in one place, it is not possible for this accident to be repeated three or four times over in the same district. The only explanation which appears to me to account for the facts of the association of the pyritic bodies and the axinite is that both solutions have ascended through the same fissures.

At the Cornwall Mine I think, therefore, we may assume as a working theory that the solutions ascended along the fault-fissure now filled with axinite, and that from this fissure they attacked and replaced the most porous or the most soluble beds or layers of shale. How far along the planes of sedimentation the mineralising solutions travelled is, of course, impossible to say, and this should be one of the

9/22

first things which the company should set about to determine. I think that the first thing to be done should be to sample the ore body very thoroughly. I would suggest that this be done in the following manner:—Two chalk lines should be drawn along the side of the tunnel, about six inches apart, and the space between them divided up by vertical lines into sections of 2 or 3 feet in length. Canvas or bags should then be laid in the bottom of the tunnel, and the whole of the surface of the stone gadded or chiselled off between the two chalk lines. The chips from each section should then be carefully collected, and assayed separately. This process will no doubt involve a considerable amount of labour, but when it is done it will be known definitely what the ore is worth, and how the tin is distributed. The importance of accurate and exhaustive sampling of these big pyritic bodies cannot be over-estimated, because, without it, work is practically being carried on in the dark. If the sampling is carried out after the method outlined above, it will be known which part of the deposit it will be most advisable to drive on. The richest bands in the deposit should of course be selected, and drives should be started on either side of the present tunnel, cross-cuts being put out at short intervals to ascertain the width and value of the deposit. The present tunnel should also be continued along the axinite vein, with the object of finding other shoots of ore. Even if the ore cuts out on both walls, which will probably be the case, the vein is worth driving on, as it may be presumed that where other favourable beds are intersected these will also contain ore. As to the prospects of the tin ore living down, nothing very definite can be said, and this can really only be proved by actual mining work. I think, however, that it is not too much to hope that the shoot will be continuous in depth. If it is true, as I believe, that the principal factor in the deposition of the tin is the favourable nature of the bed of shale which has undergone replacement, then we may expect that the shoot of ore will live down until the bed alters its character, which is not at all likely to take place within a short distance. Certainly, the deposition of the tin is in no way connected with the present surface, for the deposition of the tin took place during or shortly after the intrusion of the granite, which is believed to be of Devonian Age, and is certainly older than Permo-Carboniferous. But since that time denudation has lowered the surface of the ground many hundreds or, possibly, many thousands of feet, so that the tin which we now find near the surface

10/22

was really deposited deep down below what was then the surface.

The treatment of pyritic tin ore, though by no means as simple as that of free milling ore, involves no insuperable difficulty. It will have to be crushed and roasted, and the tin oxide concentrated from the roasted product. It would be advisable, before erecting machinery, to send a trial parcel to some well-equipped works, in order to decide upon the most suitable class of machinery to be employed.

I believe that the Cornwall Mine is a really good prospecting show, and has every prospect of developing into a valuable property.

*Section 2959-87M, 80 acres.*

This section, which is north and adjoining the Cornwall Company's ground, is vacant at the time of writing. There was nobody on the ground at the time of my visit, and I regret that I was unable to examine it as carefully as I would have liked. The axinite vein, which has already been described as occurring in the Cornwall Company's workings, continues for a considerable distance in this section, and has been trenched along for 120 feet. Some pyrites and pyrrhotite have been taken out of this trench, but no considerable body of ore was uncovered. I understand that no tin was found. One hundred feet to the east of this axinite vein there are several old trenches and open cuts, which have exposed a body of pyrites of considerable thickness. This is also evidently connected with an axinite vein, as I found a good many pieces of axinite on the various tips, though I could not locate the vein in the workings. The pyrites is of the same nature as that found in the Cornwall Company's ground, and the deposits are evidently closely connected. I am told that some of the pyrites from these workings is very rich in tin, and nearly all of it is stanniferous.

Some six or eight chains north-west of these workings, there is a another large pyrrhotite formation exposed in the bed of a creek, and likewise connected with veins of axinite and fluorite. A tunnel has been driven underneath it without striking the pyrites. I think it is probable that in this case the ore body has dipped to the south of the tunnel, and might be picked up by a crosscut in a short distance. The pyrrhotite contains some copper pyrites, but I did not see any tin oxide. It is, however, of the same nature as the Cornwall Company's deposit, and I would not be at all surprised to learn that tin had been found in it; but, unless

encouraging assays can be obtained from the pyrites at the surface, I do not think it is worth further testing from the present tunnel. Copper lodes have been known to change to tin in depth, but this is not likely to happen within the 50 or 60 feet which the tunnel is below the outcrop. It would be better to wait until a considerable depth had been gained on the other known tin-bearing deposit, and then to crosscut for this one at as great a depth as possible.

