REPORT ON THE TIN ORE DEPOSITS OF MOUNT HEEMSKIRK.

[Four Plans.]

I have the honour to forward you the following Report, the result of my examination of the tin ore deposits of Mt. Heemskirk:—The district may be regarded as extending along the coast from Trial Harbour on the south to Granville Harbour on the north. The mountain range is approximately parallel to the coast-line, and the major axis is distant therefrom about five miles. The range comprises a number of peaks, of which Mt. Agnew, the most southerly, is the highest. Its height above sea-level is about 2800 feet. To the north and north-west of Mt. Agnew there are a number of other peaks, several of which are not much lower than Mt. Agnew itself. Mt. Heemskirk is situated about five miles N.N.W. of Mt. Agnew. It is connected with the Mt. Agnew group by a high saddle. To the north-west of Mt. Heemskirk, and separated from it by a low saddle known as The Gap, is North Heemskirk, while to the north of this again, and separated therefrom by the valley of the Tasman River, is Donnelly's Look-out, a comparatively low peak directly east of Granville Harbour, which may be regarded as the most northerly portion of the Heemskirk Range.

This range of mountains is composed almost exclusively of granite. The southern margin of the mass runs from about a mile north-west of Trial Harbour, on the coast, in a north-easterly direction for about 4½ miles. From this point, which is about two miles south-east of Mt. Agnew, the eastern contact runs in a northerly direction for about three miles, and then in a north-westerly direction to Donnelly's Look-out. North of this point the granite-belt is much narrower, but I am informed that it runs along the coast with occasional breaks as far as ten miles north of Pieman Heads, though I have not yet had an opportunity of examining this country. In the vicinity of Granville the granite is overlaid by a Tertiary basalt, and this has produced some thousands of acres of excellent agricultural land, some of which is now used for grazing purposes.

The granite mass is intrusive in the Silurian sandstones and slates which surround it, and the latter have suffered

metamorphism near the contact. Gabbro and serpentine occur in considerable masses to the south of the granite-mass, and are believed to be older than the latter. I have not found them to the north. There is a large area of country to the north-east of Mt. Heemskirk covered by Mesozoic diabase. This is the same rock which forms the greater part of the central plateau of the Island, and appears to form the capping of many of our mountains, as, for example, Mt. Wellington, Ben Lomond, Barn Bluff, Mt. Pelion, Mt. Dundas, and Mt. Sorell. In the Heemskirk district this rock appears to be overlying the Silurian strata.

In my report on the ore-deposits of North Dundas I have described a type of tin-vein to which I have applied the term "tourmalinic casserite-veins." These veins are abundant throughout the Heemskirk district, but I now think that the term "stanniferous quartz-tourmaline veins" would be more appropriate, as my observations at Heemskirk have shown that these are but a modified form of a more general type, namely, "quartz-tourmaline veins," which may or may not carry tin. There are also three other types of tin veins to be recorded from the Heemskirk district, for which I propose the terms "pinitoid-veins,"* "greisen-veins,"* and "pyritic-veins" respectively; all of these types will be described in this Report. I also propose to use the term "quartz-tourmaline reef" to describe any tabular deposit consisting essentially of quartz and tourmaline, for, as will appear later, my observations lead me to the conclusion that some of the reefs are not veins, but true igneous dykes. Quartz-tourmaline reefs, therefore, may be divided into (1) quartz-tourmaline-dykes, and (2) quartz-tourmaline-veins, while the pinitoid-veins, greisen-veins, and pyritic-veins may be regarded as modified forms of quartz-tourmaline veins. In the Heemskirk district there are very exceptional opportunities for studying the origin of these quartz-tourmaline reefs; and as the subject is one of the very greatest scientific interest, as well as of great practical importance, I propose before describing the various deposits in detail to give a general sketch of the evidence presented.

What appears to be the normal granite of the district consists of a coarse-grained mixture of feldspar (orthoclase and plagioclase), quartz, and black mica (biotite), but, over con-

* Pinitoid is a complex substance somewhat resembling sleatite in appearance, and muscovite (white mica) in composition. It is believed to be formed by the alteration of the feldspar. Greisen is a rock composed of granular quartz and white mica (muscovite or lithiore mica), believed to be due to the alteration of granite.

siderable areas, other types of granite are present in even greater abundance than the normal type. Frequently the granite contains abundance of black tourmaline, in addition to the other constituents, or replacing, wholly or partly, the biotite. In many parts there are numerous dykes of fine-grained granite or aplite, often containing large quantities of tourmaline. I believe that the tourmaline granites and aplites are essentially of the same composition. They differ from the normal granite principally in the greater abundance of quartz and tourmaline, in the greater relative abundance of orthoclase over plagioclase, and of muscovite over biotite. With the tourmaline is also associated a small percentage of tin oxide. The specific gravity of the aplites is appreciably less than that of the normal granite; an average of three determinations of the former giving a result of 2·575, while that of a similar number of determinations of the normal granite gave 2·634. In each case pieces were chosen for determination which did not contain tourmaline, as the object was to demonstrate the greater abundance of silica in the aplite. Where the aplites are rich in tourmaline, the specific gravity is no doubt much higher than that of the normal granite. The aplites, however, do not always occur as dykes; they are sometimes present in the form of irregular masses, or nodules, in the granite. This type of occurrence may be well seen on the road from Trial Harbour to Zeehan, where, in places, the surface of the granite is laid bare for considerable distances. The masses vary from the size of a cocoa-nut upwards. Sometimes, where the granite is weathered, the aplite nodules are less decayed than the surrounding granite, and may be dug out. It is evident that there has been no connection between them and an interior source of molten rock; they must, therefore, have separated *in situ* from the granite magma surrounding them before the latter solidified. This process is known as magmatic segregation. The term implies that during the consolidation of the granite magma the latter has become separated into two sub-magmas, containing the original constituents of the magma in different proportions. The actual cause of this separation is still a matter of speculation, and need not be discussed here. Suffice it to say, that the water contained in the original magma is believed to be one of the most important factors in the process. The original magma appears to separate into two sub-magmas, one being more aqueous than the original magma, and the other less so. The aplites are believed to have consolidated from the more aqueous of the two sub-magmas, while the less aqueous is

believed to be responsible for the normal granite. We have indeed direct evidence in the Heemskirk district that the aplite magma was highly aqueous. On the Trial Harbour Road, there is a small dyke of aplite, containing a central seam of larger crystals of quartz and feldspar (pegmatite), with small cavities or druses (miarolitic cavities), not unlike the druses in some fissure-veins. These cavities were no doubt originally filled with some of the water contained in the aplite magma, which segregated to the centre during consolidation.

The presence of water in a magma is known to have an important influence on the temperature of consolidation. The molten lava of volcanoes which eject large quantities of steam, thereby producing immense showers of ashes, is generally much cooler than that of quiet eruptions, in which steam is emitted in smaller quantities. The presumption is that the less aqueous magma requires a higher temperature to preserve it in the liquid state. From this it follows that the more aqueous aplite magma will remain in a liquid condition longer than the less aqueous magma of the normal granite. This is just what has happened in the Heemskirk district, for we find the aplite occurring in dykes in the normal granite, showing that the former had been injected in a liquid condition into fissures in the solidified granite. The difference in composition between the aplites and the normal granite may, at least, be partly explained by the theory of magmatic segregation. In the more highly aqueous magma (*i.e.*, the aplite magma) will be concentrated such substances as have an affinity for water, or such as are at high temperatures very soluble in water. We know that all the constituents of tin veins must be highly soluble, for in the tin veins they have been deposited from an aqueous solution. This, therefore, will account for the greater abundance of quartz-tourmaline, the alkalies (as shown by the greater abundance of orthoclase and muscovite), and tin-oxide in the aplite magma.

In the Heemskirk district we have very abundant evidence that the process of magmatic segregation does not end with the production of the normal granite and the aplite magmas. For, just as we find nodules of aplite in the normal granite, so do we find balls or nodules in the aplite, and to a much lesser extent in the granite, of a different composition from that of the surrounding rock. These nodules are composed of tourmaline, quartz, a little feldspar, and tin-oxide. The feldspar appears to be absent from the central portion of these nodules, while the tin-oxide is pro-

bably absent from the margin. Sometimes they contain a hollow space lined with quartz and tourmaline crystals. They may therefore be described as consisting of a kernel of quartz and tourmaline, with a little tin occasionally surrounding a central cavity, and surrounded by a layer of quartz and tourmaline, with a little feldspar. These nodules are often extremely abundant, and, since they withstand the influence of the weather to a greater extent than the enclosing rock, they stand out on the exposed surface, and give the rock a most striking appearance. Sometimes they are so abundant that they are actually touching each other, and have even run together to form large botryoidal masses. These quartz-tourmaline nodules are not confined to the fine-grained aplites; they also occur in some localities over large areas, in fine-grained granites, and also to some extent in comparatively coarse-grained granite. In the latter case, the nodules are, however, never well-developed, and are more in the form of small flecks or patches than regular balls. It would be most interesting to learn the differences in composition between these granites, which contain the quartz-tourmaline nodules, and the normal granite in which they are absent.

The presence of these quartz-tourmaline nodules in the aplites and the fine-grained tourmaline granites may be accounted for in the same way as the aplite nodules in the normal granites. They are simply a product of further segregation. Just as the original granite magma separates into the normal granite magma, and the original aplite magma, so does the original aplite magma separate into the normal aplite magma and the quartz-tourmaline magma. Just as the normal granite magma is less aqueous than the aplite magma, so is the normal aplite magma less aqueous than the quartz-tourmaline magma. Just as the affinities and solubilities of certain elements produce differences in composition between the normal granite magma and the aplite magma, so do these same causes operate to produce even greater differences between the normal aplite magma and the quartz-tourmaline magma.

Now, these quartz-tourmaline nodules are composed of the same minerals as the numerous quartz-tourmaline reefs of the district. Can it be that the latter bear the same relation to the quartz-tourmaline nodules as the aplite dykes bear to the aplite nodules? That is, are they a portion of the quartz-tourmaline magma which has collected in masses within the granite, and has been ejected into fissures after the latter had solidified? A very superficial examination

of the reefs themselves is sufficient to show that the majority of them, at least, are not true igneous dykes. When they occur in granite, they consist of a tabular mass of quartz, quartz-tourmaline, pinitoid, or greisen (which I propose to call the vein-rock), with a central vein filled with black or green tourmaline, quartz, and frequently tin-oxide (the vein-stone). The walls of the vein, *i.e.*, the contact-planes of the vein-rock and the granite, are generally well-defined, but there is a complete absence of slickensides, or any signs of parting; the vein-rock simply "passes over" into granite. The structure of the vein-rock is not banded, but granular, like the surrounding granite, while that of the vein-stone is occasionally banded. When the reefs pass through aplites, or granites containing quartz-tourmaline nodules, the latter appear in the vein-rock practically unaltered. This most significant fact may be observed in almost all parts of the district. There can be only one explanation of these facts. The veins are due to the replacement of the felspar of the granite by the constituents of the vein-rock. Solutions, probably in the gaseous condition, ascended along the central fissure, and, penetrating into the surrounding granite, attacked the felspar of the latter, and replaced it with other material. In many cases these fissures occurred close together in parallel groups. These, then, either form a number of parallel veins, or, if the replacement has extended sufficiently, may form a mass of vein-rock with parallel parting-seams filled with tourmaline.

The quartz-tourmaline veins are not only found in the granite itself; they frequently pass out into the surrounding Silurian slates and sandstones. Here the rock, which has suffered replacement, is not granular, but laminated, and a corresponding alteration may be noted in the structure of the quartz and tourmaline. As a rule, the laminæ of the shales are beautifully preserved. The original differences in texture and composition have led to the deposition of tourmaline along certain planes, and quartz along others, with the result that in many cases a beautifully black and white laminated rock is produced. In the centre of the vein the laminæ are often twisted and contorted to an extraordinary degree, and these contortions are all faithfully reproduced in the resulting vein-stone. An excellent example of this may be seen on a vein exposed on the cattle-track between Zeehan and Corinna, on the Zeehan side of the Gentle Annie Rise.

There are certainly some quartz-tourmaline reefs in the Heemskirk district to which the above explanation is inapplic-

able—reefs in which there is no parting-plane in the centre, and which pass out of the granite into the sedimentary rocks without undergoing any change in structure. These reefs, when they occur in the sedimentary rocks, have usually clean-cut walls, and frequently contain apparently isolated fragments of country-rock (sandstone, &c.), enclosed in them. There is no trace of banded structure, and, with the exception of a very thin layer of tourmaline along the walls, there is no visible alteration in the proportion of the minerals from the walls to the centre. These reefs must have been erupted in a plastic condition, and are therefore correctly described as quartz tourmaline dykes." Mr. F. J. Ernst was, I believe, the first to discover these dykes, and I understand he has examined the rock microscopically. I am not aware that any of them have been proved to be stanniferous.