*Section 5215-93M, 30 acres.*

This section, which is charted in the name of R. Fox, is situated on the western slope of the Commonwealth Hill. I noticed in some old workings an axinite vein, passing through a dense pyrites formation. I am not aware that tin has been found here, or if it has been looked for, but certainly, wherever axinite occurs in this district, tin is worth looking for. If, however, it is not found on the surface, I do not think it is worth seeking underground at present. It is possible that some day it may be proved that all of these pyritic formations contain tin in depth, for there are theoretical grounds for believing that this may be possible, but this should first be proved by deep mining on deposits which will pay for their development from the surface. There is a galena lode on the section from which two tributors are winning some metal.

*The Renison Bell Prospecting and Mining Co., No Liability.*

This company holds Sections 165-93M, 166-93M, 2534-87M, 2606-87M, and 2536-87M; in all, 181 acres. The Emu Bay Railway passes through the northern sections, and by this route the distance from Zeehan is about 10 miles.

The country rock in the vicinity of the mine consists of clay, slates, and sandstones, striking from 30° to 45° west of north, and dipping to the north-east at angles varying from 0° to 35°, and sometimes steeper. In several places flat anticlinal and synclinal folds may be observed, but these do not alter the general north-easterly dip of the strata. To the west of the tin-bearing deposits a dyke of tourmaline porphyry traverses the sections, and there is no doubt that the tin deposits are genetically connected with this intrusion. There are quite a number of large tin-bearing formations known on the property, but they are at present in a very undeveloped state. They have been trenched across in a number of places, and some tunnelling has been done, but,

until lately, the underground work had not succeeded in proving the formations to any extent. Even now there is very little underground work done on the tin-bearing formations themselves.

In my examination of the mine I did not take any samples for assay. My reason for not doing so is that I believe that unless samples are taken with the greatest care they are only misleading. It would take at least a week's work to sample the Renison Bell Mine properly, and a very large number of samples would have to be assayed before any accurate notion of the value of the deposits can be formed. In the present report the assay-values given are those furnished to me by Mr. C. Stevens, the Mining Manager. These samples have been very carefully taken, and I have no reason to doubt their trustworthiness. That in several cases they represent fair bulk samples of the class of ore that can be won, is substantiated by the fact that five parcels of ore of one ton each were taken from five different places, and in each case the result of treatment in Melbourne came out very close to the results obtained from Mr. Stevens' samples.

One error, the result of too great a desire for economy, was, however, made in the sampling of the mine. The samples taken for assay generally represented either bulk samples right across the whole width of the formations, or specially selected samples of very rich ore. Neither of these methods of sampling afford sufficient information on which to base an estimate of the economic value of the deposits, or enable one to form an opinion as to the best method of mining which may be adopted. For example, one of the outcrops at the Renison Bell Mine is 120 feet across, measured horizontally; the bulk sample of this 120 feet gave a result of 1.2% of tin. This result gives only a small portion of the information which is desired. What we principally want to know is what proportion of the deposit is barren, how much of it will go 3%, how much 5%, and so on. This can only be obtained by sampling and assaying separately each few feet across the deposit.

Plate I. gives a sketch plan of the lode system and mine workings. This is not an accurate plan of the mine, but is the result of a quickly-made plane table survey. The aneroid was used in determining the contour lines. In this plan there are five large formations shown; they are known as follows:—No. 1 Lode, The White Lode, The Cross Lode, The Pyritic Lode, and the Big Blow. All these lodes have had more or less work done upon them, and have been

proved to be stanniferous. There are several other outcrops on the property, but, as no work has been done upon them, their value is at present an unknown quantity.

*No. 1 Lode.*—The outcrop of this lode has a course of about 30° west of north, and the dip is very flat to the north-east. On the surface it is exposed in the open face on the southern bank of the Argent River; also in No. 1 trench, No. 2 trench, No. 4 trench, and in the deep cutting of the Emu Bay Railway. Underground, what is supposed to be No. 1 Lode, has been cut in two easterly crosscuts from No. 1 Tunnel. All these exposures are marked on the plan, Plate I.