In addition to these evident dykes, there are others, which appear to occupy an intermediate position between dykes and veins. Thus, on the Gentle Annie Rise, I found what appeared to be a small quartz-tourmaline dyke occurring in slate, with a central zone of tourmaline. The analogy between this dyke and the before-mentioned aplite dyke, with a central seam of pegmatite, on the Trial Harbour Road, is obvious. Where these dykes occur in sedimentary rocks, the wall-rock is hardened, and impregnated by quartz and tourmaline. I have not yet observed whether this has also taken place in the granite, but, if so, it is evident that we might have a complete passing-over from quartz-tourmaline dykes to quartz-tourmaline veins. Further research is necessary to finally determine this most interesting point.

As regards the relative age of the dykes and veins, the following evidence is worth recording:—In several instances, I found the dykes cutting across and faulting small veins of tourmaline and quartz, but not one instance of the reverse phenomenon. These observations are perhaps not sufficient to justify us in assuming that the dykes are invariably younger than the veins, but they certainly appear to be usually so.

We may now form a general picture of the processes which have produced these quartz-tourmaline reefs. We have already seen that the quartz-tourmaline magma has been derived from the original granite magma by a process of segregation, by which the latter is separated into two parts—the one highly aqueous and the other less so. In the former the constituents of the quartz-tourmaline reefs and tin veins become concentrated, owing to their greater affinity for or solubility in water. By a repetition of this process of segre-

gation in the aqueous portion, the quartz-tourmaline is separated from the aplite magma, and in the upper portions of the granite-mass forms into small globules, which afterwards solidify to the common quartz-tourmaline nodules. In the deeper portions, however, where the cooling would proceed at a much slower pace, we may imagine that the quartz-tourmaline magma would collect into masses (as it evidently has a tendency to do even in the upper portion), and that here the process of segregation would be still further continued, producing in one part a more or less aqueous quartz-tourmaline magma, and on the other a highly-concentrated solution, containing a large proportion of the heavy metals originally present in the granite magma, and, in addition to these, large quantities of silica, compounds of the alkalies, and the constituents of tourmaline, &c. These masses, or reservoirs, may then be intersected by fissures, when the more fluid solutions would ascend, and, owing to the presence of certain "mineralising agents"—fluorine, boron (both of these are present in tourmaline), hydrogen, sulphide, and water—they would have a strong chemical action on the wall-rock, and would attack and replace it in the manner already described. Later, the more viscous quartz-tourmaline magma might be erupted, and form dykes, traversing the granites and surrounding rocks. This, in outline, is the theory which I believe the evidence at our disposal must lead us to adopt. It is not an altogether new theory, indeed, as far as the origin of the tin veins is concerned, it is essentially the same as that now generally adopted by geologists. I must say, however, that I have not heard of any other tin-mining district where the evidences of magmatic segregation are so profuse and so readily interpreted. I can most heartily recommend the district to the earnest attention of students of mining geology.

Before passing on, I must describe the mineralogical character of the several types of tin veins, in greater detail.

Quartz-tourmaline Veins.—As has already been stated, these veins consist essentially of a tabular mass of quartz or quartz-tourmaline, containing in the centre a vein, from which the country on either side has become mineralized. Either the vein-rock or the vein-stone may carry tin, but usually the vein-stone is the richer of the two. Tin appears to be associated with both black (iron) and green (alkali) tourmaline; but I think that, of the two, the green is the more favourable. This is also the case at Mt. Bischoff. A little iron, copper, and arsenical pyrites is often present,

either in the vein-stone or in the vein-rock, and in all probability these minerals will be found in all the veins in depth. Their absence from the upper portions of the veins being due to the oxidising and leaching action of surface waters. To this list must be added small quantities of bismuth sulphide, wolframite, and, rarely, molybdenite. Numerous examples of quartz-tourmaline veins may be seen at the Federation Mine, J. Mayne's Mine, and other sections too numerous to mention.

Pinitoid Veins.—These veins have the same general character as the quartz-tourmaline veins. They also contain a central vein of tourmaline, or cassiterite and tourmaline, but the vein-rock is much softer, and contains less quartz. The felspar of the granite has been altered to a massive substance, which has been termed pinitoid. This is not a definite mineral, but a complex substance, containing probably several minerals, all of which approximate to muscovite in composition. A slice of very similar stone from the Ben Lomond district, examined under the microscope, revealed the presence of a good deal of crystalline mica, together with the amorphous pinite, or massive mica. The vein-rock generally contains the original quartz of the granite unaltered, but sometimes the quartz also has been replaced. The vein-rock, as well as the vein-stone, is sometimes very rich in tin. The accessory minerals, mentioned as occurring in the quartz-tourmaline veins, will probably also be found in the pinitoid veins; but up to the present, I have only observed the presence of a little pyrite. Typical examples of pinitoid veins may be seen at Mr. M. Bullin's mine (the old Montague), and many others.

Greisen Veins.—This type is not abundant in the Heemskirk district. In these veins, the felspar of the granite has been altered to a white crystalline lithia mica, so that the resulting rock (greisen) consists of a mixture of granular quartz and white mica. Tourmaline and quartz are present in the central vein, and both the vein-stone and the vein-rock may carry tin. Typical examples of greisen veins may be seen at the old Orient Mine and on the Corinna track at Donnelly's Look-out.

Pyritic Veins.—In these veins the felspar of the granite has been replaced by pyrites, resulting in a mixture of granular quartz and pyrite. Copper and arsenical pyrites are often fairly abundant, and it is probable that in some cases copper will constitute the principal metal of value. Both gold and silver are present in small quantities, and in one case (Mt. Agnew Mine) rich antimonial silver ores occur

in veins traversing the deposit. These are probably of secondary origin, and point to the presense of small quantities of antimony in the pyrite. Galena is sometimes present in small quantities. Stannite (sulphide of tin, copper, and iron) and wolframite have been observed in one instance. Cassiterite may be present, either in the pyrites or together with quartz and tourmaline, in the central vein, from which the mineralization has taken place. Typical examples of pyritic veins may be seen at the Mt. Agnew Mine and J. Wood's sections on the Orient Creek.

Between these four types of tin veins there are innumerable intermediate types. Greisen and pinitoid are often found in connection with quartz-tourmaline veins, while all of them contain pyrites more or less abundantly. The several types are therefore not to be regarded as separate geological formations, but only as modifications of one great process of vein-formation.

Tin-mining at Heemskirk.

It cannot be denied that the Heemskirk district enjoys an unenviable reputation amongst the investing public. This reputation was, I believe, quite undeservedly earned during the period of the never-to-be-forgotten Heemskirk boom, when the wildest speculation and the most unparalleled extravagance were indulged in without any serious attempt to prove the value of the mines. The mining companies were all floated under the old Limited Liability Company's Act, and in the excitement of the boom many of them purchased and erected machinery largely in excess of the capital which had been called up. When the bubble burst, the creditors came down on the shareholders, and hundreds of investors were sold up, notwithstanding the fact that many of the mines had excellent prospects. No doubt the whole of the folly was not perpetrated during boom days; since then, several well-meaning and industrious parties, still possessed of a faith in the ultimate success of the field, have attempted to resume operations on one or other of the abandoned claims, and in some cases upon more recent discoveries; but the majority of these efforts were, from the outset, doomed to premature failure. In no case was sufficient capital produced to do much more than erect the necessary battery and concentrator, and make connection with the mine workings. Even this work has, in most cases, been carried out with such false economy, that the cost of treatment must have been excessive. For this reason very

little capital was available for opening up the mines, so, unless they were rich enough to pay for their own development, their abandonment before any serious attempt had been made to prove their value was a foregone conclusion.

The presence of pyrites in the veins appears to have been always regarded as an insuperable difficulty in the treatment of the stone. This idea evidently arose from the fact that the Mt. Bischoff Company has not pyrites in its ore, and, in consequence, has not installed any plant to deal with ores which contain this mineral. As the Bischoff Company is practically the only buyer of tin ore in Tasmania, its refusal to purchase pyritic ores left the impression that they were of no value. So prevalent is this idea in the district, that within the last two years a party of tributors abandoned a really good shoot of ore that they had opened up, because they could not dress the pyrites from it. As a matter of fact, all tin ores contain more or less pyrites below the oxidised zone, so that if its presence were a serious difficulty no lode tin-mining could be carried on except close to the surface. Fortunately, however, this is not the case. Pyrites may be easily got rid of by roasting and redressing the concentrates. This process is carried out at every tin mine where the lodes are systematically worked, and it will have to be adopted at Heemskirk. As a rule, the Heemskirk lodes do not contain an abnormal amount of pyrites, nor even appreciable quantities of any other mineral which presents a difficulty in its separation. The veins are normal tin veins, such as are successfully worked in other parts of the world.

During my visit to the district I counted no less than 10 batteries or old battery-sites. One of these batteries was erected on the mistaken hypothesis that the black tourmaline, which is so common throughout the district, was valuable tin ore. Three others were erected on mines where the only mining work done consists of a few surface trenches, or shallow prospecting shafts. In one case the lode had been cut in a poor place by a deep adit. With the exception of 80 feet of driving, no further attempt was made to locate the shoot of ore before the erection of the battery. In another case the battery was erected within almost a stone's throw of the recent discovery of tin ore on Mr. Mayne's Mine; and in the excavation for this battery a lode formation of promising appearance was exposed, which carries a fair percentage of tin. In the four remaining cases operations were suspended, notwithstanding the fact that developments were of a satisfactory nature.

These facts are, I think, sufficient to show that notwithstanding the large expenditure of capital in past years, the Heemskirk field has never had anything like a fair trial. Only a very small proportion of the money was spent in developmental work, and even in those cases, where the results of the under-ground work, so far as it went, were satisfactory, the panic that set in at the termination of the boom was so great that shareholders could not be induced to continue operations.

It is also evident that the failure of the field was, to a very large extent, due to inexperience on the part of those in charge of the operations. In some cases it is impossible to avoid the conclusion that the managers did not know tin ore when they saw it; but in the majority of cases the principal mistake made, both during and since the boom, has been the erection of elaborate machinery before the mines were sufficiently developed to enable them to yield a continuous supply of stone. It is to be hoped that this mistake will not be repeated in the Heemskirk field. The mines require large capital for their development, and unless this is provided, it is useless to attempt to work them.

As far as lode-mining is concerned, there are no "poor man's shows" in the Heemskirk district.

Mr. John Mayne's Mine.

The recent discovery of two rich tin-bearing lodes and of valuable detrital deposits of tin ore at their outcrops on Mr. John Mayne's farm is principally responsible for the increased attention which has lately been directed towards the Heemskirk field. Mr. Mayne's discovery is situated about seven miles south-west of Zeehan, and the principal section, No. 124M, will be found near the south-east corner of the Heemskirk (Montague No. 2) chart. Plate I. gives a topographical sketch map of the section. The main discoveries are situated in the northern portion, on a small spur (known as the main spur) on the western side of Pyke's Creek. The country-rock consists of Silurian sandstones and slates, traversed in many places by quartz-tourmaline veins, which have hardened and tourmalinised the strata in their vicinity. The contact of the Silurian strata with the main mass of granite is situated some 20 chains north of the section.

Tin ore was first found on the surface of the spur in the form of floating nuggets. These soon led to the discovery that much of the surface-soil and rubble was rich in tin,

and eventually the source of the tin was located by the exposure of the outcrops of several lode-formations. Up to the present, however, practically no developmental work has been done, beyond that which was necessary to win the few tons of ore which have already been sold, so that it is impossible to form an estimate of the amount, either of the detrital or lode tin, which is available. The great possibilities of the mine, however, as an ore-producer will become apparent from the following description:—

The Detrital Deposits.—These have been discovered, both on the north and south slopes of the main spur. At the time of my visit a small piece of ground on the north slope was being stripped, and the surface soil and rubble therefrom was being washed in a couple of sluice-boxes. I tried two dishes of this wash, which weighed together 26 lbs., and obtained just 2 lbs. weight of dressed tin ore. This prospect is equivalent to about two bags of ore to the cubic yard of dirt. The rubble on this side of the hill is rather shallow, and probably will not average more than 12 or 15 inches. On the south side of the spur several dishes were washed from the three holes marked C, D, and E on the plan. In each case, both the amount of rubble taken, and the prospect obtained, was carefully weighed. The results were very uniform, the average coming to almost the same as that obtained from the rubble on the north slope. On this slope, however, the depth of the rubble is much more than on the north slope. In no case has it actually been bottomed, although the deepest hole reaches a depth of over 3 feet. It is evident that we have here a very valuable deposit of tin ore, though sufficient work has not been done to ascertain its full extent.

The tin ore itself is grey in colour, and much of it is quite coarse-grained. Nuggets occur from the size of a walnut up to 20 lbs. and more, and quite a large proportion of the tin won to date has been in this form. Most of the nuggets have, on one side at least, a curious botryoidal structure; the central portion is granular, but towards the outside the tin-oxide has been deposited in thin concentric layers, resembling the structure of an agate; frequently the structure of the layers is radiating. In no case that I have observed are the nuggets completely surrounded by these concentric layers. They are angular, and have the appearance of having been broken off from a larger mass. The nuggets contain no vein-stone, nor any visible fragment of country-rock; they contain from 68 to 70 per cent. of metallic tin. The method of treatment in vogue at the time of my visit is

not one which should be continued. The rubble is not ordinary water-worn wash, but consists of angular fragments of sandstone and tin-oxide of all sizes. Such dirt cannot be effectively treated in a streaming-box, as indeed is amply demonstrated by the richness of the heaps of tailings alongside each of the boxes which were in use at the time of my visit. I should recommend the erection of a small jigging plant for the treatment of the surface rubble. This may be of the simplest type, since very little classification need be introduced, owing to the great difference in the specific gravities of the tin-oxide and sandstone.

I should suggest the following parts:—

One single compartment topping-jig with side discharge, to treat everything over ½ inch diameter.

One double compartment jig with discharge through sieve, to treat everything between ½ inch and ¼ inch diameter.

One three compartment fine jig with discharge through sieve, to treat everything below ¼ inch diameter.

The above would necessitate the erection of two trommels, one with ½ inch and the other with ¼ inch perforations. A grizzly would also be a convenient addition. Ample water-supply, both for power and treatment, could be obtained from Pyke's Creek.

With the above plant, it should be possible to save the whole of the free tin, excepting the very fine slimes, but of these there will probably be but a small proportion; they could be readily separated, and saved for future treatment, when it becomes advisable to erect a more extensive plant. Of course, if the immediate erection of a complete stamp battery and concentrating plant is decided upon, the erection of a separate plant for the treatment of the rubble would be unnecessary. This course, however, would be ill-advised, as, until the character of the lode-stuff and its extent has been ascertained by pretty extensive underground work, it would be very foolish to erect an expensive plant.

The Lodes.—Just above the stripped ground on the north slope of the main spur, the outcrop of No. 1 lode was discovered. It consists of a vein of decomposed bluish-green tourmaline from 12 to 18 inches in width, striking a little to the east of north, and dipping to the east at an angle of about 40°. On either side of this tourmaline vein the strata, which strike nearly at right angles to the vein, have been attacked by the mineralising solutions, and are richly impregnated with tin ore. The seams of rich ore run parallel to the planes of stratification, showing that certain strata

have been more favourable than others for the processes of ore-deposition.

The position of the exposure, as well as the strike and dip of the tourmaline vein, is indicated on the plan. It will be seen that it is situated near the eastern end of the spur, and that the vein is nearly parallel, both in strike and dip, to the surface of the eastern slope. A small open cut—"A"—has been made from the north side of the spur, and on the south side of this the vein is exposed along the underlie for about 20 feet. On the eastern end of this cutting the vein disappears underfoot. Here two holes have been sunk, each about 6 feet deep, one on either side of the tourmaline vein, and approximately following its underlie. I am informed that some hundreds of pounds worth of tin ore was obtained from these two holes. The floor of the open cut slopes to the east, with the footwall of the tourmaline vein, and is from 2 to 4 feet below it, so that for the width of the open cut (about 8 feet) the altered sandstone overlying the vein up to the surface, and underlying the vein to a depth of from 2 to 4 feet, has been taken out, as well as the vein itself. Most of the tin, however, which has been won up to the present, has not been obtained from the tourmaline stone, as, except quite close to the surface, this is not sufficiently decomposed to permit of tin being won by simple sluicing.

The floor of the open cut is composed of almost normal, slightly argillaceous, sandstone, somewhat decayed, and containing a fair percentage of tin, while there are some rich seams running through it, striking parallel with the strata, and approximately at right angles to the tourmaline vein. A sample taken by me, along the floor of the open cut to the west of the two holes mentioned above, for a distance of 6 feet, returned 4 per cent. of metallic tin. This sample was principally composed of sandstone, the stone taken being distant from the tourmaline vein about 3 feet. Another sample from the rich stone on the footwall side of the tourmaline vein returned 39 per cent. of tin, while a third, from the decomposed tourmaline vein itself, returned 14·5 per cent. About 20 feet to the south-east of "A" open cut, a prospect hole "B" has been sunk, for a depth of 7 feet. In the bottom of this hole a white kaolin formation was cut, which proved to be very rich in tin. A dish of the dirt, washed for me, gave an excellent prospect, and a sample taken from the bottom of the hole, and assayed by Mr. W. F. Ward, yielded the satisfactory return of 17·2 per cent. of metallic tin. From the position of the prospect-hole, it

is evident that this kaolin formation is on the hanging-wall of the tourmaline vein, though the hole is not deep enough to have cut the vein itself. This discovery is most satisfactory, as, apart from the richness of the find, it practically establishes the connection between the tourmaline vein and the tin-bearing stone which forms its walls.

On the plan will be found a line, marking the calculated position of the outcrop of No. 1 lode. The line has been plotted from the observed strike and dip in the open cut, and may be of use in finding the continuation of the lode; but it should be remembered that a small variation, either in strike or dip, will alter the position of the outcrop very materially, and therefore it should not be adhered to too closely.

No. 2 lode is situated on the southern slope of the spur. It consists of a large quartz-tourmaline formation, forming a bold outcrop, and striking about 60° W. of N.; in this lode the tourmaline is black, not green, like that of No. 1 lode. No work has been done on this formation, but it is known to be tin-bearing. Mr. Mayne showed me the assay-certificate of a selected piece of stone from this lode, which yielded 30 per cent. of metallic tin.

About 25 feet south of No. 2 lode a prospect-hole, marked "C" on the plan, has been sunk on the outcrop of a third lode. This is composed of the same decomposed green tourmaline as characterises No. 1 lode. The work done is not sufficient to enable the strike to be determined with accuracy, but it appears to be nearly east and west. The stone which is exposed is rich in tin, a sample taken by me yielding 10 per cent. of that metal. This formation, which may be called No. 3 lode, is a most promising one, and should receive immediate attention.

About 160 feet south of No. 3 lode there is another large quartz-tourmaline outcrop. This is situated on the other side of Pyke's Creek, and forms the crest of another spur; it is of the same character as No. 2 lode, and is probably parallel with it. No work has been done upon it, and it is not known whether it is tin-bearing. A short distance to the east of this outcrop, I am informed that a fair prospect of tin was obtained from a green tourmaline formation which is exposed on a small bush-track. This is worth attending to, as it may prove to be a continuation of No. 1 lode. Also, to the east of the main spur, in a trench marked "F," there are indications of a lode formation, from the rubble of which a fair prospect of tin was washed in my presence.

It appears certain, from the above, that there are quite a number of tin-bearing lodes on this section. Very little work has been done on any of them, but the results which have been obtained are of the most encouraging description. Most of the tin ore won to date has been taken from open cut "A," on the outcrop of No. 1 lode. Only the thoroughly decomposed stone could be treated, as no crushing was attempted. The remainder was won from the piece of stripped ground below the open cut. From these two places 342 bags of ore have been forwarded to the Mt. Bischoff Smelting Works, realising the sum of £960 3*s.* 6*d.* Besides this, about 1½ ton of ore was sent to Sydney; of this parcel I have not been able to obtain particulars.

A prospecting tunnel has been commenced from the east end of the main spur, with the object of cutting No. 1 lode. This should certainly be continued, and should cut the lode at a very short distance. It has also been suggested that a tunnel be driven right through the spur, to the west of the present workings. This tunnel would have two objects. It would effectually prospect No. 2 and No. 3 lodes at creek level, and also, by diverting the creek through it, the bed of the creek surrounding the main spur could be readily worked. As this must contain a very considerable quantity of tin, this work would much more than pay for itself.

After the lodes have been effectually prospected above creek level, a site must be chosen for a main shaft, and further operations conducted from it. The work of opening up the lodes on Mr. Mayne's Mine is one of the greatest importance to the Heemskirk district, and it is to be hoped that it will be undertaken with energy and skill. There are certainly two lodes already known, which, at their outcrops, are very rich in tin, and which have shed large quantities of ore on to the slopes of the spur on which they occur, and into the creek which flows round it. This detrital deposit of tin ore, as it stands, constitutes one of the best "poor man's shows" which has yet been discovered on the West Coast, while the lodes themselves afford an opportunity for the investment of capital, which there is every reason to believe will prove remunerative.

Section 106M, R. Clarke.

This is a small section of about six acres, north and adjoining Mayne's Mine. As will be seen from Plate I., Mayne's No. 1 lode should pass into the section, but, unfortunately, owing to its flat underlie, it would soon dip out of it to the east. The section had not been prospected at

all at the time of my visit. If the rich shoot which has been worked on on Mayne's Mine continues across the creek, there ought to be a good deposit of detrital tin on the spur opposite. A few trenches will soon prove this. The western portion of the section should be carefully prospected for other lodes.

Section 173M, W. D. Hull.

This section is north and adjoining R. Clarke's Section 106M. The contact of the granite with the Silurian strata runs through the northern and western portions of the section. On the hill to the west of Pyke's Creek a few trenches have been made, and detrital tin ore has been found in the rubble. A tunnel has been lately started from Pyke's Creek in sandstone country, in search of a lode, but so far nothing but small quartz stringers have been cut. I am of opinion that for the same money more could be done by extensive surface-trenching than by underground work at the present time. Until the outcrop of the lode has been found at the surface, it is impossible to determine the best direction for the underground work. The contact of the granite with the slate and sandstone country is especially worthy of attention. The section is close to Mr. Mayne's rich find, and on that account alone should be most carefully prospected.

The Old Orient Mine.

This old mine has recently been taken up, though the ground was not surveyed at the time of my visit. The underground workings disclose the presence of a great number of parallel veins of quartz and greisen, striking from 50° to 70° W. of N., some of which carry visible tin. Most of the veins are too small to pay for mining, but some of them go up to 3 feet in thickness, and should be payable, provided they carry a fair percentage of tin. I did not have time to sample the mine, but I think this would be worth doing. The fact that the mine did not prove remunerative under the conditions existing in the old boom days is no reason why it should not be made so now. I also think it would be well worth while prospecting along the contact of the granite and the slate country, where these veins cut it, as this is a likely place for a deposit of ore to be found.

Whelan's Section.

This is a 40-acre section, held at the time of my visit under a prospector's licence, and situated to the north-east of

Mayne's Mine. There is an old prospecting shaft on this section, which has been put down on a pyritic vein. Judging from a large lump of ore at the surface, the vein is about 15 inches in thickness, and carries iron and copper pyrites, stannite, a little wolfram, and black tourmaline.

The shaft is situated in slate country, but within two chains of the granite contact. Unfortunately, stannite is not at present a marketable ore of tin, and this ore, unlike that of Zeehan, is poor in silver. I think, however, it would be well worth locating the vein at the granite contact, which could probably be easily done. Many of the Cornish tin veins contain a little stannite, and this occurrence may prove to be merely a patch in an otherwise normal vein.

Section 227M.

This is a 40-acre section, charted in the name of E. Healy, and situated about a mile N.N.E. of Mayne's Mine. A large quartz-tourmaline lode runs through the section, striking about north and south. It has been trenched across in one place, and is here about 15 feet in width. For 6 feet on the western side the lode is mostly composed of seams of decomposed green tourmaline, yielding a good prospect of tin. A bulk sample from these seams, assayed by Mr. W. F. Ward, Government Analyst, yielded 2¼ per cent. metallic tin, while another sample, taken by clipping the hard lumps of stone lying about the surface, yielded 0·9 per cent. A good deal of alluvial tin has been got from the small creeks in the vicinity. This lode is well worth prospecting.

J. Wood's Sections.

These are four 20-acre sections, situated on the Cumberland Creek, below the dam, and charted in the names of J. S. Robertson and A. Goldstraw. Near the centre of the sections a small trench has exposed the outcrop of a pyrites formation of considerable width. The stone consists of a granular quartz iron and copper pyrites and a little tin. One assay that has been made gave a return of 1 per cent. tin, 2 per cent. copper, 1 dwt. gold, and 14 ozs. silver per ton. The strike of the formation is undeterminable where exposed. Excellent facilities for testing the lode exist at this point, as the hill falls at an incline of about 1 in 1 towards Cumberland Creek. Some distance further south, but possibly outside these sections, an old tunnel has been put in, at the mouth of which I noted some very similar stone. It is quite likely that this is a continuation of Gold-

straw's lode. The creek to the east of the lode is known to be rich in tin, and there is a possibility that the latter may have been derived from this lode. I should recommend further surface prospecting; 1 per cent. of tin would not be payable with a complex ore of this nature, but it is possible that richer shoots may be found. Unless good ore exists near the surface, I am of opinion that it is not worth while going underground. I may mention again that the presence of pyrites is not an insuperable difficulty in connection with tin ore. Its presence certainly increases the cost of treatment, but not to such an extent as would materially affect the prospects of any but low-grade propositions.

Mr. M. Bullen's Mine.