In the open face the lode looks very promising indeed; it is about 20 feet wide, and consists of gossan on the top and partially decomposed pyrites below. A number of bulk samples from this face have been taken, and have given results of from 9% to 12% of metallic tin. One parcel of a ton of ore, representing a bulk sample of the pyrites exposed, was treated in Melbourne, and yielded 10% of tin. Mr. Stevens assures me that this sample was taken from the bottom of the open face, and consisted of, practically, solid pyrites. It contained no gossan or rubbly matter which might be regarded as having been enriched by mechanical concentration. It should therefore represent the true value of the ore at this point. Unfortunately, at the other points where this lode has been exposed, it is very poor. In the three trenches and in the railway cutting the lode is completely oxidised. In No. 4 trench the gossan carries a little tin, but in the others it is practically barren. In the two eastern crosscuts from No. 1 tunnel, what is supposed to be No. 1 Lode has been cut. In the first crosscut a pyritic formation about 9 feet in thickness is cut, dipping at about 45° to the east, and for 10 feet more the country contains veins of quartz and a little pyrites. A bulk sample taken by Mr. Stevens from a length of 20 feet gave 1/2% of tin. In the next crosscut a dolomite formation about 30 feet in width has been intersected. On both the western and eastern wall of this dolomite there are bands of pyrites, but both of these are very poor in tin. The most easterly of these has not been driven through, so that its width is as yet unknown.

*The White Lode.*—This lode is exposed in four trenches and in the railway cutting. A detail sketch of the exposure in the cutting is given in Plate II. The lode consists of a zone of fissured rock, highly charged with mineral matter. The upper portion of the lode, as exposed in the railway

cutting (E, Plate II.), consists of rather soft white sandstone, with numerous veins and bunches of quartz and many cavities and cracks which are often encrusted with minute crystals of tin oxide; below this softer portion there is a layer of hard lode matter (F) consisting of quartzite, with a good deal of pyrites and vein quartz; and below this again, in the bottom of the cutting, there is a layer of almost solid pyrites (G). This occurrence will be referred to again, when discussing the geological relations of these deposits. The White Lode has not been systematically sampled. It is undoubtedly rich in places, but on the whole it is poor. In the trenches the lode matter consists of sugary quartz and sandstone containing some tin wherever it has been cut.

*The Cross Lode.*—This lode has been cut in No. 2 trench, No. 3 trench, No. 4 trench, and the railway cutting. Further, what is believed to be the same lode, is cut in No. 6 trench, seven chains south-east of the railway cutting, and also in the entrance of the No. 2 tunnel, near the open face at Argent River. It is at present not quite certain that all these exposures are on the same lode. At the entrance of No. 2 tunnel a small but very rich seam of tin ore was cut. It was about two feet in width, and a winze was started upon it, but, as it was practically at river level, it was only possible to sink about three or four feet, owing to the influx of water. Thirty-five bags of picked ore were sent away for sale from this lode some years ago. I have not been able to get particulars of the assay value of this parcel, but I note, from Mr. Twelvetrees' report on the mine, that it only realised £8 per ton. This is an extraordinary result in the light of subsequent tests on the ore, for one ton of the strippings from this parcel, *i.e.*, the stone which was rejected as being too poor to send away in the first parcel was treated in Melbourne, and yielded 22½% of metallic tin; this parcel was not selected, but was taken straight away from the heap of strippings. It is evident that either the lowest grade material was selected for export in the first place, or that some very serious mistake was made in the sampling or assaying of the parcel.

No. 2 tunnel was started on this rich vein, but a few feet from the entrance a belt of broken country was entered, which faulted the lode, and its continuation has not yet been picked up at this level. In No. 2 trench, the cross-lode is 19 feet wide. It consists of two bands of pyrites 4 feet and 1 foot in thickness respectively, separated by 14 feet of soft sandstone, carrying numerous veins and bunches of

quartz, with joints and cavities encrusted with fine crystals of tin oxide. A bulk sample from 14 feet of lode-matter in this trench gave 1.5% of tin oxide.

In No. 3 trench, the cross-lode is 14 feet in thickness. The lode is of the same character as in No. 2 trench, but the tin contents are much more satisfactory. A bulk sample across the whole lode yielded 7½% of tin.

In No. 4 trench, the lode is 20 feet in width. A bulk sample from this place yielded 1% of tin. In the railway cutting the cross-lode is small and poor.