Section 1362-91M, 20 acres. This section comprises the most important part of the old Montagu Mine, which played such an important part in the early history of the Heemskirk field. It was the old Montagu Company which, in conjunction with the Cumberland Company, constructed the Cumberland Dam, with the object of supplying both mines with power, and water for dressing purposes. The company owned a fine battery and concentrating plant, but, unfortunately, underground development was neglected, and the elaborate machinery was never called upon to treat more than a few score tons of stone. Some time after the mine was abandoned the ground was taken up by Mr. M. Bullen, who for the last 12 years has been engaged in working out the rich ore at the outcrops of the lodes, and working the small creeks in the vicinity. It is unfortunate that, at present, none of the workings can be examined, and as even the outcrops of the lodes have been underhand-stoped from the surface wherever they contained ore, there is very little left to be seen. I have had to rely, therefore, largely on information which has kindly been supplied to me by several gentlemen who were well acquainted with the mine in the early days, and whose accounts are quite unanimous as regards the essential details.

A small creek runs through the western portion of the section in a north and south direction, and this is crossed by what is known as the east and west lode. It consists of a number of parallel pinitoid veins, containing black or green tourmaline, and striking a little north of east, the dip being nearly vertical. The country-rock consists of a fine-grained quartz-felspar granite or aplite, and this also contains a small percentage of fine tin. The veins vary in width from 3 inches

up to a couple of feet. Two of these veins, which occur close together, but which are said to come together a short distance below the surface, are known as the main lode, and this for some distance contained a rich shoot of tin ore at the surface. Another pinitoid vein follows the bed of the creek for some chains, striking north and south. This is known as the north and south lode, or the cross lode. It also contained rich tin, and has been underhand-stoped along the surface for some distance. On the junction of the main lode and the cross lode a prospecting shaft was put down on a rich shoot of stone, but this cut out in the bottom of the shaft. A main shaft was then sunk to the south-west of the prospect shaft to the depth of 118 feet, and at the 100-feet level a crosscut was driven west, which cut the north and south lode to the south of the prospecting shaft. The lode proved to be unproductive at this point, and was driven on north to the junction. Here a rise was put up to connect with the prospect shaft, and a second shoot of rich ore was discovered below the first one. The ore is described as having been very rich, consisting of massive tin-oxide and tourmaline. This is borne out by the numerous specimens of the ore that are still preserved, and of which I was shown about 1 cwt., which should carry between 50 and 70 per cent. of metallic tin. Mr. Bullen tells me he has sold about 2 cwts. of ore, derived from similar specimens, which he collected from the stone at the surface. There is also a good deal of rich tinstone lying about the surface—just too poor to pay for hand-crushing—indicating the class of ore which was met with below. The shoots of ore were stoped for a total distance of 36 feet. The lode appears to have varied a good deal in width; south of the prospect-shaft it was from 1 to 2 feet wide, while to the north it is said to have been from 3 feet 6 inches to 4 feet. On the surface this lode has been traced for about four chains. The old stopes came to within 7 feet of the surface, and Mr. Bullen has underhand-stoped the remainder of the rich ore, which he crushed by hand and dollied. These underhand stopes extend further north than the old company's stopes underground. The old company appears to have done very little with the east and west lode. It was poor at the junction, and appears to have contained a little pyrites, which, in those days, was regarded as a refractory mineral. The lode was driven on 12 or 15 feet, and is said to have been 12 feet wide. I am told that when the company stopped work the lode was looking much more promising, the favourable green tourmaline beginning to show in the face. That shoots of

rich ore are to be expected in this lode is proved by the fact that to the east of the prospect-shaft Mr. Bullen has worked the lode along the surface for about a chain. This underhand-stope is about 7 feet deep at the west end, going up to 14 feet at the east. Only the very rich stone was taken, as it had to be crushed by hand and dollied; still, the ground worked yielded no less than four tons of marketable ore.

About five chains east of these workings another patch of ground was worked, on the main lode, which is said to have yielded 30 cwts. of ore, and, three or four chains further east still, a prospecting-shaft 18 feet in depth was sunk on a make of rich stone. The lode here was 26 inches wide, and some of the stone was crushed by hand and dollied, the remainder being good battery dirt.

The shoots of ore in this mine appear to have been small but rich, and its success will depend upon the frequency with which they are met with when mining operations are carried on in a systematic manner. So far as they have been explored, the lodes appear to have been payable. The second shoot was found within a short distance of the first, and it is almost certain that, had the mine been properly developed, others would have been discovered. I think that the mine certainly deserves a further trial.

The Federation Mine.

Sections 3689, 3688, 3919, and 4143—93M; total area, 256 acres; charted in the name of J. S. Munro. This mine is situated about two miles south-west of the peak of Mt. Agnew. The sections comprise most of the land held by two old companies, namely, the Cumberland and the West Cumberland. Both of these companies owned batteries in the old days, and on the ground held by the former the well-known Cumberland Dam was constructed, which affords a good supply of water all the year round at a high elevation. This is now reserved from leasing, and the water is available to any company requiring it.

More genuine mining work was done on the Cumberland and West Cumberland mines than on any others in the Heemskirk field. Both mines produced a considerable amount of tin, but it is difficult now to obtain reliable information. The sections were held for a number of years after the Heemskirk boom, but eventually the West Cumberland became forfeited, and this was taken up by Messrs. Fowler and Dunn. This party worked the mine

successfully for some time, supplementing the five-head battery of the old company by ten additional head, which they purchased from the Montagu Company. This plant was worked by steam, a most expensive method in this district where firewood is scarce, and although the stone was rich, averaging 6 per cent. of tin ore, I understand there was not a large amount of profit left after paying expenses. When the shoot of ore was worked out the mine was put into a larger company, which, unfortunately, spent nearly the whole of the available capital in the re-erection of the battery, and in bringing in a race from the Cumberland Dam. It appears to have crushed some stone, but no provision had been made for a continuous supply, and it eventually closed down. The sections were again abandoned, and finally they were taken up by the present owners. The latter have worked the mine with some success, but the whole arrangements for mining, handling, and milling the stone are inadequate, and it has become evident that more capital is required to put the mine on a firm basis.

Plate 2 gives a topographical sketch-map of the mine. The country is all granite, much of it being rather fine-grained, and composed principally of quartz and white feldspar, with very little mica. Quartz-tourmaline nodules are very abundant in much of this rock. There are numbers of large quartz-tourmaline reefs running through the sections. Most of these strike a little E. of N., but there are several notable exceptions to this rule. Some of these reefs consist largely of white quartz, with small veins of tourmaline running with them; others consist of a mixture of quartz and tourmaline. The tourmaline is of two varieties, the common black, or iron tourmaline, and the green alkali tourmaline. As in other parts of the field, the green tourmaline appears to be the most favourable for tin. Tin is contained in the reefs, both in the form of a central seam of rich ore, and also distributed in small grains through the stone. It is not an invariable constituent, but appears to occur in shoots, some of these being of considerable length.

The Western Workings.—These are mostly the workings of the old West Cumberland Company. They are now connected with the battery by a self-acting tramway, erected by the present owners of the property. Most of the tin obtained by the old company was won from a mass of ore between the 530-feet level and the 450-feet level. This ore was taken out in a large chamber, which has since been filled up, and could not be examined. It was situated below and a little to the south of the open cut, at the 450-feet

level. It was an open chamber when Messrs. Fowler and Dunn took up the property, and Mr. Fowler informs me that the tin had cut out, both in the roof and floor. By an accidental fall of earth, however, a second mass was discovered above the one which had been worked out, and it was from this that Messrs. Fowler and Dunn obtained their tin. In working out their second mass of ore, the open cut, at the 450-feet level, shown on their plan, was made. There is not a great deal to be seen at present to indicate the presence of the ore-body, the only indications being a number of small veins showing in the face of the cutting. The stone is described as having been composed of an iron-stained decomposed rock, containing a good deal of brown iron oxide; when this was absent, the stone was always poor. Quite lately a seam of similar stone, about 6 feet in width, has been exposed on the western side of the open cut. This contains a good deal of brown oxide of iron and some black tourmaline. A dish of dirt taken by Mr. Yates for a width of 4 feet yielded 3 ozs. of tin ore, equivalent to about 1 per cent. I believe that this soft stone results from the decomposition of granite, the feldspar of which has been partially converted into pinitoid by the solutions which deposited the tin. As regards the tin contents of the stone, Mr. Fowler tells me that his party saved an average of 6 per cent. of tin ore from the whole of the stone treated. The facts of the case are therefore as follows:—Two considerable masses of rich tinstone have been mined at this place. Both of these were practically self-contained, being only connected with each other by small veins of quartz-tourmaline and pinitoid. With the exception of the drive at the 450-feet level, nothing has been done to ascertain whether other masses of stone exist on the same line of lode. It is not unreasonable to suppose that, just as the upper mass of tinstone was separated from the one below it by a blank space, so the latter may be separated from others below or alongside it by similar spaces of barren rock. It is not an uncommon phenomenon in connection with tin lodes for the good stone to occur in considerable masses, tapering out to nothing in every direction, only to come in again just as strong a little further on, or a little deeper. There can be no doubt that the masses which have been worked were highly payable, and it is certainly worth while further exploring the line of lode in which they occur.

The only other development of importance in these western workings is a lode which has been discovered in and above the 500-feet level. The latter has been driven along a

quartz-vein of somewhat unfavourable appearance, but at about 100 feet from the entrance good stone was met with. I believe this is another lode, striking nearly E. and W., and cutting the lode that was driven on at an angle of about 30°. The level at this point is connected with the surface by a shaft which was sunk on the lode. A short intermediate level has been driven, and a little stoping has been done by a party of tributors, who mined 330 tons of stone. This parcel yielded 5½ tons of concentrates, carrying from 63 to 69 per cent. of metallic tin. The stone near the surface was free-milling, and the concentrates were sold to the Bischoff Smelting Works in Launceston; but in the lower stopes a little pyrites is present in the stone, and here tin could not be dressed clean. The product could not be treated at Launceston, and it was thought for the time that it was worthless, so the tributors abandoned their claim. It was not till some months afterwards that a market was found for the product in New South Wales, where the parcel was sold at a remunerative price to Messrs. Kelly and Co. The parcel contained 63·5 per cent. of tin, and the price obtained was equivalent to £54 12*s*. 6*d*. per ton. Beyond a little pyrites, there was nothing of a refractory nature in the ore. This lode is 6 feet wide in the stopes, just above the 500-feet level. The length of the shoot is at present unknown, but there is evidently a considerable body of payable stone ready for stoping.

The 570-feet level was driven below the 500-feet level on the same quartz-tourmaline vein. One small shoot of ore was met with on which some stoping has been done, but, on the whole, the lode is of the same unfavourable appearance as in the upper level. The productive lode on which the stoping was done in the upper level has not been cut at this level.

The 450-feet level was driven from the open cut. Nothing definite appears to have been followed, but several makes of quartz rock were cut. One vein contained a little bismuth ore, and a little stoping is said to have been done. In the end of the tunnel a large oxidised tourmaline lode was cut, striking about 50° W. of N. This carries a little bismuth oxide, but is poor in tin. The tourmaline is the black variety, which, I think, is unfavourable.

To the north-west of these workings there is a very strong reef, striking 22° N. of E., on which a prospecting shaft has been sunk 30 feet in depth. A trench put across the lode at this point has exposed a wide tin-bearing formation, which looks promising. The stone from the shaft also car-

ries tin. This is all low-grade ore, but under favourable conditions might well be payable. Four hundred feet to the N.N.E. a trench has been put across another reef, striking a little E. of N., in which some really good stone is exposed. The tourmaline here is of the green variety, and the whole formation is of a favourable appearance. A tunnel driven from the creek-level, along this lode, would effectually prospect it, and might be continued, to cut the other lode a little to the east of the shaft. The contact of the two lodes is a likely place for discovering a good shoot of ore.