In No. 6 trench, a formation is exposed 120 feet in width. It consists principally of pyrites, with some quartz and hardened country-rock. Some of this pyrites is rich, but a bulk sample across the 120-feet yielded only 1.2% of tin.

*The Pyritic Lode.*—This lode was first discovered in the Emu Bay Railway cutting, and was subsequently picked up in a trench about three chains to the north of the first exposure. Further north, at the Argent River, a third exposure of what is probably the same lode has been made, but no work has as yet been done at this point. The pyritic lode as exposed in the railway cutting is 30 feet in width, and is composed of almost solid pyrites, with some quartz and altered country-rock. At the surface, the pyrites was barren, but, as depth was gained, it was found to contain tin. One ton of stone from the bottom of the cutting, treated in Melbourne, yielded 2% of metallic tin.

*The Big Blow Lode.*—This is a very remarkable deposit of tin ore. It is situated about 20 chains south of the railway cutting, in which several of the other lodes have been intersected, and the outcrop is about 300 feet above this level. As will be seen by the plan, the course of the outcrop of this deposit is very irregular, and at once suggests the fact that it is not an ordinary lode. The deposit is conformable with the surrounding strata, and forms a layer from 10 to 25 feet in thickness of nearly solid pyrrhotite and pyrite. Observations of the dip and strike of the slates lead me to the conclusion that the deposit takes part in an anticlinal and synclinal folding of the strata; but, before this can be regarded as established, further observations are required. At the time of my visit, observations were only possible in two or three places. The axes of the supposed anticlinal and synclinal folds are shown on the plan. The main tunnel was driven below and a little to the east of the large gossanous outcrop of the deposit. At about 70 feet from

the entrance, two short crosscuts were put in east and west, and in the eastern crosscut the foot-wall of the deposit was broken into. At this point the ore-body is dipping very flat, not more than 5° or 10° to the eastward. Forty-five feet further in the foot-wall of the deposit was struck in the roof of the tunnel, and another short crosscut was put in to the eastward in the solid pyrites. Thirty feet beyond this crosscut, a fault occurs, which has thrown the ore-body for a few feet to the east, but the tunnel was kept on in a straight line, and again intersects the pyrites about 30 feet further on. It is, of course, a pity that the tunnel was not driven along the ore-body, and crosscuts put out at regular intervals. The tunnel was put in before the nature of the deposit had been realised, and it was driven along a formation carrying a little quartz and pyrites, but no metal of value. Another short tunnel has been put in to the east of the main tunnel, and, after some 20 feet of broken country had been passed through, the pyrites was cut, and a small chamber opened out. In the east of this chamber, the pyrites is cut off abruptly by a dolomite formation, which occurs between the slate and pyrites. In the western portion of the chamber, the lode is oxidised, but the foot-wall has not yet been reached.

Parts of this Big Blow Lode are undoubtedly rich in tin, but the deposit has not yet been systematically sampled. One sample, consisting of hard oxidised lode-matter, has been taken along the foot-wall of the deposit at the surface for a distance of two chains, and gave the satisfactory return of 5 3/4% of tin. A parcel of one ton of ore, broken out from the face of the first eastern crosscut from the main tunnel, returned 7% of tin. This is still more satisfactory, because the ore consisted of solid pyrrhotite and pyrite, and there can have been no question of mechanical enrichment. In the eastern tunnel, the ore has not yet been sampled. Some of the ore exposed certainly contains very fair tin, but, on the whole, the deposit is not so rich at this point as where it has been cut in the crosscuts from the main tunnel.

From the above descriptions of the Renison Bell deposits, it will be evident that they are very patchy in their occurrence. In places they are very rich, and in other parts they are practically barren. The proposition, therefore, which the miner has to face is that of discovering these rich patches, or shoots, mining them, and leaving the poorer portions of the deposit standing, or using them for filling in the stopes. The question as to whether the proposition will be a payable one or not depends upon whether these shoots

occur in sufficient abundance, and of sufficient size and richness, to pay for the prospecting work which will be necessary for their discovery.

The Renison Bell deposits have undoubtedly been formed, like the other pyritic tin-deposits of North Dundas, by replacement of the slates and sandstones with mineral matter. In most cases, as, for example, No. 1 lode, the white lode, the cross lode, and the pyritic lode, the mineralisation has taken place along certain zones of fracture or fissuring. The mineralising solutions have ascended along the cracks and fissures, and have attacked and replaced the country rock with which they came in contact. In other cases, as, for example, the Big Blow Lode, and, probably, also the wide deposit which is exposed in No. 6 trench, the mineralising solutions travelled along some specially-porous or specially-soluble bed, and attacked and replaced it with mineral matter more or less completely. In the latter case, also, the solutions, in all probability, originally ascended along fissure planes, or zones, of fissuring. In fact, these deposits may form only flat branches, or spurs, from the first type of deposit. Now, the important point which the miner has to take into consideration is the fact that certain beds of sedimentary rocks are more favourable to the deposition of mineral matter than others. This fact is very evident in some other pyritic tin mines in North Dundas. In the Cornwall Tin-Mining Company's mine, which has already been described, the rock which has undergone replacement is a finely-laminated shale, containing separate layers of of different composition. These layers have been attacked and replaced to a varying degree, some of them being completely replaced, others only partially, while some have repelled the attacks of the mineralising solutions altogether. The result of this has been that the ore retains the whole structure of the original shale to a remarkable degree. In the case of the Renison Bell-deposits, the rock which has suffered replacement is a normal slate or sandstone, and is not finely-laminated like that of the Cornwall Mine. The replacement is not so evident, and the change in composition of the different layers is not so sharply defined. That the composition of the lode does vary with the character of the rock which has suffered replacement is, however, plainly shown by the section of the white lode which is exposed in the railway cutting. A sketch of this section is shown in Plate II. As already explained, there are here three layers exposed, the upper layer being composed of somewhat decomposed sandstone, containing sugary and vein quartz, and

numerous cavities and joints lined with minute tin crystals. The second layer is composed of hard sandstone, or quartzite, with quartz veins and veins and bunches of pyrites. The third and bottom layer consists of almost solid pyrites. Now it is possible, and even probable, that the upper layer is merely a decomposition product of the layer just below it, produced by the leaching away of the pyrites and deposition of the tin in the cavities and joints. But is it inconceivable that the second layer, which is composed of hardened sandstone, impregnated with pyrites, could be the result of the decomposition of the bottom layer, which is composed of almost solid pyrites. It is quite evident that here we have a case of replacement of two layers of rock of different composition, the bottom one being more favourable to replacement than the layer immediately above it. In the same cutting, the pyrites lode also shows a remarkable alteration in composition, which cannot be explained by any surface-action. Here the lode consists of nearly dense pyrites, but, whereas at the top of the cutting the pyrites was practically barren, at the bottom it contains considerable amounts of tin oxide. From this it would appear that the deposition of tin in the deposit has been influenced by the composition of the rock which has undergone replacement. We see exactly the same thing on a much smaller scale in the Cornwall Mine. Here some of the seams are rich in tin, others are poor, and each seam is evidently a replacement of a particular layer in the finely laminated shale.

I think it is probable that the seeming irregularities not only in the tin contents, but also in the general mineralogical composition of these deposits, may be satisfactorily explained on the assumption that certain beds, owing either to their greater porosity or solubility, or to differences in chemical composition, and the presence of suitable precipitating agents, have been more favourable to the processes of replacement and to the deposition of certain metals than others. Where, therefore, these favourable beds have been intersected by fissures carrying mineralising solutions, there will be the most likely place for shoots of payable ore to be deposited. Should this theory prove to be correct, we may find that the shoots of ore at the Renison Bell Mine are by no means so irregular in their occurrence as might at first be supposed. They will be generally fairly flat, as the dip of the planes of stratification of the country seldom exceeds 35°, but they may prove to be continuous for long distances. Although no one shoot of ore is likely to live to any depth, since its extension will be more in a horizontal than in a

vertical direction, still there is a strong probability of other similar flat shoots being met with in depth along the same lines of fissuring. The solutions originally emanated from the granite at a great depth, and probably deposition of tin has taken place along each favourable bed which the ascending solutions encountered during their journey upwards.

These theoretical considerations lead me to believe that the exploration and exploitation of the Renison Bell deposits need not be of such a costly nature as might at first be supposed. With careful management, and intelligent observation, of the mode of occurrence of the ore-shoots, there appears to me to be every probability of the mine turning out a very payable one.