The Central Workings.—The most important developments which have taken place since the mine came into the hands of its present owners are in this portion of the property. As will be seen by reference to the plan, there is here a very large outcrop of quartz-tourmaline stone. It appears to have been produced by the junction of several reefs. The very wide part at the north end is much disturbed, and is evidently not in its original position. There are probably several bands here, which have fallen over, and to some extent slid downhill. As the granite surrounding them is quite decomposed, this is not an unlikely thing to happen. Several small trenches have been made at the north end of this blow, exposing a very favourable quartz-tourmaline rock, in which tin ore is visible in almost every piece that is broken. The tourmaline is of the favourable green variety, and is evenly distributed with tin ore through the stone. There appears to be a very large quantity of this class of stone here; it is low-grade, but should be payable if worked economically. To the west of these trenches the 85-feet level tunnel has been driven. This passes through decomposed lode-matter for 40 feet, when the south wall was reached. This was then driven on N. and S. for some distance. The tunnel was continued, and cut another band of hard quartz rock. For the first 15 feet the stone in this tunnel yields a fair prospect of tin, but towards the south wall it becomes poor. The 115-feet level, below this, is not driven far enough to cut the lode. The stone is showing 6 feet above the tunnel, but this has evidently slid downhill, and its continuation is to be sought further in. To the south-west of this tunnel is a small open cut, which exposes the north-eastern portion of the formation. I took a sample from the western wall of this cutting, representing a bulk of 9 feet 6 inches, measured across the lode, which yielded 1 per cent. metallic tin; 150 feet to the south-west of this open cut another (larger) cutting, known as the Black

Face, has been made. The formation here is composed of soft, black, partly-decomposed lode-stuff, with bands of hard quartz-tourmaline stone running through it. I took a bulk sample across 12 feet of the soft lode-matter, at this point, which yielded 2¼ per cent. metallic tin. Another sample from the hard bands, totalling 5 feet 8 inches in thickness, yielded 0·35 per cent. This gives an average of 1·64 per cent. metallic tin for a width of 17 feet 8 inches. From this face 720 tons of stone have been treated in the mill, yielding 12 tons 18 cwts. 22 lbs. of concentrates, and containing from 58·7 to 69·4 per cent. metallic tin. This is equivalent to about 1 per cent. of metallic tin in the crude stone. The result is lower than that obtained by my sampling, in part due, no doubt, to loss in concentration, which was heavy. I believe that, with more efficient machinery, this loss could be to a great extent avoided. I may mention that the tailings from the battery are now being re-treated at a profit by a tributor. On the north side of the Black Face there is a considerable body of iron-stone, which carries good tin. Samples which have been assayed yielded from 2 to 3 per cent. metallic tin. One hundred feet S.W. again, what is now known as Munro's Shaft has been sunk on the formation for a depth of about 25 feet, and from the bottom of this a crosscut has been driven to the eastern wall, a distance of 16 feet. There were no means of getting down this shaft at the time of my visit, so I could not examine it. The ladders have, however, been put in since, and Mr. Yates informs me that he found the whole of the stone to be tin-bearing, though it is low-grade. He estimates it to carry an average of 1 per cent. of tin. About 80 feet south of Munro's Shaft an underlay shaft has been put down, which, however, is under water, and has not been examined by the present owners of the mine. Mr. G. Thureau, former Government Geologist, reporting on the mine in 1881, states that from the bottom of this shaft a crosscut was driven, and proved the lode to be 14 feet wide. Of this 2 to 3 feet is described as being rich, and the remainder probably remunerative when operated upon in large quantities. The stone from this shaft was crushed by the old company. This formation also appears to have been cut in the long tunnel from the low ground to the E. This tunnel is now blocked up by a fall of earth, a little over 600 feet from the entrance. At about this point, according to Mr. Thureau's report of 1884, a quartz reef of unfavourable character was cut. The tunnel was continued for 300 or

400 feet further, and here a more promising lode was intersected, containing rich bunches and pipes of tin ore; this lode was only driven on for 90 feet. The stone was treated in the battery, but I have been unable to ascertain the results obtained. At the mouth of the tunnel there are several heaps of what appears to be discarded lode-matter. It is very silicious, and contains a little tourmaline and fluorspar. A bulk sample taken by me from the whole of the stone in these heaps yielded 0·25 per cent. of metallic tin; while a bulk sample from a large quantity of hard stone from the heaps taken by Mr. Yates yielded 1·05 per cent. metallic tin. I think there is little doubt that this formation is the continuation of one of the reefs which junction near the Black Face. There are 280 feet of backs above the long tunnel. The lode must have been cut 300 feet to the south-west of the Black Face, and 550 feet south-west of the northern portion of the outcrop. For this distance, therefore, the lode has been proved to be tin-bearing. The successful treatment of the deposit depends, I believe, on the treatment of the low-grade ore. I think we have reason to believe that there are, in this portion of the mine, very large bodies of stone, which will average about 1 per cent. of metallic tin. A good deal of it, no doubt, will go higher than this; but to work the mine economically it will not be possible to take only the richer ore. The low-grade material must be treated, for it will be by following up and mining the latter that the rich shoots will be discovered. As will be shown later, the mine is exceptionally favourably situated for economically handling the stone.

The Eastern Workings.—These are not at the present time an important part of the mine. A prospecting shaft has been sunk on a formation which appears to be a good deal broken up, but which carries some nice tin in places. There is green tourmaline in the stone, which may be regarded as a favourable feature. A few chains to the south-east of this shaft a green tourmaline formation is exposed on the track, from the rubble of which good prospects of grey tin are obtainable. This portion of the mine deserves further prospecting.

The present arrangements for the handling and treating of the crude stone are not satisfactory, and, in my opinion, will require to be completely reorganised before the mine can be put on a satisfactory basis. Before this is attempted, however, the mine should be opened up, so that definite information with regard to the quality and quantity of the stone available may be obtained. Only then will it be

possible to decide upon the best surface arrangements, and the class of machinery which will be best adapted to the treatment of the ore. The long tunnel should be opened out, and the lode driven on to the N., and underground communication established between this drive and the workings on the hill. Intermediate levels should then be driven N. and S., and the whole formation thoroughly explored. The question will have to be considered whether it will be advisable to work the mine from the present long tunnel, or from a lower adit from the north side of the hill. The latter would be about 800 feet in length, and would gain about 150 feet more backs. From either of these tunnels a well-graded tramway could be made, connecting with a self-acting tram running to the mill. The present horse-tram and self-acting tram are only temporary structures, and will require re-erection in any case. The mill also is badly designed, and will require rearrangement and additional concentrating appliances.

A splendid permanent supply of water, sufficient both for power and dressing, is available from the Cumberland Dam. The present race comes in 450 feet above the battery-site. The capacity of the dam might be increased many times at a very moderate cost, by increasing the height of the dam, so that, practically speaking, the water-power is unlimited, and could be used for winding, hoisting, powder-drills, &c., as required. To the north-west of the mine there is a fine belt of timber, 500 acres of which have been declared a timber reserve by the Government, and reserved from leasing. A short tramway could be made into this belt, and the requirement of the mine in the matter of mine timber and fuel cheaply supplied.

It will thus be seen that the facilities for working the mine economically are very exceptional. The mine can be worked for a long time by adits, thus avoiding the cost of sinking and pumping, and the latter, in this granite-country, will never be excessive. Mine-timber can be obtained cheaply, and ample water for treating the ore and supplying power to the mine and battery is available. The large masses of tin-bearing stone which have already been explored near the surface, and which have proved to be tin-bearing for a distance of over 500 feet, lead us to suppose that we have to deal with a very large formation indeed; and although we cannot expect the whole of this to be payable, there are indications that a considerable portion of it will be, provided the work is laid out, so that the stone can be mined and treated in an economical manner. In

the western workings two considerable bodies of good tin-bearing stone have already been mined, and it is reasonable to suppose that others await development on the same line of lode. There is at least one known shoot of payable ore in another lode in these workings, which is now ready for stoping. Besides these, there are several other lodes on the property on which a little work has been done, and in some cases with most encouraging results.

I think, therefore, that the property is well worth a fair trial, and that it has every reasonable prospect of becoming a valuable mine.

Section 221M, W. Fisher and G. Smith.

This section is situated at the head of the St. Clair River. There are several quartz-tourmaline reefs running through the section, on which some trenching has been done. In the eastern portion of the section there are three veins of very promising appearance, striking north and south, and dipping vertically. Of these, the most westerly is 15 inches wide, with from 6 inches to 9 inches of green tourmaline stone, rich in tin. About 10 feet to the east of this there are two others of the same character, each about 12 inches in width, with about 6 inches of rich stone in the centre. I took a bulk sample of the good stone from these three veins, which gave the satisfactory return of 9·5 per cent. metallic tin.

A tunnel has been started to cut the veins at a moderate depth, and since my visit this has been continued, and is now within about 40 feet of the lode. This is a very promising prospecting show.

Section 3843-93M, 80 Acres.

This section is situated near the coast, just north of Granite Creek. Mr. G. Smith kindly accompanied me over the ground. There is a small lode on the section, which has yielded some rich tinstone. The vein strikes 60° W. of N., dipping to the south-west at a high angle. At the surface it is about 6 inches wide, but at the bottom of a prospecting shaft 20 feet deep, it is said to be 2 feet 6 inches from wall to wall; 28 cwts. of ore, containing 23½ per cent. of metallic tin, and 3 cwts., containing 72 per cent., were obtained from this shaft. The top of the shaft was boarded over, and covered with mullock, at the time of my visit, so I could not examine the lode below the surface. A good deal of alluvial tin has been obtained in the vicinity.

The Peripatetic Mine.

Section 5157-93M, 10 acres, charted in the name of G. Smith. This section is situated in the north-western portion of the Heemskirk field. It is a mine which, in the old days, was held in high repute, but, like some other good mines in the district, was abandoned when the boom which was the cause of so much extravagance collapsed. The company owned a stamp battery and concentrator, but I learn from Mr. Con. Curtain, Inspector of Mines at Mount Lyell, who was the then mining manager, that very little stone was crushed. The old mistake was made of erecting the battery and concentrator before developing the mine, and without making provision for unfortunate contingencies, which are almost inseparable from a mining venture of this kind in a new district. From information kindly supplied to me by Mr. Curtain, I conclude that the plant was so inefficient, the consequent loss in dressing the fine tin (aggravated by want of skilled labour) so great, that only the richest ore would pay for treatment, and, under these circumstances, with tin at a very low price, the mine could not pay for its own development, and for want of further capital had to close down. Mr. Curtain tells me that he still has faith in the mine, and that twice since the mine was abandoned he has himself taken up the ground, and tried to get capital into it; unfortunately, without success. Such is in outline the history of the mine about to be described.

Plate III. gives a topographical sketch-map of a portion of the section. The mine workings are situated on the eastern slope of a low spur which separates two small creeks. The surface rubble of the eastern slope of this spur proved to be rich in tin, and some of this has been worked by the present owner of the mine, with satisfactory results. The tin is both coarse and fine, the coarse-grained pieces being often beautifully crystallised. Great difficulty was experienced in saving the fine tin in the streaming-box, and no doubt a large proportion of this was lost.

The underground work has demonstrated the presence of, at least, one tin-bearing vein, striking about 40° E. of N., and dipping towards the north-west. Both the granite in which this vein occurs and the vein-matter itself are much decomposed, and it is often not an easy matter to distinguish between them. Where the tin is richest the matrix consists of a soft iron-stained kaolinic substance, which I think is derived from the decomposition of pinitoid and felspar. I think, therefore, that in depth the vein will turn out to be one of the pinitoid type, but it is too soon yet to speak with

certainty. Where I could observe it, the vein has no walls; the decomposed vein-matter simply passes over into the decomposed granite. In one portion of the mine, at least, the granite is not normal. It is fine in the grain, and contains quartz-tourmaline nodules in abundance. In general character it approaches an aplite. On the beach, to the west of the mine, I observed a rock of similar texture, also with quartz-tourmaline nodules, occurring as a distinct dyke in the coarse-grained granite, and I think it is likely that this rock is also a dyke. The rock is one which should be carefully studied, because, as will be seen later, it has to some extent been impregnated with tin ore from the vein.

No. 1 tunnel was started almost from creek-level, on a course of N. 30° E. A fall of earth prevented my making an examination of the workings. It appears that the lode was cut about 75 feet from the mouth of the tunnel, and driven on for 45 feet. At this point a winze was sunk on the lode for a distance of 33 feet. Mr. G. Smith tells me that about seven years ago he bailed out this winze, and found that the lode was 4 feet in width, and contained a seam of almost solid ore 4 inches in thickness, the remainder being decomposed vein-matter, containing fine tin in payable quantities. Mr. Curtain informs me that the rich ore is very patchy, no less than three makes having been encountered in 33 feet. Below water-level there is a good deal of pyrites present, which probably accounts for much of the difficulty experienced by the old company in treating the ore. No provision was made in those days for roasting, and, in consequence, where pyrites occurred, the lode was considered to be unworkable.

No. 2 tunnel was started about 10 feet (vertically) above No. 1. The lode was cut 30 feet from the entrance, and some ground to the north of it was stoped out and crushed. There is pyrites in the ore, which no doubt gave the company much trouble. The stopes are open and untimbered, and could not be properly examined.