With regard to recommendations for future work, this should be directed, for the present, to the exploration of the known shoots of ore, in order to definitely determine the amount and value of the ore in sight. In the case of the Big Blow, several crosscuts should be put across the lode from the main tunnel, and the stone which is taken out carefully sampled and assayed. The main tunnel should also be extended, but I should recommend it to follow the foot-wall of the lode, instead of the apparently barren formation along which it has been driven up to the present point.

The big formation exposed in No. 6 trench is certainly worth prospecting. At present I am uncertain whether to regard it as an impregnated bed, branching from one of the other lodes, like the Big Blow, or as a very wide portion of the cross-lode itself. This could be determined by a short tunnel into the hill from the bottom of the trench. The subsequent work would entirely depend on the results obtained in this tunnel. If good ore were met with, it should be driven on, and the extent and direction of the shoot determined.

The exploitation of the other lodes would have to be performed from a tunnel driven 50 feet below the level of the Emu Bay Company's line. This would afterwards be a useful working tunnel, as it would be sufficiently above the Argent River to give fall for the dressing-plant and get-away for the tailings. It should, however, be remembered that, as we may expect the shoots of ore to be flat, sinking or rising on the lodes will be more effective as regards the discovery of new shoots of ore than driving.

The very rich shoot of ore which is exposed in the open face on No. 1 lode at the Argent River should not be neglected. It is certainly surprising that it was not struck in the first crosscut east from No. 1 tunnel, and the only

29/22

explanation which I can offer is that the shoot of ore has dipped underfoot. In order to test this, I should put in a short crosscut from No. 2 tunnel, and, if the rich ore is struck, drive on it, and find out what becomes of it. If it is not struck in this crosscut, then sink a winze, and ascertain if it is underfoot. A problem of this sort should be solved definitely, at whatever cost, but in this case the cost would probably be trifling.

The erection of a dressing plant should not be undertaken until a considerable amount of payable ore has been proved to be available, and I am of opinion that further trials are necessary before it will be possible to decide upon the best class of machinery to adopt. The majority of the ore consists of dense iron pyrites and pyrrhotite, with small grains of tin oxide embedded in it. The ore will have to be first crushed, then roasted, and the tin oxide concentrated from the roasted product. In some of the ore, where the pyrites is not dense, it will probably pay to concentrate before as well as after roasting. Some of the tin is in an extremely finely divided state, and this no doubt will be difficult to save, and the loss in concentration will be considerable; but I think that, with the majority of the ore, the tin is sufficiently coarse-grained to enable a fairly close saving to be effected.

In conclusion, I desire to thank Messrs. T. Brannan, Borley, and C. Stevens, Mining Managers, for much valuable assistance and information which they have willingly given, often at considerable inconvenience to themselves.

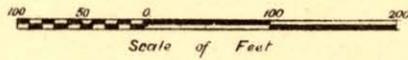
I have the honour to be,  
Sir,  
Your obedient Servant,