In No. 3 tunnel the lode was cut close to the entrance; it is here 7 feet wide, and consists of decomposed iron-stained kaolinic matter, carrying fair tin. A bulk sample taken by me from the whole of the lode-matter exposed returned 2·5 per cent. metallic tin. A little further in, a second, somewhat irregular, vein was cut, which carries rich tin in patches. A bulk sample across 2 feet of lode-matter yielded 2 per cent. metallic tin. This tunnel continues in the coarse-grained aplite already mentioned, containing abundant quartz-tourmaline nodules, but is blocked up 42 feet

from the entrance by a fall of earth. Up to this point the rock all contains fine tin ore, distributed through it. A large bulk sample, taken outside the veins for a total distance of 30 feet, yielded 0·93 per cent. of metallic tin. With the object of ascertaining the distribution of the tin ore, the following selected samples were taken:—(1) A sample of the quartz-tourmaline nodules; this yielded 0·4 per cent. of metallic tin, or approximately the same as that obtained from these nodules in other parts of the field. (2) White decomposed aplite, or fine-grained granite, which yielded 0·8 per cent. metallic tin. (3) Decomposed aplite, or fine-grained granite, slightly stained with iron-oxide, which yielded 1·6 per cent. of metallic tin. I think these results practically demonstrate that the tin has been derived as an impregnation from the veins. Had the tin been an original constituent of the aplite, we should have expected it to have been concentrated, more or less, in the quartz-tourmaline nodules; the opposite, however, is the case. The nodules contain their normal percentage of tin, while the aplite contains an abnormal amount. The fact that the iron-stained aplite contains a higher percentage than the white aplite, may be accounted for on the assumption that the former has been more affected by the impregnating solutions than the latter, and that, besides more tin, perhaps a little pyrites, or some other iron mineral, has been deposited. Perhaps, also, the cause of the impregnation may be found in the structure of the aplite. Aplites frequently contain numerous minute spaces, known as miarolitic cavities; and assuming that to be so in the case of this aplite, we may readily imagine that the rock would lend itself to impregnation by the stanniferous vapours arising along the vein-channel. Whether this is the case or not, the fact remains that this rock has been impregnated to a much greater extent than the surrounding granite. I tested the granite in other parts of the mine, but nowhere did I obtain more than $\frac{1}{4}$ per cent. metallic tin.

The bulk samples taken in this mine are, I believe, reliable so far as they go, the nature of the stone permitting a large sample to be easily taken. In each case, from 40 to 80 lbs. of stone was broken, and carefully quartered down. The results, I believe, are satisfactory, and demonstrate the presence of a large formation, carrying tin in payable quantities. The bulk sample from the aplite is, of course, low, but still, considering the extent of the formation, it should be payable; and it must be remembered that this sample is exclusive of the richer stone contained in the veins. If

this be included, we get, as an average of all the stone exposed in the first 39 feet of tunnel, 1·26 per cent. metallic tin. In depth we may expect the tin contents to decrease somewhat, as, owing to the decomposition of the granite, and the consequent removal of a portion of the felspar, the tin becomes to some extent concentrated near the surface. This cause affects the tin contents of the vein-matter to a greater extent than the aplite, because the former is more decomposed; but, on the other hand, none of the rich patches of solid tin ore which were met with in No. 1 tunnel, and the winze below that tunnel, are included in the samples, so that these rich patches may to some extent make up for any decrease in the amount of the finely disseminated tin.

It is impossible to estimate the extent of the tin-bearing aplite at the present time. It is not cut in either of the tunnels further north, and I think it may be a flat dyke dipping to the north, and, therefore, underneath the northern workings. This theory is strengthened by the fact that flat dykes of a similar nature occur on the coast-line to the west of the mine, where a good section is exposed. It is also possible that it is merely a mass produced by segregation in the granite magma. The point can only be definitely decided by underground work.

No. 4 tunnel was started from a small surface-stope, which was made by Mr. G. Smith, on the second vein of tinstone met with in No. 3 tunnel. The stone was thoroughly decomposed, and was treated in a sluice-box. Mr. Smith tells me, however, that the tin ore was so fine that he only succeeded in saving a small proportion. I took a sample from some of the better-class stone exposed, which yielded 4 per cent. of metallic tin. The tunnel is driven through decomposed granite, which contains a little tin. Two samples taken by me along the tunnel from the first 22 feet and the second 22 feet yielded 0·25 and 0·2 per cent. of tin-oxide respectively, showing that, although the granite has been to some extent impregnated with tin ore, this has not taken place to such an extent as in the aplite.

No. 5 tunnel was driven along a flat quartz-tourmaline vein of unfavourable appearance, dipping towards the east. The granite here also contains a very small percentage of tin. This tunnel is too far west to have cut either of the lode formations exposed in the other workings.

I believe the Peripatetic Mine is a thoroughly genuine prospecting show. It presents two propositions, both of which appear to me to be very promising. In the first place, there is the lode, which, so far as I can learn, is pay-

able as far as it has been developed; and, in the second place, there is the impregnation of ore in the aplite, also payable as far as exposed. Further developmental work is, of course, required before the value of the mine can definitely be demonstrated; but, as far as surface indications go, I consider them to be most encouraging. It is to be hoped that, in the event of a mining company being formed, it will not follow the example of so many mines in the district, and erect machinery before testing its mine. Developmental work must precede the erection of machinery; any other course must end in failure.

The Persic Mine.

Section 233M, 40 acres, charted in the names of W. Rodd and D. Sullivan. This section is situated on the St. Dizier Creek, at North Heemskirk. There is a small vein of green tourmaline on this section, striking about 30° W. of N., which carries good tin, and has shed a fair quantity into the rubble at its outcrop. Much of the tin contained in the rubble is in the form of coarse nuggets, and these have also been obtained from a small creek in the vicinity, which has been worked for tin. I think the vein is hardly large enough where exposed to warrant much expenditure, but it would be worth while sinking a prospecting shaft a short distance, to ascertain if any improvement takes place. Some more surface trenching should also be done, to locate any larger veins of the same character which may be present. There is a good deal of tourmaline aplite on the section, some of which is exceptionally rich in tourmaline nodules. These all contain some tin, and I think it would be worth while taking a bulk sample to ascertain if it is present in payable quantities; with the large quantities of stone present, a small percentage would pay.

Wilson and Brampton's Sections.

Sections 178M and 179M, each 40 acres. These are situated north and adjoining the Persic. Near the south-east corner of Section 179M a prospecting shaft has been sunk on a small quartz-tourmaline vein, from which some rich samples of tin have been obtained. The tip has been industriously picked over, and the best of the stone crushed by hand and dollied. I fear that this vein, where exposed, is too small to warrant sinking operations being undertaken.

and I can only recommend surface work. This should be carried out both along the strike of the vein, in order to ascertain if it increases in size, and at right angles thereto, in order to cut any parallel veins which may occur. By testing the subsoil for detrital tin, with small pot-holes, at short intervals, the outcrops of any workable tin-bearing veins could be most readily located. The contact of the granite and slate country is met with in the northern portion of these sections, and it would be worth while doing some prospecting along this line of country.

Sections 166M and 167M.

These two 80-acre sections are situated at North Heemskirk, west and adjoining the St. Dizier Mine. They are charted in the names of W. L. Calder and J. T. M'Donald, and W. Ryan and J. T. M'Donald respectively. The country-rock is composed of slate, but the granite contact is not far off to the south. I think there is reason to believe that the granite is underfoot at no great depth. An east and west lode runs through the sections, the gossan capping of which outcrops at several points. At about the centre of the section two prospect-shafts have been sunk on the lode. and have revealed the presence of rich copper ore. One of these shafts was bailed out for me to inspect. The lode formation extends across the full width of the shaft, about 8 feet, neither wall having been encountered. The north end of the shaft is in a yellowish clayey formation, containing no mineral matter. South of this is a yellow-and-black pug formation, 3 feet wide, and containing much arsenical pyrites; then follows a seam of black pug, containing a good deal of pulverulent chalcocite, or copper sulphide. This is 9 inches wide on the east side of the shaft, and 22 inches wide on the west side.

A bulk sample from this formation, taken by me from both sides of the shaft, yielded—gold, trace; silver, 2 ozs. per ton; copper, 11 per cent. To the south of this formation there is another band of yellow clayey matter, and beyond that again the southern end of the shaft is in greyish-black pug. Only one of the bands is at all rich in copper, samples taken from the others only yielding from 0·2 to 1·3 per cent. Mr. W. L. Calder has kindly furnished me with the results of a number of additional assays, which have been made from the rich seam. These range from 16 to 19 per

cent. copper, and from 6 to 9 ozs. of silver per ton. The following analysis of a sample from half a bag of ore was made at the Mt. Lyell M. and R. Co.'s Laboratory:—

Silver, 6·8 ozs. per ton.
Gold, trace.
Copper, 17·6 per cent.
Silica, 9·6 per cent.
Iron, 21·0 per cent.
Alumina, 6·8 per cent.
Zinc, 8·0 per cent.
Sulphur, 30·55 per cent.
Arsenic, 1·55 per cent.
Bismuth, *nil*.

The lode is, of course, thoroughly decomposed so far as it has been exposed. The proximity of the lode to the granite, and the presence of arsenical pyrites in the ore, both suggest the probability of its being connected with the tin lodes. In Cornwall many of the tin lodes were worked for copper in the upper levels, and I think it most probable that this will develop into a tin lode in depth. The rich copper ore found in the prospecting shaft is, of course, of secondary origin. It is due to the precipitation of copper sulphide from solutions of copper sulphate, which have been derived from the decomposition of yellow copper pyrites. Many copper mines contain a zone of these rich copper ores at water-level, and for some distance below it. In the case under review the extent of the rich zone might be ascertained by a series of trenches and prospect-shafts sunk along the outcrop of the lode.

Unfortunately, the section is not favourably situated as regards access to the market. At present the mine can only be reached by means of a pack-track from Zeehan, some 12 miles in length, and it can hardly be expected that copper ores will be found sufficiently rich to pay for transportation under these conditions. The position resolves itself, therefore, into this, that unless the prospects of the mine are good enough to warrant the construction of a tram, or light railway, connecting the mine with the Government system of railways, it can hardly become payable. I need not say that, before this can be determined, a large amount of developmental work must be done. There is, however, no necessity for incurring a large expenditure at once. A comparatively small amount of work in trenching and sinking prospecting-shafts will prove whether the mine is worth developing on a large scale.

STUDDART'S MINE.

Sections 5082 and 5065-93M, each 80 acres. This mine is situated to the west of the Heemskirk River, about three-quarters of a mile from where that river joins the Pieman. The country consists of slates and sandstones, the contact of the granite being distant some three miles to the west of the mine. A tin-bearing vein has been traced for a long distance through these sections, striking N. 70° E., and I am informed that several others have been found on the sections. I believe these lodes to be normal stanniferous quartz-tourmaline veins, differing from those which traverse the granite only in that the rock that has undergone replacement is laminated and argillaceous, not granular and felspathic. The vein-rock is composed of quartz and tourmalinised slate, in wavy, curly bands, representing the original laminæ of the sedimentary rock, which have been contorted along the planes of the fault-fissure. Exactly similar veins may be seen on the Gentle Annie Rise, and at South Agnew, in the vicinity of Mayne's Mine. Unfortunately, no one was at the mine at the time of my visit, and, in consequence, I was not shown the spots where tin ore in payable quantities exists. I am, however, informed that there are several lodes carrying good tin at the surface. The prospects were so encouraging that a small syndicate was formed some years ago, consisting of 12 shareholders, half of whom paid in and the other half worked. This party drove a tunnel about 360 feet in length, and cut what is believed to be the main lode, 120 feet below its outcrop. At this point the vein is very small, and contains only a little tin; it was driven on east and west for a total distance of 80 feet without showing any improvement.

Subsequently, Messrs. Studdart took the claim up, and erected a ten-head battery on the opposite side of the Heemskirk River, connecting the battery with the tunnel by means of an aerial tram. A little stone appears to have been sledged from the trenches and shafts at the outcrop of the lode, but I have not been able to obtain particulars as to the results. I fear the party showed more energy than discretion in erecting a battery on the mine as it stands. Granting that there is good ore at the outcrop, and that there is every reason to believe that it will line down, the fact remains that there is none available for treatment, and until it is available the battery is of no use. Had the money which was spent in erecting the battery been spent in developing the mine, a shoot of ore might have been dis-

covered which would have converted a prospecting show into a valuable mine. The mine has not yet had a fair trial. That the lode was poor where cut goes for nothing, since all lodes are poor in parts. If it is true that the lodes contain payable stone at the surface, and considering the faith which these parties of practical miners have had in their mine this certainly appears to be the case, then it is worth while looking for in depth. The tinstone at the surface is hard and undecomposed; consequently, it has not been enriched by surface-action. We may, therefore, expect that it will be equally rich when cut at a depth. I should recommend a careful examination of the surface-workings; if these are satisfactory, then the mine is well worth developing.

ALLUVIAL TIN MINING.

Section 240M.

This is a 25-acre section, charted in the name of J. J. Darby and J. Connor. It is situated to the south of J. M. Mayne's Section 124M, a small strip of land intervening. Pyke's Creek flows through the section with a tortuous course, and along this creek there are a number of small flats, which may be expected to contain a large amount of wash. The largest of these flats, situated about half-way through the section, has been prospected by a number of holes; but as the ground was only held under prospector's licence up to the time of my visit, the precaution had been taken to fill in the wash, after it had been examined, so that I had no opportunity to test its quality. Mr. Connor tells me that the wash goes up to 7 feet in depth, the best prospects obtained going as high as 3 or 4 lbs. to the dish. From the results obtained he estimates that there will be an average of 4 feet of wash, carrying 1 oz. of tin to the shovel. At the time of my visit a tail-race was being brought up to work this ground, through a small flat below the one that has been prospected. In cutting this a little wash was taken out, from which several prospects were washed in my presence. These yielded from ¼ lb. to 1 lb. of coarse water-worn tin ore to the dish.