G. A. WALLER,  
*Asst. Govt. Geologist.*

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

21/22

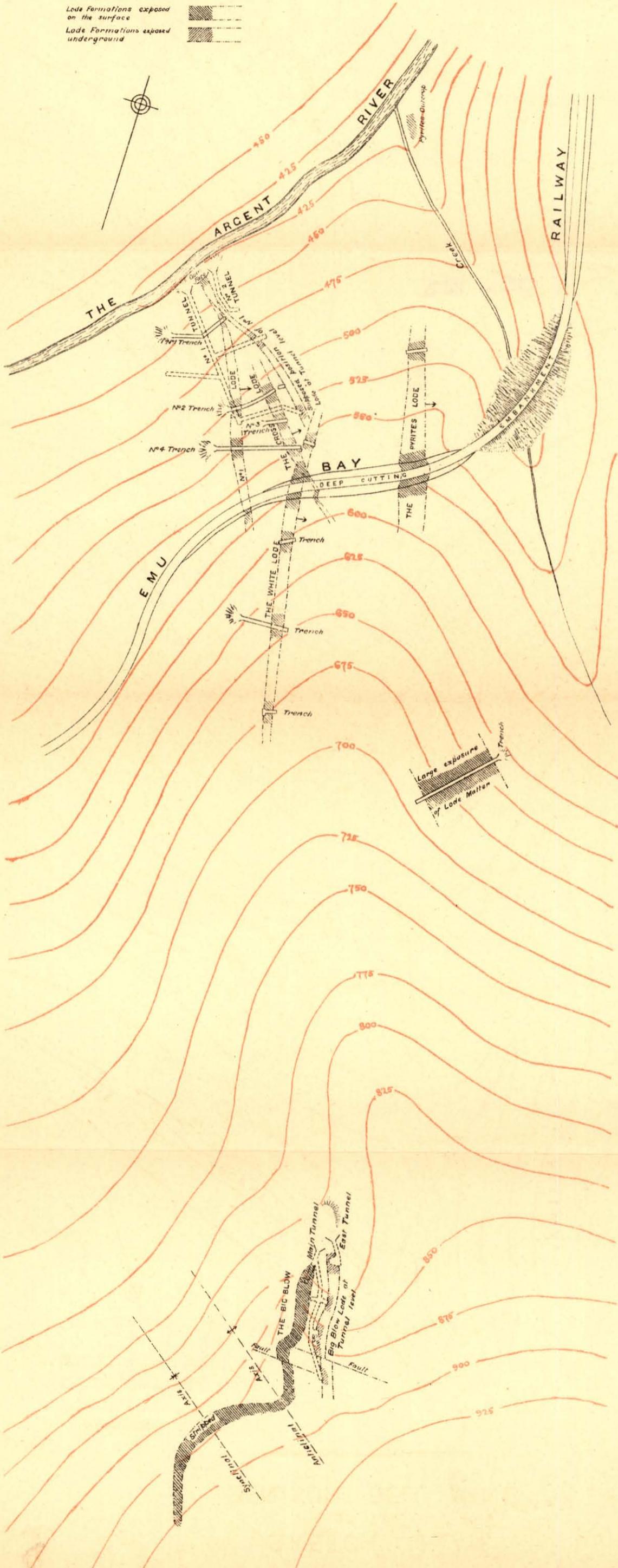
# SKETCH PLAN OF THE RENISON BELL MINE



### REFERENCE

- Underground workings shown in dotted lines.
- Lode Formations exposed on the surface
- Lode Formations exposed underground

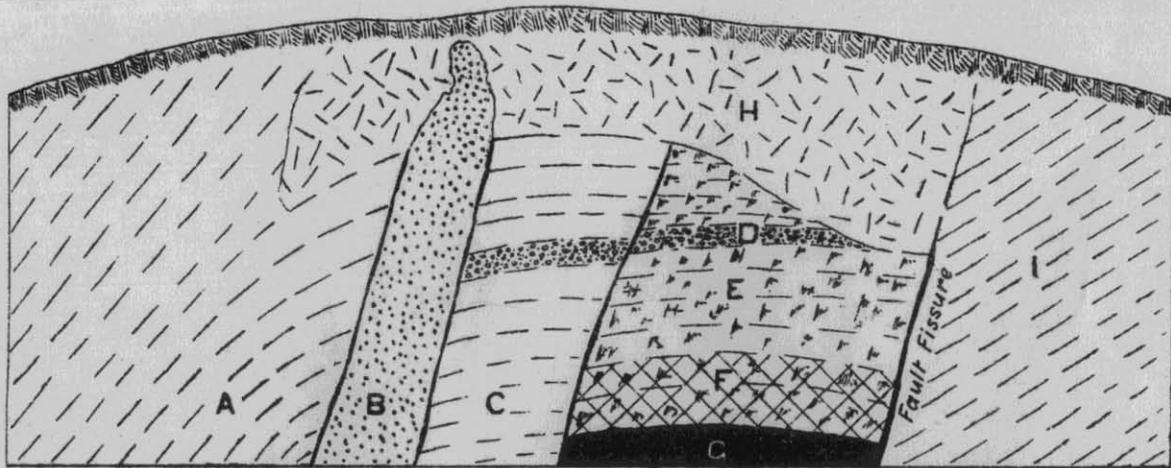
S. A. Waller  
Asst. Geol. Geologist



SECTION EXPOSED IN RAILWAY CUTTING

RENISON BELL MINE.

*S. A. Walker  
Geol. Surv. Geologist.*



A.—Slate and Sandstone. B.—“The cross lode,” soft pug and gritty formation, evidently a fissure filling. C.—Slate, &c., dipping very flat. D.—Seam of pebbly grit, carrying tin in cavities. E.—Soft sandstone and sugary-quartz formation, with cavities encrusted with tin oxide. F.—Hard quartzite formation, containing stanniferous pyrites. G.—Almost solid stanniferous pyrites. H.—Broken country. I.—Slate, sandstone, &c., unconformable with E. D, E, F, and G = “The White Lode.”

(22)

22