This section is situated just below the recent discovery of rich ore on Mr. J. Mayne's section, and, as there are no extensive flats between this section and the spur which has shed the tin, it is reasonable to suppose that a large amount of tin must have been brought down by the creek, and deposited here. I believe this section is a very valuable one.

Section 191M.

This is a section of 34 acres, charted in the name of E. Swenson. It is situated at the lower end of Pyke's Creek, close to its junction with the Little Henty River. From Darby and Connor's section the creek falls rapidly for about half a mile, when it passes over an extensive flat for 10 or 15 chains before joining the larger river. This flat is included in Swenson's section. No prospecting had been done at the time of my visit, but the section is likely to be a valuable one, as most of the tin which passes Darby and Connor's section must lodge here. Plenty of water at a high pressure is available for the processes of hydraulic mining, and, as there is probably a large amount of wash, it could be profitably worked, even if it proved to be low-grade. I think the prospects of this section turning out a good one are excellent.

Section 212M, A. Tengdahl.

This is a five-acre section, situated on the Cumberland Creek, at the base of the hill below the dam. Above the section the creek flows for about a quarter of a mile below the ground. The cause of this is instructive. The granite has weathered for some distance below the surface, leaving great boulders of undecomposed rock as hard kernels in the otherwise completely decomposed granite. The creek has cut down its channel into the soft rock, sluicing away the fine detritus, and permitting the solid kernels to come together. These eventually formed a massive covering over the water-channel, and on the surface became covered up with soil and vegetation. During its underground passage the creek falls rapidly, so that it is possible that the channel may be in places some hundreds of feet below the present surface.

When the creek emerges from its underground channel it passes over the flat button-grass country to the south of Mt. Agnew, and for the first quarter of a mile it has been worked for alluvial tin with satisfactory results. Mr. A. Goldstraw, who kindly accompanied me over the section, informed me that this work was done some years ago by Mr. A. Tengdahl. He found that the tin increased in richness going up the creek until the latter disappeared underground. He also discovered the fact that during flood-time considerable quantities of tin were brought down by the creek from some reservoir underground. The proposition, therefore, suggested itself, as to whether it would not be possible to

follow up the bed of the creek along its underground channel. Mr. Tengdahl determined to make the attempt.

He first diverted the water in the creek by cutting a water-channel across a low saddle at the top of the hill, near the dam. By means of this channel the by-wash from the dam could be diverted at will into Pyke's Creek to the east. Having got rid of the water, he began to cut a tail-race up the bed of the creek, between the boulders. This he succeeded in doing for a considerable distance, though he did not carry on long enough to get actually underground. While he was carrying out this work he met with numerous rich patches of alluvial tin ore in the crevices between the boulders, and by putting a number of large ripples across his race he succeeded in catching a good deal of tin, which was washed out from the underground channel ahead, during periods of flood. This work was all done when tin was at a low price, and presumably it did not pay, as the section has been vacant for several years. Since the price of tin has gone up, Mr. Tengdahl has taken up the ground again, and I presume he intends to give it a further trial.

The proposition is a peculiar and certainly a very novel one. The chances of finding rich and valuable deposits of ore in the larger crevices and cavities underground are decidedly good. It is not quite certain at present whether the tin is derived from lodes which cross the underground channel, or from tin originally distributed through the granite, but, from the character of a small sample of tin which was washed for me, I am strongly inclined to the former theory. The possibility, therefore, of finding a payable lode forms an additional inducement to give the mine a further trial.

There is a big element of speculation in the proposition, but it is a thoroughly genuine one.

Section 272M, J. C. Climie.

This is a 20-acre section, situated on the Agnew Creek. A large quantity of tin has been won from this creek in the past, and at the time of my visit there were two parties who were working the creek gravels below the section. On the section itself the bed of the creek has been worked many years ago, but the gravels on the flat have been left untouched. These have now been well prospected, and Mr. Climie tells me that he has obtained very encouraging prospects, the wash going up to several ounces to the dish. A tail-race was being cut, and preparations being made to start

sluicing. Mr. Climie also informs me that he has reason to believe that the lode which shed the tin will be located on his section.

Flaherty's Claim.

Messrs. Flaherty Bros. and party are working a nice lead of tin on the button-grass country to the south-west of Mt. Agnew. When I visited the claim there were 15 inches of wash covered by 3 or 4 feet of overburden. A dish washed in my presence gave about 4 ozs. of slightly water-worn grey tin ore. There are six men in the party, and they appear to be doing well.

Alluvial Workings at the Heemskirk River.

Mr. Owen Meredith and mate are working a small flat on a tributary of the Heemskirk River for alluvial tin. The wash is from 12 to 18 inches deep, and contains a fair prospect of tin, but, unfortunately, there is a large quantity of chromite with it, which is found difficult to separate. Fortunately, most of the tin is coarser than the chromite, and a large proportion of it can be won by simply screening it off. The mesh which was being used at the time of my visit was 12 holes to the running inch, but since then a finer mesh has been used with advantage. Mr. J. G. A. Stitt assayed a sample of the screenings from the 12-mesh screen, and found it contained no less than 22 per cent. of tin-oxide. A sample which Mr. Meredith sent to me, however, was by no means so rich. A little ore was separated by putting the sample through a 20-mesh screen, and the screenings from this, which were assayed by Mr. W. S. Watt, of the Zeehan School of Mines, were found to contain only 1·5 per cent. of metallic tin, or a little over 2 per cent. of oxide. There is no doubt that, in this case, there was a great difference in the original tin-contents of the two samples, but I believe some of the difference was due to the fact that the sample tested by Mr. Watt had been put through a finer screen. If the sample forwarded to me by Mr. Meredith may be taken as a representative one of the screenings, then the tin can be nearly all separated from the chromite by using a 20-mesh screen. The tin ore will still contain some chromite, but not sufficient, I think, to seriously depreciate the value of the ore. Mr. J. Earle is working another flat on the banks of the Heemskirk River, and his tin is also mixed with chromite.

THE ST. DIZIER MINE.

Sections 1615, 1658, and 1438—91M; each ten acres. This old alluvial mine has been worked with more or less success for many years. I learn from the valuable articles on West Coast history which appeared in the *Zeehan and Dundas Herald*, 1896, that this ground was comprised in the first mineral section which was taken up on the Heemskirk field tin being discovered on the ground by Mr. Owen Meredith, in 1876. The extensive shallow gravels along the St. Dizier Creek have been nearly worked out, but there remains a deep lead, which may yet afford a large amount of tin. A portion of this lead has already been worked, and now Messrs. Brampton and Wilson, who have held the mine on tribute for the last twelve months, are determined to further explore it.

Plate IV. gives a sketch-map of the workings already carried out on this lead. A long tail-race has been cut from the Tasman River into the deep ground, and in this a very curious section is exposed. The lower end of the tail-race is all in granite. At point A on the plan it enters sandy clay shales, containing in parts a good deal of brown oxide of iron and a little pyrites. The shales strike 30°E. of N., and dip to the south-east at an angle of 60°. Beyond these shales sandy clays are passed through, and then at point B a seam of black quartz-wash, containing lignite and some tin-oxide, is exposed. The seam is seen on both sides of the cutting, and is probably conformable with the shales first met with. Beyond the wash the cutting, which is now about 15 or 20 feet deep, passes through grey decomposed basalt, showing the remains of columnar structure and spheroidal weathering for a distance of 150 feet, when the wash is again seen on both sides of the cutting at points C and D. At this place, however, the outcrop of the wash does not appear to have crossed the cutting, as at point B. At C, on the northern slope of the cutting, the seam strikes a little to the south of east, dipping to the south at about 30°; but at D, the seam (which is only 2 or 3 inches thick at this point) dips towards the north or north-west at a very steep angle. This thin seam occurs between the basalt and the granite. From here up to the face of the cutting at its eastern end the south slope is composed of decayed granite, with the exception of one small patch of wash which has been left standing at point E. This seam strikes about east and west, and dips steeply to the north. In the face it is again seen, still dipping to the north, but not so steeply. On the north side of the cutting, between C and F, the slope is composed

of sandy clays, probably the same as those passed through to the west of point B. At F the wash again appears, dipping steeply towards the south. On its hanging-wall basalt again appears, and after that shales and clays, containing lignitised wood, and old tree-stumps in great abundance. In the rubbish heaps which are piled along the sides of the cutting I noticed numerous lumps of opaline and jasperoid rock, as well as masses of hard silicified shale, and even white quartz. These appear to have been found in irregular masses in the lead, and as some of them are certainly silicified clays and shales, they must have been formed *in sitû* in the lead. The decayed felspar of the basalt suggests itself as a possible source of the silica. To the east of the cutting on the St. Dizier Creek Flat there are rather extensive alluvial workings, and Mr. Brampton pointed me out two outcrops of wash, marked H and K, which appear to be a continuation of the seam exposed in the cutting.

These are the facts so far as I could learn them. The ground was not worked by the present party of tributors, so they could give me little information about the ground that has been taken out. In most places only the rock at the top of the cutting could be observed, owing to the rubbish having been piled up along the sides of the race. It appears evident from what was observed, however, that a great deal of movement has taken place since the beds of shale and wash were deposited. In many places the beds of wash are almost vertical, and the whole formation appears to be very irregular. The bed of wash exposed on the south side of the cutting, at points D, E, and G, appears to be the same as that exposed on the north side, at points B, C, and F; but the former is dipping to the north, while the latter is dipping to the south. It, therefore, appears that we have to deal with a synclinal folding of the beds, possibly also accompanied by faulting. What the cause of this movement was it is difficult to say; probably it was in some way connected with the volcanic disturbances which gave rise to the basaltic flow.

I have sketched in on the plan what appears to be the most probable course of the lead. To the east of the cutting I think there is very little doubt about the matter. There is a well-marked depression in the surface along here, with the granite outcropping on either side, and the beds themselves are exposed on the old alluvial workings on the St. Dizier Creek Flat. Beyond this point the old lead must have come from the south, approximately following for some distance the present course of St. Dizier Creek. There is

an outcrop of quartz and opal near the huts, some distance further south, which I believe to be connected with the lead. To the west of the workings, however, the position of the lead is more doubtful. I have sketched in what I believe to be the only possible position of the lead in this direction; that is, if it is not found to be approximately where I have marked it on the plan, I should accept the fact as evidence that it had been raised above the present level of the surface by faulting, and removed by denudations. I think, however, that the first portion, at least, will be found to be correctly placed. On the plan I have marked the position of a quartz and opal blow to the south-west of the cutting. I believe this marks the outcrop of the lead, as we find similar quartz and opal along the lead in other places. As far, therefore, as the small creek to the south-west of the workings, I think the position of the lead is correctly charted. Beyond this I have only been guided by some wash which I found on the steep bank of the Tasman River, at the sharp bend to the south of the tail-race. The scrub was very thick here, and I could not examine the formation closely, but I think it may very possibly be a portion of the old lead.

A short tunnel has recently been made along the seam of wash from the face of the cutting. The seam is about 18 inches in thickness, and is dipping at an angle of about 30° to the north-west. A dish washed in my presence yielded nearly ½ lb. of tin ore, but Mr. Brampton tells me that it is rather patchy. The seam has pinched in the face, and the tin-contents are also not so good. Messrs. Brampton and Wilson propose to drive a tunnel from the Tasman River, as shown on the plan, which will come in 15 feet lower than the present drive. This will very likely cut the bottom of the syncline, and, in that case, will open up a large amount of ground which is likely to carry good tin. The deep wash will, however, have to be stoped out, and it remains to be proved whether the tin-contents will bear the cost of mining. Unfortunately, mining timber is an expensive item in the locality. I think, however, the venture is well worth trying. The tunnel will effectually prospect the lead, and at least the richer portions will probably pay to take out. I think also that some attempt should be made to pick up the western extension of the lead. If it could be located on the banks of the Tasman River, it could be worked back in a face from that point. It is, however, likely to be narrow at this point, and not highly stanniferous. Perhaps the most likely point to pick up the lead would be where it crosses the small creek to the south-west or west of the quartz-opal blow. A few trenches, and perhaps a prospect-shaft, would

soon prove this part of the ground; and, if located here, and provided it was not too deep, it might be worked by a tail-race joining the old one at the bend to the west of point A.

Messrs. Brampton and Wilson are working miners, who have to pay their way as they go; they have shown great pluck in the way they have gone to work, and deserve every success.

I must also mention a very curious tin-bearing formation which has lately been discovered on this property. It consists of a large lode of magnetite, and some arsenical pyrites, with steatite and a green partly-decomposed mineral somewhat resembling chlorite. Some of the magnetite contains small irregular seams of grey tin-oxide running through it. A sample of the stone, assayed by Mr. A. D. Wilson at the Zeehan School of Mines, yielded 3 per cent. of tin. I tried a sample myself, qualitatively, and confirmed the fact that tin is present in the stone. Some of the rubble from the top of this lode yields very good prospects of grey tin. This lode belongs to a type which I have not yet described. They are very abundant in all the country immediately surrounding the granite of this district, and I believe them to be the same as those which are known among geologists as "contact deposits of the Kristiania type." They will be described in detail in a future report. The discovery of tin ore with the magnetite is extremely interesting, apart from any economic importance which it may possess. The formation is a large one, and should be opened up. It is, however, so unique that I can express no opinion at present as to its prospects of turning out a valuable deposit.

In conclusion, I wish to express my gratitude for the many kindnesses which I received during my visit to the district at the hands of prospectors and all with whom I came in contact; also to several gentlemen who were acquainted with the district in the old days, and who have done all in their power to supply me with information.

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

GEORGE A. WALLER,
Assistant Government Geologist.

W. H. WALLACE, ESQ.,
Secretary for Mines, Hobart.

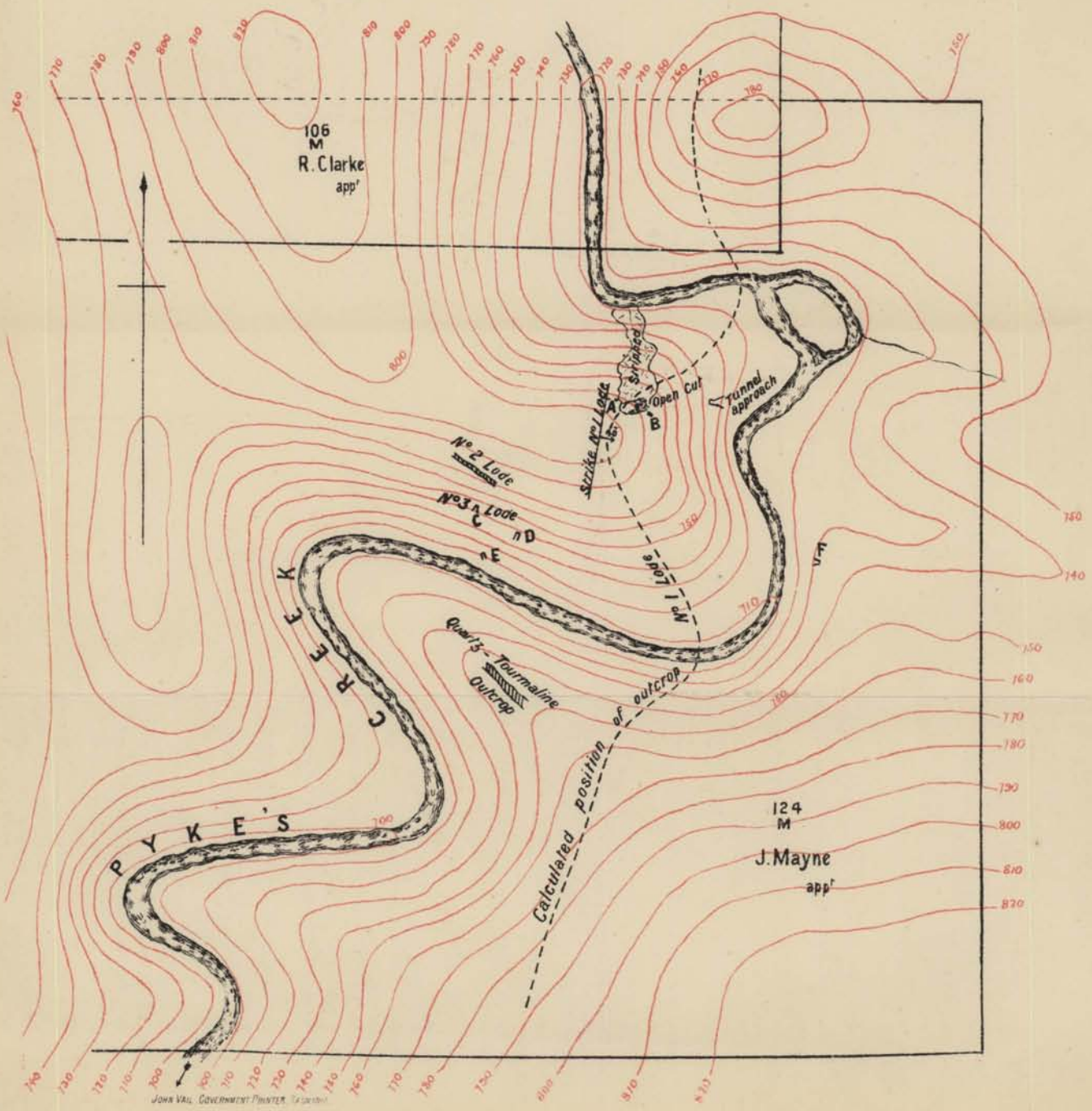
JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.

PLATE I

SKETCH PLAN
OF
Mr JOHN MAYNE'S MINE
SCALE OF FEET

5 cm

C. A. Watkins
Asst. Govt Geologist
5.9.02



JOHN VAIL, GOVERNMENT PRINTER, TASMANIA

47/58

PLATE 2

SKETCH PLAN OF FEDERATION TIN MINE

5 cm

SCALE OF FEET

G. A. Waller
Asst. Govt. Geologist
5.9.01.

REFERENCE

Quartz-tourmaline outcrops shown thus

Adit Level numbers denote depth below Munro's Shaft

Trench
Prospecting Shaft
HORSE
TRAM
3688 93M
WESTERN WORKINGS
Prospecting Adit
450' Level
500' Level
550' Level
Shaft
CENTRAL WORKINGS
Open Cut
Munro's Shaft
The Black Face
Underlay Shaft
Air Shaft
Long Tunnel
3919 93M
EASTERN WORKINGS
4143 93M
ORE DRESSING MILL
SELF ACTING TRAM
3689 95M
The Line
Water race
CUMBERLAND DAM

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49/50

PLATE 3

5 cm

SKETCH PLAN

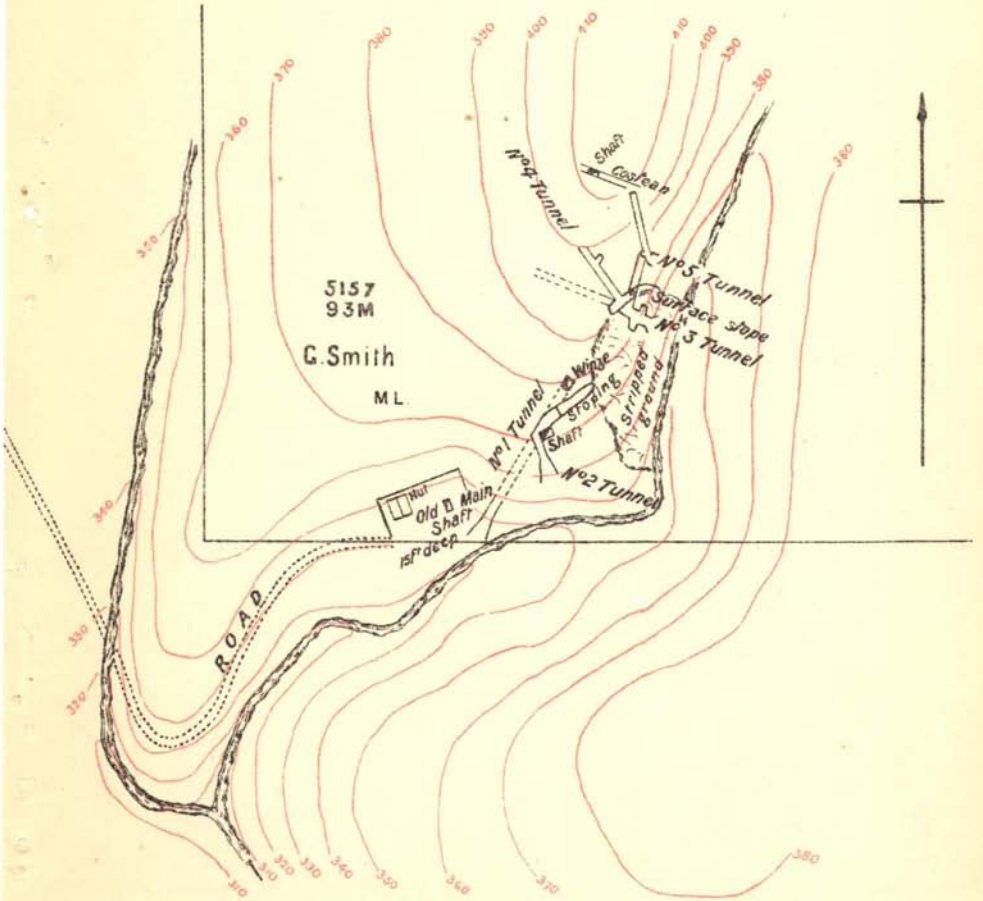
OF

THE PERIPATETIC MINE

SCALE OF FEET

0 50 100 150 200

G. A. Waller
Asst. Govt. Geologist
5. 9. 02



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50/50

PLATE 4.

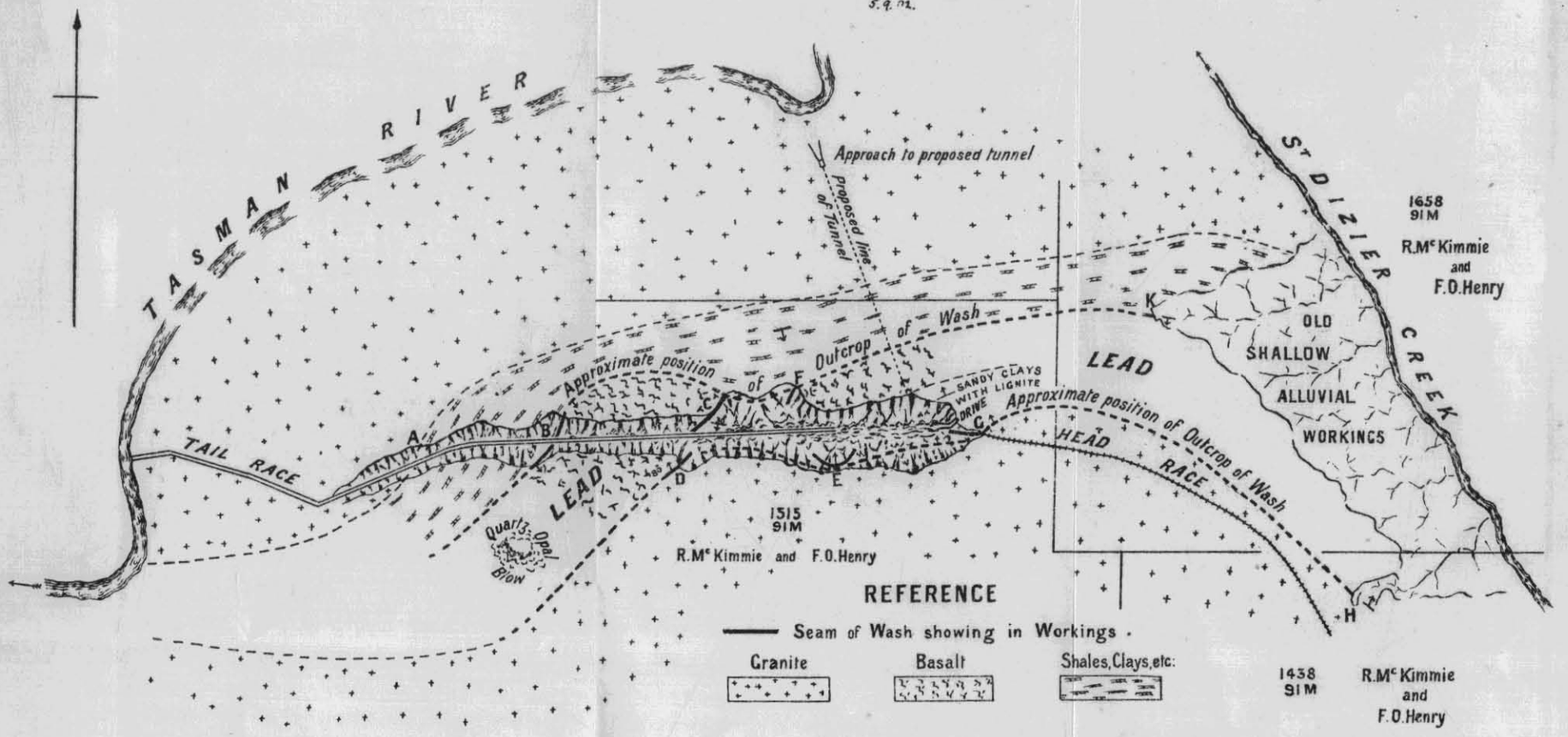
5 cm

SKETCH PLAN OF ST DIZIER DEEP LEAD

SCALE OF FEET

30 0 150 300

G. A. Waller
Asst. Govt. Geologist
S. G. N.Z.



REFERENCE

Seam of Wash showing in Workings.

Granite

Basalt

Shales, Clays, etc: