Another shaft a few chains east may have been the main shaft of the old company. The tip is of considerable size. The shaft itself is in disrepair. The quartz-tourmaline stone on the tip carries white mica, indicating that a vein of the greisen type has been intersected.

On the edge of the timber is another shaft, which shows pyritic quartz-tourmaline vein-stuff on the tip. An old road was constructed to this vicinity. To the east is rather low-lying swampy ground. About 3 chains to the north-west are some old alluvial workings. The area worked is about 2 chains by 1 chain. The wash appears to have been about 2 feet deep, and to have consisted of sub-angular quartz-tourmaline vein-stone, with abundant green tourmaline and occasional geodes of quartz crystals. On the southern edge of this worked patch (which discloses a granite bottom) is a bold quartz-tourmaline outcrop, which is promising for tin, and is worth sampling.

It will thus be seen that little information can be obtained from an examination of the old Orient workings, as they are at present, and no opinion can be expressed as to its future.

(20)—*Section* 3555M, 25 *Acres*.

This section is immediately to the south of Mayne's Mine (Section 124M), and was formerly known as Connor's Section. No work is being done on it at the present time, and the section is not held.

Pyke's Creek flows through the western portion of the section, and the bed of the creek was found to carry rich alluvial. This is not at all surprising when the nature of the occurrence at Mayne's Mine, a few chains to the north, is remembered. The tin won was quite similar to that at Mayne's, and there can be no doubt of its having been derived from the same deposits, and gradually washed down stream and concentrated by natural agencies. The deposits appear to have been detrital, rather than true alluvial, and of no great depth. Official records show that at least 8 tons of tin oxide were recovered, but the amount was probably greater than this, as for several quarters the whole output from the district was given in one figure, and was not allocated to the several mines which were working. Although these deposits have been worked out, the section is certainly worth prospecting, as conditions are favourable for deposits of tin ore, similar to those on Mayne's, being located. The country-rock is sandstone and slate of Pre-Silurian age, silicified and tourmalinised.

(21)—*Section* 1392M, 40 *Acres*. (*Wolfram-Bismuth Mine, south-east of Mayne's Tin Mine.*)

The exact position of these workings could not be located. They are about east-south-east from Mayne's Tin Mine, a distance of about ¾-mile. They are on the Little Henty fall, just above creek-level, on the south-western bank of a creek flowing about south-east. The mine is probably about in the northern portion of Section 1392M, 40 acres. The workings are in a state of disrepair, and no detailed examination of them was possible. A trench was cut for a length of between 60 and 70 feet, about 6 feet deep and 3 feet wide. This trench was covered with timber, and mullock and ore stacked on top. It is only partly accessible for examination. A shaft was sunk at the western end of the trench, but is now full of water. The depth is not known, but it is probably not very great. A few feet to the west of the shaft a small open-cut was put into the hillside, and after taking this in for a few feet, two small cuddies were driven from it, apparently only a few feet in. These are in a state of collapse, and the entrance only was available.

The country-rock is slate and sandstone of Pre-Silurian age, a good deal metamorphosed. To the north-west the sediments are silicified and tourmalinised. At the workings, lime-silicate rocks are abundantly developed, and although they form a fairly broad belt, and were traced down the creek for 2 chains, their extent could not be ascertained on account of the dense scrub. Reference is made to these rocks elsewhere.[229].

The trench is cut through hard, greenish tremolite rock, with magnetite and pyrrhotite. Traces of chalcopyrite are noticeable in places. The quartzose ore showing on the dump-heap on the surface does not appear to have been cut in the trench, and probably came from the shaft, which is quite inaccessible. Lenses of dense granular magnetite of small width have been cut in places. The limonite present in places indicates that pyrite is present, although it is not noticeable in hand specimens. The mineral is present in microscopical slides examined to determine the true nature of the lime-silicate rock.

In the entrance to one of the cuddies put in from the open-cut a few feet west of the shaft, a dense pyritic body, with quartz, has been cut. The width appears to be 2 feet, and the strike about north-east. Little information

(229) *Vide supra*, p. 129.

can be obtained owing to the collapse of the cuddy. Specimens of the pyrite collected oxidised very rapidly. Marcasite may be present with the pyrite, although none was seen.

A careful examination of the dump-heaps gave some indication of the reason for this work, which could not be determined from an examination of the workings available. Much of the material is lime-silicate rock, varying in colour from fine-grained to moderately coarsely crystalline, sometimes showing granular magnetite. Most of the material on the heaps has evidently been lying about for years, and shows signs of weathering.

A striking feature is the presence of fairly abundant fragments of quartz, almost invariably showing crystalline structure. Many of the pieces show massive fragments coated with projecting prismatic crystals, varying from almost microscopic size to about ⅓-inch in diameter. sometimes fragments are coated on two sides by such crystals, and may also contain small geodes within their mass. This has evidently been the "ore" worked, as metallic minerals occur associated with the crystalline quartz. Soft black masses representing decomposed pyrite are common, with occasionally fragments of the fresh mineral. Occasional crystals of wolframite are present, and the same mineral sometimes occurs in more massive form round the base of the quartz crystals. In some of the geodes, very fresh plates of bismuthinite (sulphide of bismuth) occur, always associated with wolframite. Although it might be expected to occur in such an association, no sign of any cassiterite was seen on the property.

An old puddler and sluice-box indicate that an attempt was made to treat some of the material on the spot. An examination of some of the material from the old box shows that wolframite is present.

The writer could obtain no information as to whether any concentrates had been sent out from the mine.

On the north-eastern side of the creek is a shaft a few feet deep on limonite and magnetite. This appears to be a contact-metamorphic deposit of iron ore, and does not present any very promising features as exposed.

A grab sample was taken from the heap on the surface, and submitted to the Government Assayer, Mr. W. D. Reid, for analysis, who reported:—

Tin	0·32 per cent.
Tungstic acid (WO_3) ...	0·105 per cent.
Bismuth	Trace

While this sample was not taken in bulk in such a way as to determine the true average value of the heaps, the result is useful as indicating the presence in material in which none of the ore-bearing minerals was noticeable, of tin, wolfram, and bismuth. The values are not very encouraging.

A sample was taken from the dense pyritic body west of the shaft and submitted to the Government Assayer, who reported:—

Tin	0·46 per cent.
Tungstic acid (WO_3) ...	0.047 per cent.
Bismuth	0·012 per cent.

Although these values are low, it should be worth while trying to trace the outcrop of this pyritic body for a short distance on the surface, expose it by trenches, and sample at other points, to determine whether shoots of richer ore do not occur.

Little can be said about the prospects of the property, as the ore was not seen *in situ*. Nothing can be said as to the width of the ore-body. The lime-silicate rocks, with magnetite and pyrrhotite, exposed in the trench, cannot be regarded as ore. The cassiterite, wolframite, and bismuthinite, with their accompanying crystalline quartz, appear to have been formed by pneumatolytic agencies, and are connected with the intrusion of the granite. The minerals are primary, and cannot be regarded as having been formed near the surface only, but would continue to depth. The question of treatment of tin-wolfram-bismuth ores appears to have been at least partially solved, and marketable products can be produced by subjecting the ore to electro-magnetic concentration. The presence of magnetite and pyrrhotite, however, both magnetic minerals, is to be noted, though these could probably be separated by a lower-power magnet. Under existing conditions there cannot be said to be much inducement to work the property, beyond a little surface prospecting, as recommended above.

(22)—*Section* 6743M, 80 *Acres—C. Brumby.* (*Healey and McIvor's Mine.*)

This section was formerly charted as 4393M, E. Healey, J. McIvor, C. Brumby, and O. J. Reiher, and was known as Healey and McIvor's Mine. It is on the southern slopes of the Heemskirk Range, and about 1 mile a little east of south from Mt. Agnew. The section is heavily timbered, and carries thick undergrowth, making a detailed examination difficult. The country-rock is granite, and the mine is situated about a mile from the line of contact.

Access to the property is given by the pack-track which branches off the main Trial Harbour-Zeehan Road on the flats near the Agnew Creek crossing, and continues through to the Federation Mine. This track enters the section at the south-eastern corner, and crosses and recrosses the southern boundary several times before bending south-west out of the section. The elevation of the point near the southern boundary where the ore chute crosses the pack-track, as determined by aneroid readings, is 1340 feet above sea-level. The northern portion of the section is considerably higher.

The steep slope of the surface offers facilities for economical working, which have been taken advantage of. The work carried out has been by open-cut, and adits driven into the hillside.

The lower adit, nearly 100 feet above the track, is inaccessible. The entrance was blocked, and the tunnel used as a dam for the storage of water. The adit was driven about north, and is said to have intersected a tin-bearing quartz-tourmaline vein, but to have been discontinued without being extended far enough to intersect the lode-material exposed higher up on the hill. This adit is within a few chains of the southern boundary of the section.

About 2 chains north of the lower adit are the main workings. There is an excavation connected with the surface by a short tunnel. This cut is about 35 feet long (north and south) by 6 feet wide at the bottom, and 50 feet by 40 feet at the surface. The depth is about 30 feet. The structure of the lode-formation which has been worked is not clear from the present excavation, but it would appear to have been a zone of granite impregnated with tourmaline and cassiterite, and probably pyrite, from several intersecting fissures. Fairly abundant kaolin is present, and the granite itself is altered and decomposed. These changes are probably due to the action of the mineralising solutions, and not merely to atmospheric weathering. A feature of the exposed faces is the presence of nodular masses of varying size. One of these, which was very well defined was oval in section, and measured 18 by 24 inches. It consisted of a rim of limon-

ite and gossanous material 4 inches in thickness, with a soft kernel of kaolin and tourmaline, carrying good tin values. There is much quartz-tourmaline stone on the tip, but only narrow veins appear *in situ*. The strike of what appears to be the main vein is N. 18° E. On either side of it are vughs with much limonite-stained kaolin and a little tourmaline, with crusts of hard limonite. Another vein strikes N. 75° E., and an examination of the exposed faces shows that the granite is traversed by a series of intersecting veinlets. In one narrow vein there was a well-defined central seam of soft kaolin, with tourmaline and cassiterite, bordered by normal hard quartz-tourmaline vein-rock. Fissures traverse the granite in various directions, some of which show slickensides, indicating that some movement has taken place.

A small drive was extended from the floor-level into the southern face, and another drive into the northern face of the cut, but these were both inaccessible.

It is reported that a large quartz-tourmaline outcrop occurred on the surface above where the main cut now is, that the company holding the property at the time sank a shaft between 25 and 30 feet on this, and drove about 10 feet east into granite. This shaft is said to have passed through soft tin-bearing gossan, as well as hard quartz-tourmaline stone. Tributers then drove the small tunnel and excavated the present cut. As mentioned below, the lower adit which was commenced by the company was not driven far enough to come below this cut. The quartz-tourmaline stone on the heap contains abundant green tourmaline in aggregates of very minute prismatic crystals. These sometimes occur projecting into miarolitic cavities, which are rather common in the stone. These cavities frequently contain clear crystals of quartz, which is also fairly abundant in glassy crystals throughout the mass of the stone. Doubly-terminated prisms of quartz are noticed in some of the cavities. Kaolin is frequently present in aggregates through the stone, and occasionally filling narrow veinlets. Irregular masses of limonite indicate that pyrite has been present in the unaltered stone. Much of the stone is traversed by narrow parallel fissures filled with minute needlelike prisms of dark-green tourmaline. Gossanous nodules are not uncommon on the heap.

Specimen pieces showing cassiterite indicate that it occurs in aggregates of very minute crystals of a light brown colour, frequently encrusting the sides of geodes. It is usually closely associated with green tourmaline, and sometimes with crystalline quartz.

Two chains west of the main cut is a small cut into dense green tourmaline. The width of the formation is not exposed. A little quartz is showing in places, and some specimens show a little fine tin oxide, but the bulk of the lode-material is soft, massive, green tourmaline.

About 50 feet further west is the western adit. This is, unfortunately, inaccessible, the workings being used as a reservoir by blocking the entrance and allowing water to accumulate. The adit is driven about north, and is said to be 150 feet in length. No crosscuts, winzes, or rises appear to have been carried out. It is reported that no granite was met with, the drive being in ore all the way, and that the quartz-tourmaline vein was cut through in all directions by flat and inclined veins from 1 to 4 inches in width, of soft kaolinised material rich in tin. On the tip is a considerable quantity of quartz-tourmaline stone. There is little variation in the stone exposed; it is hard, and comparatively fine-grained, consisting of about equal quantities of quartz and green tourmaline. The grains of quartz appear to be embedded in a groundmass of tourmaline. Occasional fragments of a dense green tourmaline, with small geodes of quartz crystals, are to be seen.

To try and obtain some idea of the tin content of this quartz-tourmaline stone, a sample was taken by chipping pieces off from stone over the whole heap. This was submitted to Mr. W. D. Reid, Government Assayer, who reported—

Tin ... ... 0·14 per cent.

This value is lower than one would have expected from the class of stone, and is not encouraging. Unfortunately, no samples could be taken from the lode-material *in situ*.

The width of the formation at the western adit is not exposed, but it must be considerable. Similar stone to that on the heap outcrops higher up the mountain slope, but here, again, the width cannot be determined from the available exposure.

The formation is about parallel to that worked at the open-cut, but has no connection with it.

This is the extent of the work done on the property, which had been idle for some time when the writer inspected it.

An attempt was made to treat the ore on the property. The stone from the main cut workings was sent down to the 5-head battery erected near the southern boundary of the section, below the pack-track, by a wooden launder, into which it was shovelled and kept wet by a jet of water. The slope of this ore chute was 27°. No particulars are available with regard to quantities treated by the battery and concentrating table, or the results of this treatment.

It is probable that the fine tin oxide present in the kaolin and gossan would need careful attention. The great difficulty appears to be that of getting water on to the property, and this has not been overcome. Although the section is traversed about its centre by the Agnew Creek, this is a very small stream, and the volume of water carried by it is too small to be of much practical use. No examination was made of the slopes above this section, in the absence of any tracks through the dense timber and scrub, but it seems improbable that any storage basin exists which could be utilised. It is possible that there may be small water-falls over some of the cliffs observed from the coastal plain, but the volume of water would probably be too small and too intermittent to be of much practical value. The first question to be decided is whether payable ore exists in sufficient quantities to warrant such expenditure, and if satisfied on this point, to choose between (*a*) a steam-driven plant, (*b*) sending the ore to a more suitable spot by some cheap method of transit, such as by an aerial tram, and then utilising water-power at this site. In the writer's opinion neither course is justified in the present state of the mine.

With reference to the ore-bodies on the section, unfortunately little information is available upon which to base a decided opinion. The body of ore taken out from the main cut appears to have been formed by the alteration and replacement of a mass of granite at the intersection of two or more fissures, by mineralising solutions introduced through those fissures. It is likely that if prospecting work be continued, other bodies of ore will be located, and these bulges may occur both laterally and vertically. The quartz-tourmaline vein traversing the cut with a strike of N. 18° E. appears to be the main "feeder," and the writer would recommend that a winze be sunk for a short distance from the bottom of the cut on the course of this vein, to determine whether any improvement takes place within a reasonable distance.

Where vughs are formed, such as those worked out, they are irregular, and no prediction can be made as to their occurrence. Very few feet of sinking may be required to locate another mass of ore below the present workings, while, on the other hand, a fairly extensive barren zone may be passed through. The risk is worth taking. This work will give some clue as to whether the lower adit should be continued. The writer is not aware how far this has already been driven. It may be so far in that it would be preferable to continue driving rather than commence sinking, and this should certainly be done if much water be encountered in sinking. But work should not be confined to this one point, and prospecting is recommended north and south of the present cut to try and determine whether other shoots of ore do not occur along the line of strike of the main vein. The comparatively large amount of limonite present in the ore worked indicates that pyrite may be expected to make its appearance at a greater depth. If tin values are sufficiently high, however, this fact should not discourage further work.

Should developments warrant the work, deeper adits could be driven to obtain a larger amount of backs. This work is not justified at the present stage.

With regard to the formation on which the western adit is driven, the position is unsatisfactory. The value of a single grab sample over a heap of ore must not be exaggerated; it may be unreliable. It is possible that in a length of 150 feet several shoots of ore may have been passed through, and that the material now lying on the surface of the heap is from a low grade area between good ore-shoots. Careful sampling, at regular intervals, of the ore exposed in the adit is recommended before undertaking any further work here. Surface samples along the line of outcrop should also be taken to determine whether well-defined shoots of ore occur, and what may be their extent and value. If this work gives no encouraging information, the continuation of the adit in the hope of finding better ore is not recommended. It is advisable, however, to crosscut east and west at intervals to expose the full width of the formation. It is possible that the adit may have been driven in a poor portion of the ore-body, and that richer zones occur. Short crosscuts would determine this point. A lower level adit can be brought in, if warranted, to prove this formation at a greater depth.

The treatment problem need not be considered until a reasonable tonnage of ore has been opened up. When this stage is reached, the enquiry will follow the lines indicated above.

Probably other outcrops may occur on the property, but it is difficult to locate them in its present condition

While not a developed mine, this property has prospects which justify some further work being carried out upon it, on the lines indicated above.

(23)—*The Old Globe Mine (Section* 4735-M, 10 *Acres).*

The old mine, known as the Globe, and afterwards as the Agnew Mine, was visited, but could not be exactly located on the chart. It is from ½-mile to ¾-mile north of the Trial Harbour Road where the Agnew Creek crosses, and an old track branching off the Federation pack-track leads to the mine, which is situated on the southern slopes of Mt. Agnew, about 970 feet above sea-level, and about 350 feet above the Agnew Flat on the road. The mine appears to be on Section 4735M, 10 acres, which is vacant.

The ore-body is situated within the borders of the normal Heemskirk granite, but the exposed contact with Pre-Silurian sedimentaries cannot be many chains to the east, though hidden by the surface soil and dense undergrowth of the locality.

The "mine" consists of an adit driven into the hillside, but now inaccessible. It is unfortunate that such an interesting occurrence should not be available for inspection. Some time was spent in carefully examining the material lying about on the dump-heaps to try and form a true idea of the nature of the ore won, and the conclusions arrived at resulted from this inspection.

Brief reference was made to the vein-type represented, by Mr. G. A. Waller, in his report of 1902,([230]) but no description was given of the property or its prospects.

Reference has already been made to the occurrence by the writer.

The adit from which the ore was won is inaccessible. It is driven in a direction about N. 75° W. The ore-body as cut is said to have been 5 feet wide, and to strike about north-east and south-west. The drive is said to be over 200 feet in length, and the shoot of ore which was worked

([230]) *Op. cit.*, pp. 9, 10.

to be about 30 feet long. Whether any attempt was made to locate other shoots, and whether any crosscutting was done from the main adit, could not be learned.

The minerals present are galena, tetrahedrite, chalcopyrite, blende, pyrite, cassiterite (?), quartz tourmaline, siderite, and fluorite.

No treatment plant was erected, but the ore was hand-picked, and two grades of ore produced and sent away for treatment—(*a*) galena and fahl-ore, rich in silver, (*b*) chalcopyrite. Quantities of ore despatched are not available, nor prices obtained. The fact of this separation into ores of different grades being possible, clearly indicates that the minerals did not occur intimately mixed, and the same feature is exhibited by specimens collected on the dump-heaps. There is a tendency in some specimens for the galena to occur with tetrahedrite, a little blende, and sometimes pyrite, with or without acicular crystals of quartz lining vughs in the lode-matter. Many of the fragments, however, show a banded structure, which may indicate crustification in the lode itself. In some specimens the ore consists of alternate bands of quartz, quartz and green tourmaline, and then metallic minerals—galena, tetrahedrite, blende, and pyrite. The characteristic gangue mineral accompanying the abovementioned metallics, is siderite. Vughs occur in quartz with coarsely crystalline siderite, and the metallic minerals mentioned. Similar vughs also occur in massive green tourmaline. In several of these vughs nests of green and amethyst fluorite were noticed. Tetrahedrite is present in irregular scattered masses, with siderite, in a fine-grained quartzose groundmass. It is also noticeable in veinlets with crystals of pyrite and prismatic crystals of quartz, in masses of green tourmaline. Pyrite occurs in crystals in this groundmass, which show the forms of the cube and the pyritohedron. A crystalline mass of quartz sometimes forms the groundmass for scattered crystals of galena, blende, pyrite, and siderite, and amorphous masses of tetrahedrite and chalcopyrite. No cassiterite was noticeable in any of the specimens examined.

A grab sample was taken from the heap of ore lying at the mouth of the adit, and submitted to the Government Assayer, who reported:—

Tin	0·37 per cent.
Silver	29 oz. per ton
Gold	Nil

Unfortunately, owing to the fact that the workings were not available for inspection, little can be said with regard to the future of the mine.

It is likely that other shoots of ore will be found, but it is doubtful whether the general character of the ore will vary much. The ore is likely to be complex in character, owing to the overlapping of the vein-types, but it is not improbable that patches of ore may be located, which would well pay to extract. Shoots of tin ore may be encountered in driving on the course of the formation.

The fahl-ore is held to be primary, and not merely a mineral formed by the recognised processes of secondary enrichment. Thus, the silver values may be expected to be more permanent than could be looked for in a lode-formation which has undergone secondary enrichment.

(24)—*Contact Metamorphic Deposit on the Agnew Creek, North of Trial Harbour Road.*

The exact position of the deposit to be described could not be determined, but it is approximately shown on the accompanying map. It is on the Agnew Creek, at a bridge on an old track branching off the Trial Harbour Road to the north, near the junction of the present pack-track to the Federation Mine.

Very little work has been done, and the object of this work is not clear, unless merely to determine the nature of the deposit. The outcrop is exposed in the bed of a small creek, near an old dam, and a small water-race has its intake at the outcrop.

A small cut into the creek-bed is the only work done.

The width of the mineralised belt is apparently about a chain, but it has not been fully exposed. The general strike is about north and south, and the deposit shows a well-defined banded structure, corresponding with the stratification of the country-rock, some bands of slate being unreplaced, others only partially replaced. The deposit is a contact metamorphic replacement deposit. Although it is in sedimentary rocks, the actual line of contact with the intrusive granite is only about 100 feet distant. The granite is coarse-grained pink granite (white on weathered outcrop), with abundant tourmaline-filled fissures.

The surface ore is coated with limonite, and fresh faces are necessary to determine its true nature. The metallic mineral most abundantly represented is pyrrhotite. The mineral is magnetic as usual, and occurs sometimes in rather massive bands, but usually distributed in aggregates throughout the ore-body. With the pyrrhotite are small amounts of pyrite and chalcopyrite: the latter mineral occurs in little more than traces. Magnetite is not abundant, but occurs in granular aggregates in some bands, and very finely granular masses in the groundmass of other parts of the deposit: the mass as a whole affects the magnetic needle, and renders it useless in any attempt to determine direction. There may be a small amount of blende present, but the determination is not quite certain, and if present at all, the mineral is only in traces.

The most abundant gangue mineral is a very pale-greenish amphibole, this mineral with pyrrhotite forming the bulk of the deposit. Biotite is present abundantly in some bands, but on the whole is subordinate in amount to the amphibole. A noteworthy feature is the presence of fluorite in appreciable amounts. This mineral is usually colourless and transparent, but is sometimes tinted green: it occurs sometimes in coarsely-crystalline masses in certain bands, or in granular aggregates with the other minerals. In one fissure crystals of fluorite were noticed, while closely associated with it, and lining the walls of the fissure, are abundant radiating aggregates of green tourmaline crystals. A close look out was kept for cassiterite, but none was seen. The absence of quartz is worthy of note.

The occurrence of the fluorite and tourmaline in fissures suggests that these minerals have been introduced subseqently to the consolidation of the main deposit.

Reference is made in another part of this report([231]) to the result of a microscopical examination of thin sections of several specimens: in addition to the minerals mentioned above, talc is present in abundance in certain bands of ore.

A comparison of this deposit with that of the Mt. Lindsay Mine, Parson's Hood, is interesting. The latter has recently been fully described by the writer([232]).

From the description given above, it is fairly clear that the deposit cannot be regarded as of any great economic value. The only mineral detected which might conceivably render the deposit of economic importance, is chalcopyrite, but this is an accessory mineral, occurring only in traces, and there is no sound reason for believing that it will increase to any appreciable extent.

([231]) *Vide supra*, p. 131.
([232]) Geol. Surv. Tas. Bulletin 15, pp. 65-97.

The proximity of the granite, and the presence of fluorite and tourmaline in the deposit, at once suggest that tin may occur in appreciable quantities: none has so far been located, and even if some is found to be present in the narrow fluorite-tourmaline veins, the prospects of its occurrence in payable quantities in this type of deposit are not very bright.

Thus there is little to encourage further developmental work being carried out on this deposit.

(25)—*Agnew Creek Alluvial.*

In the vicinity of the Agnew Creek, 1½ mile south-east of Mt. Agnew, the Zeehan-Trial Harbour Road crosses a fairly extensive flat on which some work has been done. This flat is partly included in Sections 1499M, 1869M, 1501M, 3470M, 3718M, and 3717M. The granite-slate contact traverses several of these sections, but there are no surface outcrops, as the rock is covered with a deposit of alluvial material derived from the higher ground, and this deposit was found to be tin-bearing.

Work in the locality has been very intermittent, and at the time of the writer's visit, two men were employed.

In his "Report on the Progress of the Mineral Industry of Tasmania for the quarter ending 30th September, 1900," the Secretary for Mines states (page 8): "The Mount Agnew Alluvial Tin Mining Company, holding about 60 acres near Mt. Agnew, has begun hydraulic sluicing. During the quarter a dam capable of holding 70,000 gallons of water has been constructed, and water-races of 37 and 18 chains cut, also a tail-race 10 chains. The fall from the dam to sluicing ground is 110 feet, and the length of piping 1200 feet. A paddock 50 feet by 33 feet has been stripped showing wash of an average depth of 3½ feet. Only one nozzle has been started, but preparations are being made for two more."

No further reference can be found to the operations of this company, which do not appear to have been successful. The writer was not able to locate definitely the site of the company's workings, as various patches have been worked at different points on the flat. The plant referred to has long since been removed.

The depth of the alluvial material exposed varies somewhat, but averages about 3 feet: it consists essentially of quartz-tourmaline stone from various veins on the slopes above, and occasional boulders of granite. The stones are mainly sub-angular to rounded. The amount of overburden is slight, varying from a few inches to about 2 feet. Where exposed, the bottom is mainly granite, with slate to the east.

The deposit appears to be partly a recent accumulation of detrital material derived from the weathering of veins outcropping on the higher ground, but the rounded nature of some of the material suggests that it has been subjected to more grinding and pounding than such material would be likely to have received. It is not unlikely that it may represent older alluvial material which has been redistributed. In the discussion of the geological history of the field elsewhere, it has been shown that part of the old land surface was worn down by the long-continued action of weathering agencies, almost to base-level, the gradient of the streams becoming so flat that the burden of rock-debris could not be carried to the sea, and was deposited. Probably some such deposits were formed in this locality, and the recent uplift of the surface rejuvenated the streams, allowing these older deposits to be cut through and redistributed.

Some good patches of tin ore have been worked from time to time, but these have all been small, and the main troubles appear to have been (*a*) the patchy distribution of values in the ground, (*b*) the difficulty of getting an adequate supply of water on to the ground. It is doubtful whether any expensive scheme for getting water on to the ground is justifiable in view of past experience of the nature of the wash.

Thus while it is unlikely that any large number of men will be employed, these deposits will probably be worked intermittently by single men and small working parties when water is available.

(26)—*Section* 6667M, 80 *Acres—H. D. Marsh.*

This section is situated about 2 miles east of Mt. Agnew, and about 1 mile south-west of the Kynance (old Silver Stream) Mine, Comstock. It is on low-lying ground east of the foothills of Mt. Agnew, which rises steeply on this side. Portion of the section is occupied by a low marshy flat, through which gabbro-amphibolite outcrops at intervals. The whole of the section is very heavily timbered, and in most parts the scrub is so thick as to be impenetrable: consequently, no accurate mapping of the boundaries of formations was possible.

Access is given by the Zeehan-Trial Harbour Road, which approaches to within less than one-half mile of the property. From the road, a track led to the deposit about to be described: this, however, is completely overgrown in places, and in consequence the ore deposit is difficult to locate. At comparatively little expense, however, connection could be made with the road if occasion demanded, and the proximity of the road is a distinct advantage.

With regard to geological formations, no accurate mapping was carried out owing to the difficulties mentioned above. Attempts were made to locate corner pegs of the section without success. It appears, however, that the extreme north-western corner of the section is occupied by granite, the western half by contact metamorphic slates and lime-silicate hornstones, and the eastern half by gabbro-amphibolite.

The compass is so strongly affected at certain points as to suggest the presence of probably several magnetite bodies on the section. So far as the writer was able to find out, only one body has been definitely located, and the work done on the section has been confined to the partial exposure of this deposit: its position was not exactly located, but it appears to be about the centre of the section, or perhaps somewhat to the south-west of the centre. The outcrop was cut through by a small creek, and the amount of work carried out on it has been small, consisting of an open-cut into the creek bank. The length of the cut is 25 feet, width at entrance 15 feet, height of face 12 feet. This cut is taken on the strike of the formation, which appears to be about east and west, although where exposed in the vicinity the strike of the slates of the country-rock appears to be more nearly north and south. The full width of the deposit has not been exposed, as the cut is on the south side. The average width exposed in the face of the cut is about 10 feet: the deposit is narrowing somewhat in the face, measuring 12 feet in width in the upper part, and 8 feet in the lower part of the face: the width sampled was 10 feet.

The metalliferous minerals of the deposit are magnetite and blende, with a small quantity of pyrite in places: the gangue minerals are various silicates of lime and magnesia, the minerals noted being diopside, serpentine, chlorite, talc, and phlogopite. A description of these lime-silicate hornstones is given elsewhere, with the results of an examination of several thin sections of the rocks.([233]).

([233]) *Vide supra*, pp. 132–133.

The ore-body consists of irregular masses of magnetite and blende, with varying amounts of lime-silicates: frequently for several feet the ore is composed almost entirely of magnetite and blende, or it may be traversed by veinlets of diopside, or contain small amounts of greenish lime-silicates in the groundmass, indistinguishable in hand specimens. There is no defined banded structure in the ore-body as exposed; usually the magnetite and blende are very closely associated, although fairly pure masses of both minerals occur. Even in the purer magnetite, however, crystals and aggregates of blende are usually distinguishable in the groundmass. The ore is not uniform: in a few inches it may change from almost pure magnetite to almost pure blende. Sometimes masses of almost pure blende occur, bounded sharply by magnetite, but showing no walls. It is important to consider whether masses of blende occur which could be separated from the lower grade material, and which would be sufficiently pure to form a marketable product. The irregular masses of blende exposed in the present face are usually not more than a few inches across, but there is always the possibility of the masses widening. Where they do occur, the masses of blende are usually fairly pure, and it appears that some attempt has been made (successfully so far as the grade of ore is concerned) to hand-pick some of the high-grade blende.

A noteworthy feature of practically all specimens examined is the presence of small amounts of pyrite: this mineral is never present in large quantities. It sometimes occurs in minute veinlets traversing the magnetite and blende, more often in scattered crystal aggregates. The presence of pyrite in the magnetite is important when the latter is considered as a possible source of iron ore. A sulphur content is decidedly detrimental, and if it rise high enough, may nullify the value of the material as an ore of iron of economic value.

There is no well-defined wall to the formation exposed in the work done. Outside the boundaries of the main deposit are irregular masses (usually of small size) of magnetite and blende enclosed in the lime-silicate rock. Some of these masses of blende appear to be very pure.

No work other than this open-cut appears to have been done on the deposit. The exceptionally thick scrub at the time of the writer's visit rendered any attempt to trace the extent of the deposit futile.

An old tramway was constructed from the deposit for some distance, but is now in a state of disrepair, and there

are no signs that it crossed the boggy flat which lies between the property and the road, although some old timber suggests that a corded track was formed for at least part of the distance.

On the edge of the flat, between the road and the property, and about half a mile from the road, is a heap of from 4 to 5 tons of blende: this appears to have been hand-packed to its present position from the deposit described above. It evidently represents hand-picked ore, and an examination shows that it is remarkably free from magnetite. The inference is that purer blende occurred in the portion worked out than is exposed in the present face. A grab sample was taken from this heap and submitted to Mr. W. D. Reid, Government Assayer, for analysis. Mr. Reid reported:—

Zinc	40·81 per cent.
Iron	20·4 per cent.

A sample broken across the face of the open-cut, width 10 feet, was assayed by the same officer, who reported:—

Zinc	7·39 per cent.
Iron	23·4 per cent.

(27)—*Section* 892M, 80 *Acres* (*Nickel Reward.*)

This section is situated about 1½ mile east of Trial Harbour, and wholly within the area of Devonian serpentine, which has been previously described. A certain amount of work has been done to prospect an occurrence of nickel ore, but the section is vacant at the present time.

On the site of the old township of Remine there is a coastal strip, varying in width up to about ½ mile, of comparatively level ground, when the ground rises rapidly to the coastal peneplain. It is on the summit and slopes of this hill that the work has been carried out. The situation of the workings is well shown in Photo. 7.

No corner-pegs were available, and hence the exact position of the nickel ore on the section could not be determined.

The serpentine of the locality is very frequently covered by a crust of limonite,[234] but outcrops of the rock are to be noticed in places. The presence of nickel was betrayed in an outcrop on the summit of the hill overlooking Trial Harbour, by the green stains in partially

[234] *Vide supra*, pp. 215–217.

weathered specimens. A shaft was sunk here on the summit of the hill, about 200 feet above sea-level, for a depth of 26 feet, and an adit (called for sake of convenience No. 1 Adit) was driven in from the hillside to connect.

Lower down the hillslope, another adit (No. 2) has been driven. These workings are on the summit and western slopes of the hill. Some chains to the north, at about 80 feet below the summit, an adit (No. 3) has been driven south from the northern hillslope.

About the collar of the shaft on the hilltop, green nickel stains are noticeable in the serpentine in places, and it would appear that these stains have induced the work to be carried out. In the absence of ladders and a rope, no examination could be made of the shaft itself. At a depth of 26 feet, this shaft connects with the No. 1 Adit driven from the western slope of the hill. About 15 feet west of the shaft, on the brow of the hill, the serpentine carries an appreciable quantity of magnetite in streaks, irregular masses of magnetite slightly stained with manganese, and masses of radiating rosette-shaped aggregates of white brucite, associated with occasional tabular hexagonal crystals of the same mineral. These specimens are occasionally stained with bright apple-green garnierite.

The No. 1 Adit appears to have been of the nature of a prospecting drive, for it is too near the crest of the hill (26 feet below) to be of value as a working adit, as it would not open up sufficient backs. It has been commenced from the southern slope of the hill. The abundant magnetite in the vicinity affects the magnetic needle, and renders compass readings of little value. The adit is driven a little east of north for a total distance of 80 feet into the hill, the approach being 14 feet. At 47 feet from the entrance crosscuts extend west and east 21 feet and 17 feet 6 inches respectively. The shaft from the surface connects at 47 feet, and at this point a winze was sunk for 21 feet 6 inches.

The striking feature in this vicinity is the variety of secondary minerals met with in the serpentine. The rock is traversed by veins filled mainly with various lime and magnesia minerals. These minerals have been described more in detail elsewhere[235], the principal being magnesite (carbonate of magnesia), arragonite and calcite (carbonates of lime), dolomite (carbonate of lime and magnesia), brucite (magnesium hydrate), deweylite (hydrous silicate of magnesia), pyrolusite (manganese dioxide), limonite (hydrated iron oxide), selenite (sulphate of lime), opal and chalcedony (silica).

([235]) *Vide supra*, pp. 41-47.

The serpentine exposed in the No. 1 Adit is much fissured, and carries these minerals in abundance. No information was available as to the class of stone met during the progress of driving or with regard to the exact locality from which the ore on the dump-heaps was obtained. The examination of the walls of the drive was not very satisfactory owing to the length of time the adit had been open, but a partial cleaning down disclosed some interesting information. At about 20 feet in, nickel ore was noticeable *in situ* on the western side of the adit. The serpentine here is traversed by numerous veinlets of a greenish opaline mineral, which proves to be deweylite. There are smaller quantities of a darker-coloured mineral with similar characteristics, also in veins. Arragonite is also present in some veins in radiating masses, these veins being sometimes 3 inches in thickness. There is a main fissure of narrow width, nearly vertical, filled with greenish deweylite, and from this lateral branch veins extend on either side, some of these being about horizontal. The serpentine, which carries visible pentlandite, is surrounded by these veinlets of deweylite, the pentlandite being also included in the latter mineral, which has apparently impregnated the serpentine to some extent. The relation of this deweylite to the pentlandite is discussed in the chapter on Economic Geology.[236] The nickel mineral is closely associated with magnetite. The serpentine in the vicinity is stained green, with garnierite derived from the weathering pentlandite, and from this point onwards along the course of the adit stains of garnierite are particularly noticeable along the more or less horizontal veins of deweylite which traverse the serpentine. The drive appears to have followed one well-defined horizontal vein, which shows green nickel stains almost continuously. At 47 feet in, the serpentine shows abundant stains of garnierite, various flat veins of deweylite and arragonite showing such stains to a marked degree. Pentlandite is visible occasionally in small quantity with magnetite, disseminated through the serpentine. At this point crosscuts have been driven, a winze sunk, and the shaft connected with the

([236]) *Vide supra*, p. 187.

surface. Apparently some at least of the high-grade ore on the heap at the mouth of the tunnel came from this portion of the workings, but no information was available, and the matter could not be definitely decided, as no similar rich ore was noticeable *in situ* at this point. The eastern crosscut extends 17 feet 6 inches through similar serpentine to that described carrying secondary lime and magnesia bearing minerals, and showing green nickel stains in places. The shaft from the surface, 26 feet, connecting in this eastern crosscut adjoining the main adit, is not available for inspection. In the roof of the crosscut at this point, however, there is seeen to be a vein striking about east and west, which is impregnated with limonite. This gossan band appears to be of very irregular width, varying from 6 to 18 inches. This gossan shows abundant nickel stains. It seems likely that the crosscuts may have been driven at this point to prove this vein, with the idea that it was a true vein of nickel ore.

The western crosscut has been driven for 21 feet through similar serpentine to that described above, still showing some stains of nickel. A winze was sunk from this crosscut, adjacent to the main adit, to a depth of 21 feet 6 inches. The upper portion only of this winze could be examined, but the serpentine appears to carry nickel here also. Veins of deweylite are noticeable, sometimes carrying garnierite, and a little scattered pentlandite is present in places.

In the face of the main adit, 33 feet beyond the crosscuts, no nickel ore was noticeable. The serpentine is seamed with veinlets of pale-green deweylite, intersecting at all angles. At times veins split and again coalesce, including areas of serpentine. Many of these veins of deweylite are traversed by veinlets of pyrolusite (manganese dioxide). A sample was broken from the face of the main adit, and submitted to Mr. W. D. Reid, Government Assayer, for analysis. He reports—

Nickel ... ... 1·9 per cent.

On the dump-heap at the mouth of the adit is a heap containing a few cwt., evidently, of hand-picked ore. This shows pentlandite freely in places, almost invariably associated with magnetite, the serpentine being light-green in colour, and sometimes slightly stained with garnierite. The writer was unable to find out from which part of the workings this ore was extracted. The pentlandite is always disseminated through the serpentine; no massive

sulphide was seen. A grab sample was taken from this heap and assayed by the Government Assayer (Mr. W. D. Reid), who reported—

Nickel ... ... 18·6 per cent.

An examination of the dump-heap showed that the ore had not been very carefully hand-picked, and a certain proportion of the serpentine on the heap also showed disseminated pentlandite. A rough sample was taken of this material, essentially to act as a check on that taken from the heap of ore, and as a result of his assay the Government Assayer reported—

Nickel ... ... 14·6 per cent.

About 1 chain north of the No. 1 Adit is a small open-cut extending for about 10 feet into the serpentine. On the outcrop at the brow of this cut is abundant white. radiating brucite, which includes granular aggregates of magnetite, a little recognisable pentlandite, and not uncommon splashes of bright-green garnierite. A narrow vein of fibrous chrysotile was noticed in one specimen, while deweylite and arragonite were also observed as fissure-fillings. Obviously, nickel is present in the serpentine at this point, but apparently not in such quantity, as it occurs a little further south.

About 40 feet below the No. 1 Adit a second adit (No. 2) has been driven about east into the hillside. The total length is 157 feet, with an approach of 11 feet. At 92 feet in, the drive bends a few degrees north, but no cross-cutting has been done. The magnetite in the serpentine affects the compass, so that exact bearings could not be taken.

Although less nickel ore has been exposed in this adit than in No. 1, the nature of the serpentine passed through is very similar. About 5 feet from the entrance some green stains of garnierite were noticed, evidently derived from a small amount of nickel sulphide in the rock. No other ore was noticed *in situ* in the adit, although scattered pieces of oxidised ore are present on the dump-heap. These may have been derived from the surface outcrop. For 50 feet the serpentine is weathered, and numerous veins of secondary minerals are noticeable, frequently dipping west at a low angle. The minerals noted in these veins were deweylite, arragonite, calcite, dolomite, magnesite, and abundant stainings of pyrolusite. Towards the face of adit, the serpentine is fresher, bluish-grey in colour, and showing aggregates of magnetite. This serpentine is less frequently traversed by similar veinlets of secondary minerals.

At about 50 feet from the entrance a fissure was intersected which dipped south at 20°, and which is noticeable in the drive for about 30 feet. This appears to be a fault-plane, for the serpentine on either side of it appears to be a good deal disturbed; secondary minerals are developed here also.

It is unfortunate that the work carried out at this point has not been successful in opening up a further supply of sulphide ore similar to that exposed by the No. 1 Adit. The adit has not been driven far enough to reach a point vertically below the ore in No. 1 Adit.

A few chains to the north of these workings, on the northern slope of the hill, and about 80 feet below the summit, No. 3 Adit has been driven in a southerly direction. This adit is not available for inspection, and its length could not be ascertained. The writer proceeded for about 50 feet, but found that the adit had been driven on a down grade, and water had accumulated. For this 50 feet decomposed serpentine is exposed, carrying veins of chalcedony, magnesite, calcite, and deweylite. Occasional slight stains of nickel are noticeable, but no sulphide ore was observed.

The mode of origin of the nickel deposits has been discussed elsewhere,[237] and from the explanation given it is clear that an accurate forecast of the future of the property is impossible. The ore, apparently, occurs in irregular masses, whose extent can only be determined by sampling. The veins of secondary minerals so abundant in the serpentine have no genetic connection with the sulphide ore, whose boundaries are ill-defined; in fact, the ore grades into serpentine, being merely a particular variety of that rock, in which the nickel-bearing minerals had become concentrated. Thus, systematic sampling is suggested as the only practicable method of determining the true extent of the ore.

Undoubtedly some rich ore does exist, but the work carried out up to the present indicates that the available quantity is not large, and its distribution uncertain. As described above, however, the amount of work done is small, and further prospecting might result in the discovery of larger bodies of ore. It is doubtful, however, whether such work is justified by present prospects, although the writer considers that sampling of the serpentine exposed, particularly in No. 1 Adit, is justified, to determine actual values and extent of ore *in situ*. Should the results of this work be sufficiently encouraging to justify further work, this adit might well be extended a few feet, as nickel is present in the face, and then the lower (No. 2) adit might be continued for a short distance. There can be little doubt about ore being found at greater depths, but it is not possible from indications near the surface to predict what the behaviour of such a body of ore as that under consideration is likely to be, *i.e.*, whether it is likely to continue vertically, or whether it may extend laterally, beyond the limits indicated by exploratory work near the surface, or whether the actual shoots encountered may gradually merge into serpentine which does not carry payable nickel values.

[237] *Vide supra*, pp. 187–188.

Thus, while there are certain promising indications on the property, as shown by the high-grade ore on the dump-heaps, the future of the property is uncertain. While bodies of payable ore may be found, the nature of the ore deposit does not allow any definite forecast to be made.

The property is favourably situated for economically working by means of adits any deposit of ore which might be located. Such ore could be shipped from Trial Harbour, though the uncertain nature of this method of shipment caused by the exposed situation of the so-called "harbour" would add considerably to the freight charges.

(28)—*Little Henty River District.*

Several attempts were made to explore the country along the Little Henty River, but with only partial success, owing to the thick scrub, and the lack of tracks into this part of the district. Working along the northern bank up stream from the mouth, the scrub which has grown up in recent years since a fire went through is very thick, and without a track or another burning-off of the scrub progress is slow and painful. A track which had been cut out, and which is fast becoming overgrown, enters the scrub from the button-grass plain a short distance below Section 3555M (Connor's old section). This track appears to have been cut out to give access to a property locally known as "The Publican's Purse." The track cannot be followed right to the river; if previously cut out it has now become completely overgrown. It was found possible to break through to the river bank, and this was followed up and down stream for some distance. The country-rock through this area is composed of Pre-Silurian sedimentaries, slates predominating, usually a good deal hardened. No igneous rocks were seen. The track leads through dogwood for some distance, followed by open forest country with myrtle, sassafras, leatherwood, musk, &c., and "man" and "cathead" ferns. The country certainly is favourable for the occurrence of mineral deposits. Along the river bank a look-out was kept for alluvial flats which were worth prospecting for secondary tin ore. No deposits of any extent occur along this particular stretch of river, although in the bends of the stream there are several deposits of limited extent. It is probable that these would be found to carry tin, but the small size of the alluvial deposits and the presence of driftwood, logs, &c., would probably render any attempt to work them unprofitable.

No examination was made of the southern bank of the river, which was not fordable at the points visited.

About ¾-mile from the mouth of the river is a bold gossanous outcrop on the northern bank, jutting out as a rocky point about half-way across stream. The surface crust, irregular patches in the body of the material, and the filling of fissures, is a soft limonite forming a true gossan. The material is very hard, and on freshly-broken surfaces is seen to be very dense and siliceous, though traversed by minute veinlets of chalcedony, and at times by crystalline quartz. Cavities frequently occur in the mass of the rock, lined with chalcedony, which, in turn, is sometimes encrusted with soft earthy limonite. Even on fresh faces, the rock is stained red with iron oxide. The strike is about N.N.W., and dip about vertical. The width varies considerably at different points, but would probably average 20 feet. The formation rises steeply to about 300 feet above the river, presenting a precipitous face to the west. It was traced for about ½-mile along the line of strike, until lost in the thick scrub near the belt of lime-silicate rocks which border the serpentine. Several specimens broken from different points on the outcrop were submitted as a sample to the Government Assayer, Mr. W. D. Reid, to be assayed for gold and silver, the result being—

Gold	Trace
Silver	1 oz. 4 dwt. 19 gr. per ton

While indicating that the precious metals are present in the formation, the results are scarcely such as to warrant prospecting work being carried out. It is possible that shoots may be located which will carry higher values, although the nature of the formation is not promising. Unless samples from other points show satisfactory values, no work is justified to open up the formation.

The Little Henty River was also reached from Mayne's Mine, by breaking through to the Burnt Bridge Creek, and following this creek down. The sequence of sedimentary rocks encountered here has been described elsewhere.(238) At the junction of this creek with another from the north there is a small deposit of alluvial material, and on the banks of the creek a little prospecting work has been carried out. A notice posted on a large gum tree about 1 chain to the north of these workings reads "Mines Department Prospecting, 640 acres. This notice is posted at north-west angle, date January 25, 1913: John Mitchell; witness, J. Redmond." This indicates that the work to be described was carried out comparatively recently, but no official record is available as to the objects or results of the work. On the western side of the creek is a short adit driven about west, 20 feet into the hill, which here rises steeply. This adit is in a state of collapse. In the approach are some specimens of green chlorite carrying abundant crystals of pyrite, showing dodecahedral, and occasionally cubical, forms. This material carries occasional geodes of quartz crystals, usually accompanied by soft micaceous aggregates. The structure is not clear in the present state of the workings, but the formation appears to be a narrow flat vein. At the entrance to the adit is a little gossan, the adit itself being driven on a slide, in soft white clay, showing no signs of mineralisation. On the hill to the south a little quartz-tourmaline wash was noticed. On the eastern bank of the creek is a trench which exposes only clayey wash. One-half chain east is a prospecting shaft 15 feet deep, now partly full of water. Solid country-rock does not appear to have been reached, the shaft passing through clay with angular detrital fragments of slates and sandstones. About ½-chain north of this shaft is a little pyritic material, now partly oxidised; there are segregations of pyrite in a decomposed clayey gossan. No work has been done here.

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(238) *Vide supra*, pp. 101-105.

Several specimens were picked up at the junction of the creeks of radiating aggregates of a very soft white mineral with a soapy feel and pearly lustre, apparently pyrophyllite.

A sample of the dense green pyritic material was submitted to the Government Assayer (Mr. W. D. Reid), who reported—

Tin ... ... 0·22 per cent.

While it is interesting to note that tin is present in the formation at a distance of over a mile from the exposed edge of the granite, the value is not promising, and it is doubtful if further work is justified in the locality.

The above result indicates, however, that the mineralising solutions have been active, and it is not improbable that richer deposits may be located in this part of the district.

No other mineral deposits appear to have been located in this part of the district, but it must be admitted that very little prospecting has been done owing to the inaccessibility of the country. Similar country has been reported from the opposite (southern) side of the Little Henty River, but this country is still less accessible, and is practically *terra incognita*. It is certainly favourable for the deposition of sulphide ores, and prospecting is strongly recommended. The occurrence of calcareous beds is worth noting, as these are liable to be replaced when mineralising solutions have had access to them, forming large bodies of ore.

As will be seen from the above notes, this part of the district was only broken into at a few points, and under the circumstances could not be examined in detail, but the hasty reconnaissance made left very favourable impressions as to the possibilities of the area.

VIII.—CONCLUSION

During his examination of the South Heemskirk Tin-field, the writer visited all properties on which he was aware that any work had been carried out, and although in many cases little is to be seen at the present time, the condition of the workings has been described, even though no definite opinion as to prospects can be formed. Little need be said at this stage of individual properties, which have already been described, but it seems advisable to review the present condition of mining on the field.

With only three properties being worked at all at the time of the writer's visit, with a total of a dozen men employed in lode tin mining, and about half that number working patches of alluvial ground, and acting as caretakers, it is clear that mining is not in a flourishing state in the district. This condition is certainly not the result of the mines being worked out. The total amount of mining work done is small, and out of all proportion to the amount of money which has been spent on the field, which must amount to several hundred thousand pounds since tin was discovered 40 year ago. The causes which have led to the present state of affairs have been traced as far as possible by the writer in dealing with the history of mining on the field, and it is not proposed to repeat what has there been set out. Briefly, the main causes seem to have been incomplete prospecting of certain short rich shoots of ore, and exaggerated reports of the results of prospecting work leading to a boom, when indiscriminate pegging of sections took place, and speculation was rife, and the premature erection of costly plants on undeveloped mines, leading inevitably to financial depression. Other causes, such as inaccessibility, the occurrence of pyritic ore, and (in a few cases, perhaps) mismanagement of properties, also contributed in a smaller degree. The main cause of the loss of confidence in the field was the extravagant and unwarranted expenditure on plant and surface works of money which should have been used in developing the ore-bodies. The writer is of opinion, however, that at at the present time the field is recovering from the setback it received at the period mentioned. Further prospecting has been carried out of late years, and has clearly indicated that some at least of the old properties were prematurely abandoned, and that shoots of tin ore occur in some of the veins which should pay well for extraction and treatment under modern conditions.

As pointed out in the course of this report two of the smaller properties are working at a profit, and several others have excellent prospects. In the case of the main property on the field (the Federation Mine), the immediate cause of the present inactivity is want of capital for developmental work, several attempts to secure which have unfortunately failed recently. This property is commended to the careful attention of investors, as it certainly has sound prospects, and under efficient management should prove a steady tin producer. Although the report on such a property cannot be complete without systematically sampling the various ore-bodies exposed, after a study of the principles underlying the deposition of the ore, various suggestions and recommendations are made, which, it is hoped, will be of some value in planning future work.

A noticeable feature in the case of several of the properties examined was the lack of system displayed in carrying out work at different points. With a given amount of capital available for mining operations, it seems superfluous to say that this capital should be spent to best advantage, but the fact remains that this has not been done. As a result of the expenditure of numerous small amounts in spasmodic prospecting in widely separated localities, in some cases the position at the present time is that no useful object has been attained for the expenditure of a total amount of several thousands of pounds, an amount which would have sufficed to carry out much useful and really permanent mining work, which could, moreover, have been utilised as a basis for further work, had the work been systematically planned. Future operations should be planned on definite lines, keeping in mind always the future development of the property, so that the maximum benefit may be derived from any given expenditure.

The practice followed in one or two instances of working out only the very richest portions of exposed ore-bodies, either leaving the seconds *in situ* or carelessly mixing them with country-rock on the dump-heaps, is to be strongly deprecated. While a temporary profit may be made by employing such methods, the result must necessarily be that the life of the property is shortened, and it has in some cases happened that mines have been abandoned when only a comparatively small proportion of the actual tonnage available has been extracted. Where this policy is being carried out, it usually means that the richest ore is being extracted without any corresponding developmental work being pushed ahead to provide for an uninterrupted supply of ore.

Another point to which attention should be drawn is the tendency to become somewhat careless as to treatment methods when rich ore is being treated, and to become satisfied with a good *aggregate* recovery, rather than to constantly aim at the very highest possible *percentage* recovery.

Mention should be made of the occurrence of pyritic ore on some of the properties, as noted in the text of this report. The question of the treatment of this ore will have to be faced in the near future. In the past the occurrence has caused trouble, and even led to the abandonment of good shoots of ore, because of the trouble in dressing, and the difficulty at the time of finding a market for pyritic tin concentrates. This treatment question should be honestly faced by the owners of those properties where stanniferous pyritic ore occurs, and after careful sampling, experiments made to determine the most suitable treatment process. The writer confidently believes that a successful method of treatment for these ores will be found with a minimum of experimental work, and the important aspect then becomes the actual tin content of the ore. The question indicated should not be postponed until the oxidised ores nearer the surface are exhausted, as there is a tendency to adopt this attitude in some cases. The future of these properties must depend on the pyritic ores, and as such ores are being successfully treated elsewhere, the matter should be confidently taken in hand without delay.

In mining operations the nature of the occurrence of the tin ore in the deposits should be carefully kept in mind. Past mining operations, though not extensive, have shown that it usually occurs in definite shoots, which, while very rich, may be of limited length and depth, although in some cases the dimensions of particular shoots are considerable. It is noteworthy that although in several instances mining operations at that particular point have ceased when the shoot being exploited has cut out, in cases where a reasonable amount of developmental work has been carried out, the presence of other shoots of ore has been demonstrated, both laterally and vertically. In several instances rich shoots have been located accidentally in close proximity to worked-out bodies of ore. In the writer's opinion, such a general statement as has been made from time to time, that "on Heemskirk the tin does not live to depth" is quite unwarranted; certainly, insufficient deep mining has been carried out to justify such a statement, and the evidence provided by such mining work indicates clearly that tin ore does live to depth. This question has been dealt with in the course of the report, and the opinion expressed that conditions are favourable for a continuation to depths beyond the reach of economic mining of the tin ore. The noted occurrence of the tin ore in defined shoots, however, strongly emphasises the necessity for carrying out sufficient developmental work before erecting treatment plants, and for keeping such developmental work pushed ahead of actual ore-extraction operations, to ensure a constant supply of ore for the batteries. It is the neglect of these precautions which has directly caused the failure of some of the mining companies in the district during the past.

In working the ore-deposits it is important that the structural features should be understood, and it is hoped that some of the notes given will be useful as guides in the elucidation of some of the problems to be encountered by the mining managers, to whom are entrusted the working of the properties. The structural features are of especial importance in the case of the tin ore deposits in the sedimentary rocks, and these features have been explained as far as the present conditions of the properties allow of their interpretation.

Isolated cases of mixed metals in certain shoots are recorded, where the separation of the various sulphides and the cassiterite will be fraught with real difficulty: quantities and values of ore in such cases should first be determined to show how far experimental work should be carried. These cases are, however, the exception in the district.

In addition to tin ores, there are developed ores of bismuth, wolfram, and nickel in different parts of the area examined, which deserve further investigation than they have hitherto received. Molybdenite also occurs, but unfortunately in no case in sufficient abundance to become of economic importance, even with the high price obtaining at the present time: fresh discoveries are possible at any time.

The secondary tin ore deposits of the district have provided in the past, and will in the future continue to provide employment for a limited number of men, but the chief alluvial deposits have been worked out, and the future of the field must depend on the primary ore-deposits.

The district affords natural advantages for economic mining which must have an influence in bringing the field to its rightful position as a tin producer in the future. Mining to considerable depths from adit levels is possible in several cases, and the facilities offered for cheap power by the Cumberland Dam are exceptional. It is worthy of note in passing that in the North Heemskirk district falls occur on the Heemskirk River which could be harnessed to provide electrical power.

It is suggested that in a few cases an amalgamation of interests might have an advantageous effect on the successful operation of adjoining properties, if satisfactory arrangements could be made by the owners of the properties concerned.

Owing to the facilities offered by a large tract of comparatively level country free of timber along the sea-coast, surface prospecting has been carried out more or less carefully in one portion of the district, but the writer would unhesitatingly say that the whole district has not been thoroughly prospected, and that certain areas are very favourable for the occurrence of payable ore-deposits. The mountain country of the Heemskirk Range itself may be found to carry tin ore deposits, but the extremely inaccessible and forbidding nature of the country militates against the prospector, and although the writer is of opinion that denudation of the granite has not been so excessive as to have removed the tin veins, still it must be admitted that this area does not offer the same inducements to the prospector as the marginal portion of the granite.

The portion of the district which in the writer's opinion has not received the attention it deserves at the hands of the prospector is that including the sedimentary rocks forming the contact metamorphic zone round the immediate border of the granite. These rocks are favourable for the development of tin ore deposits. The accidental discovery of the rich ore at Mayne's Tin Mine within such a short distance of an established mine indicates that the sedimentaries near the granite contact were not prospected for tin in the earlier history of the field, and even that discovery did not result in the vigorous prospecting of the country in the neighbourhood which might have been expected. Other valuable ore-deposits may occur, and prospecting in the direction of the Little Henty River is recommended. Although beyond the bounds of the South Heemskirk district, the country between the Little Henty and the Henty Rivers is earnestly commended to the attention of prospectors. Little is known of this area at the present time, owing to its inaccessibility, but conditions are favourable for the development of ore deposits, and this area occupies a corresponding position with regard to the Heemskirk granite *massif* as the Zeehan field to the east. In the course of this report the relation of the granite to the ore deposits not only of Heemskirk but also of Zeehan has been referred to, and this relationship indicates that the area mentioned must be regarded as favourable for the development of ore deposits of similar type to those known to occur in the Zeehan field. Whether ore-bearing solutions have been active in this area is for the prospector to determine, and the writer unhesitatingly recommends prospecting in the area. The country is mostly heavily timbered, and frequently carries thick undergrowth: the surface is irregular, being intersected by recent streams which have cut and are still cutting into an uplifted land surface which formerly had been worn down almost to sea-level.

The writer was unable from records available to determine the actual output of tin ore from the South Heemskirk Tinfield, but has estimated that at least 600 tons of tin oxide have been produced. This figure has been arrived at after a study of the annual and quarterly reports of the Secretary for Mines, official reports on particular mining properties, and from information supplied by individuals familiar with the mines in their earlier history. In some cases returns were quoted for the "West Coast," and an estimate has been arrived at by noting the mines known to be working other than those on the field itself, as well as those in the district, and crediting the latter with a fair proportion based on the proportion in years when full particulars were available.

Although the amount of 600 tons of tin oxide is only an estimate, it serves to give an idea that some good tin shoots must have been worked. After reading the chapter on the mining properties, in which is fully described the work which has been carried out, and noting the ore produced from this comparatively small amount of work, the writer would contend that a strong argument is presented for claiming further attention for this field.

As to resources of the district other than those of mining, it cannot be said that prospects are very bright. The bulk

of the granite area is covered by only a shallow layer of barren sandy soil and rubble from the weathering of the igneous rocks, which in the more exposed portions supports only button-grass. Clumps of timber occur in the more sheltered valleys of the Heemskirk Range, and will serve to satisfy mining requirements, but are not likely to prove of sufficient value, in their present inaccessible positions, to be exploited for sawmilling purposes. To the south and east of the granite, the area occupied by the basic igneous rocks and by the sedimentary rocks is usually fairly heavily timbered, and when this country towards the Little Henty River is opened up, it may be found that there is a certain amount of timber worth taking out. The soil here, especially that derived from the sedimentary rocks, is good, and some of this land, as for instance along Pyke's Creek, would be very suitable for grazing if cleared.

It is on mining, however, that the future of the district depends, and prospects are such as to warrant the hope that in the near future the South Heemskirk Tinfield will take its rightful place among the regular tin producers of the State.

In commenting on certain of the methods of mining and treatment in vogue at the time of his visit to the field the writer has not done so in any spirit of carping criticism, but rather in the hope that the suggestions offered may be adopted, confident that improvements on the lines indicated will help to restore public confidence in the field.

In conclusion, the writer would express his indebtedness to the reports of Messrs. G. A. Waller and L. K. Ward, which have been freely consulted in the preparation of this bulletin. He would also record his grateful appreciation of the kindness extended to him by all with whom he came into contact during his stay on the field: he would especially thank Mr. A. Yates for rendering valuable assistance in the field on many occasions, and for supplying much useful and reliable information concerning many of the mining properties which were deserted at the time of his visit.

Messrs. J. H. S. Munro and J. Barclay courteously placed their cottage on the Federation Mine at the writer's disposal during his examination of the district, and he has pleasure in thanking them for this hospitality.

L. LAWRY WATERHOUSE, B.E.,
Assistant Government Geologist.

Launceston, 15th October, 1915.

APPENDIX I.

NOTES ON PLATES.

PLATE II.—*Geological Sketch-map of the South Heemskirk Tin-field.*

This map, as its title states, purports to be only a sketch-map. Topographical features are shown in a general way only, and the contours are only intended to give an idea of the general nature of the topography. As explained in the text of the bulletin, the surface of the coastal peneplain is very uneven, although the ridges are of approximately the same altitude; no attempt has been made to depict in detail the features of this coastal strip. The map is based on the mineral charts supplied by the Mines Department, Tasmania, and includes portions of the charts of Heemskirk, Zeehan, and Mallanna.

PLATE III.—*Geological Sketch Section on the Line AB—Direction N. 55° E.;*

PLATE IV.—*Geological Sketch Section on the Line CD—Direction N. 70° W.*

These sections are designed to illustrate the geological structure of the district as interpreted by the writer, and particularly the relationship of acid and basic igneous rocks to the intruded series of sedimentaries. The writer desires to emphasise that, although vertical scales are shown on the plates, and the surface profile has been made as accurate as possible by utilising this scale to indicate altitudes above sea-level, the scale does *not* apply to the underground contacts of the igneous rocks or to the contacts of the igneous rocks with the sedimentaries; this portion of the section is intended to be diagrammatic only. In other words, the section does not pretend to indicate the exact depth below the surface at which the igneous rocks would be encountered. Plate III. shows that, in the writer's opinion, the sedimentary rocks exposed in the country traversed by this particular line of section are resting on a foundation of basic rocks, which themselves are, in part at least, resting on acid rocks.

PLATE V.—*Chart of Mineral Sections of the Heemskirk District.*

This plate includes the mineral chart of the district of Heemskirk and portions of the charts of Zeehan, North Heemskirk, and Mallanna, and is intended to show the numbers and names of the holders of the mineral sections in the area dealt with in the bulletin. The mineral charts referred to are those issued by the Mines Department, Tasmania.

PLATE VI.—*Locality Sketch-map: The Federation Tin Mine;*

PLATE VII.—*Locality Sketch-map: Kelvin and Mayne's Tin Mines.*

These plates are sketch-maps only, but illustrate the descriptions given in the text of the bulletin of particular mining properties. Plate VI. is based on the plate issued by G. A. Waller in his official report on the district in 1902, with additions by the writer, and also incorporates some information from a mine plan prepared by Mr. A. Yates, manager of the Federation Tin Mine.

APPENDIX II.

EXPLANATION OF PHOTOGRAPHS.

PHOTO. 1.—*Nodular Tourmaline Granite.*

The photo. shows a typical outcrop of "white" granite, with nodules of quartz-tourmaline, as described in the text. Being harder and more resistant to the attacks of weathering agencies than the surrounding granite, these nodules stand out in sharp relief. The scale (12 inches vertical, 12 inches horizontal) is shown. Just below the vertical edge of the rule is a narrow fissure filled with black tourmaline, standing out in slight relief, and cutting through one of the nodules, which obviously had previously consolidated. Similar narrow veins are shown on the left-hand boulder.

PHOTO. 2.—*Panoramic View of the Cumberland Dam.*

The photo. is taken looking in a south-easterly direction. The whole of the country shown is of granite. Typical rounded hills resulting from the weathering of this rock are seen.

E is the embankment across the gorge of the Cumberland Creek by which the whole of this magnificent body of water is stored. This embankment is only 1 chain in length, and is the only work which has been necessary to form this dam.

B, representing another creek, now forms the by-wash by which the overflow water escapes through the short race cut a few feet below the normal ground surface. The water is dammed back for some distance beyond the left-hand edge of the photo., and from this low ground the country rises steeply to the summit of Mt. Agnew. These slopes are heavily timbered. The country in the photo. is covered with button-grass, scrub occurring in the gullies. This plateau, another portion of which is illustrated in Photo. 19, is at an elevation of about 1500 feet above sea-level.

PHOTO. 3.—*Portion of Western Area of the Coastal Peneplain.*

This panoramic view was taken from the top of the haulage-line at the Federation Tin Mine, and includes a view from south-west to north-west. The whole of the country shown is of granite, and the photo. illustrates the manner in which the peneplain is dissected by short consequent streams. The area is covered with button-grass, scrub occurring in most of the creek-beds.

A The Pulpit Rock illustrated in Photo. 12.
B shows the position of the Cliff Tin Mine on the coast.
C shows the position of the Cornwall Tin Mine on the coast.
D is Gap Peak.

E shows the position of Granville Harbour.
F R. Clarke's Mine (old Prince George), on Packer's Creek
G Federation Cottage.
H Area stripped and worked for alluvial tin, small patches of which occur at intervals over the plain.
J The tip of the 570-feet level (No. 4 Adit).
K shows the position of the 500-feet level (No. 3 Adit).
L The Federation battery and concentrating plant.
O Outcrops of quartz-tourmaline lode-formations shedding large quantities of detrital material.
R The Trial Harbour-Corinna Road, winding over the peneplain.

PHOTO. 4.—*Panoramic View of the Southern Portion of the Coastal Peneplain.*

The view is taken from the spur of the Heemskirk Range overlooking Sweeney's Mine, and embraces the view from the south-east through south to south-west. The foreground of the photo. is granite, the contact with the Pre-Silurian slate being shown approximately by the edge of the belt of timber in the line KJJ.

A Cape Sorell.
B Mouth of the Henty River
CC Mouth of the Little Henty River, which here flows for about a mile in a meandering course across the sand before entering the ocean. The river sometimes cuts straight through the sand-bar, the conditions determining this change being discussed in the text of the report.
ABC represents the long stretch of sandy beach known as Ocean Beach, the entrance to Macquarie Harbour being a little to the left of A.
DD is a hill of supposed Silurian sandstone (shown also in Photos. 7 and 15), described in the text. Between D and E Pre-Silurian sediments, with some lime-silicate rocks intercalated, are exposed on the coast. Photo. 13 represents a view along this strip of coast.
E shows the hill of serpentine near Trial Harbour on which are situated the works of the Nickel Reward Mine. From E to F along the coast is serpentine.
F shows the position of Trial Harbour.
G is the turn-off of the Trial Harbour Road from the main road, Zeehan-Corinna.
GHHH shows the Zeehan-Trial Harbour Road following the coastal peneplain.
JJJCC shows approximately the course of the Little Henty River.

PHOTO. 5.—*Mouth of the Little Henty River.*

This photo. is taken from the northern end of Ocean Beach, looking about north. Instead of cutting through the beach in a direct course to the ocean the river, at the time this photo. was taken, was meandering along the beach, as shown in Photo. 4. The prominent peak in the background is Mt. Agnew, with the Heemskirk Range on the left. In the middle foreground is the edge of the Little Henty peneplain, here very densely timbered.

Photo. 6.—*Typical Scene on the Sea-coast forming the Western Boundary of the Heemskirk Tinfield.*

The photo. was taken from the Cliff Tin Mine, looking north-west. The rugged coast is formed by granite cliffs from 300 to 400 feet in height. The more rapid slope of the coastal peneplain near the sea-coast, as described in the report, is illustrated by this photograph.

Photo. 7.—*Panoramic View of Trial Harbour and Vicinity, Looking South.*

The hills in the foreground on the left of the photo. are Pre-Silurian sedimentaries intensely metamorphosed; the country in the middle foreground represented by ABCREE is serpentine, while that in the background is Pre-Silurian slate and sandstone, with the exception of the hill G, which is probably Silurian.

ABC This hill shows the position of the Nickel Reward Mine described in the text.
A is the No. 3 Adit.
B the shaft.
C No. 2 Adit.
D represents the remains of the jetty on which was landed all the material for Remine, and, in their early history, everything for the Heemskirk tinfield and for Zeehan.
EE Long jutting reef of serpentine uncovered at low water, covered at high water, forming the southern boundary of the so-called harbour, which is represented by EEDF. It was necessary for steamers to anchor some distance out, and material had to be landed by boats and lighters.
G Hill of probably Silurian sandstone, grits, &c., shown also in Photos. 4 and 15.
H Mouth of the Little Henty River.
J Mouth of Henty River.
K Cape Sorell.
HJK Ocean Beach.
L Mouth of Montagu Creek.
R is the site of the old township of Remine, with not a building standing at the present time to indicate the exact position of the old township, the whole area being covered with dense scrub.

Photo. 8.—*Fissured Granite Cliffs.*

Photo. is taken from the Cliff Tin Mine, looking west, and shows well the parallel fissuring of the granite described in the text. The fissures are brought into prominence by weathering, largely assisted in this instance by salt water and moist sea air. The effect of this fissuring in determining the configuration of the coast-line is well

shown. Large flakes of rock break away, and the sea encroaches in narrow inlets along the line of strike of the fissures.

Photo. 9.—*Coarse-grained Pink Granite with Veins of Aplite.*

The veins of aplite traversing the granite shown are quite characteristic, and are very common throughout the district. The main vein of aplite shown has been faulted and displaced several feet. The scale is approximately shown by the geological hammer.

Photo. 10.—*Nodular Tourmaline Granite.*

The photo. shows a characteristic outcrop of the "white" granite of Devonian age on the high ground in the northern portion of the Federation lease. The quartz-tourmaline nodules frequently stand out several inches in relief, and, as weathering proceeds, collect on the hillslopes and in the creek-beds in great numbers. A thin plate of quartz and tourmaline is shown about the centre of the photo., and has resulted from the weathering away of the granite from a narrow fissure filled with the harder and more resistant quartz and tourmaline. The scale is shown in the centre of the photo. (12 inches vertical and 12 inches horizontal).

Photo. 11.—*Typical Granite Country of the Heemskirk Range.*

The photo. was taken from the old horse-tram of the Federation Tin Mine, looking about north. It shows the typical rounded granite peaks of the Heemskirk Range, and the parallel fissuring of the granite described in the text. Many of the hillslopes are covered with button-grass and low scrub, but in all sheltered gullies thick timber and very dense undergrowth flourish.

Photo. 12.—*Pulpit Rock.*

This rock (referred to in the text) represents a residual weathered boulder of coarse-grained pink granite of Devonian age. The photo. shows the effect of weathering and changes of temperature on such an exposed rock, thin plates flaking off from time to time. An idea of the size of the boulder is given by the camera bag at the foot of the boulder, measuring 12½ by 7½ inches, and the 5-feet stick alongside the bag. The rock stands on a ridge a short distance from the edge of the cliffs, and is said to be visible for many miles out to sea, and forms a landmark for the surrounding country. Its position is shown at A in Photo. 3. Elevation, 450 feet above sea-level.

Photo. 13.—*Differential Weathering of Calcareous Bands in Pre-Silurian Sediments.*

The exposure illustrated is on the sea-coast, about 1 mile south of Trial Harbour, and not far beyond the boundary of the serpentine. The Pre-Silurian sediments in this locality consist of slates and sandstones, usually indurated, with intercalated calcareous bands sometimes converted to lime-silicate rocks. The more rapid erosion of the calcareous bands at this spot gives the rock the honeycombed appearance which is well illustrated in this photo. The scale is indicated by the 2-feet rule bent at right angles.

PHOTO. 14.—*Folded Pre-Silurian Slates.*

This exposure (in a side-cutting on the Zeehan-Trial Harbour Road) of Pre-Silurian slates illustrates well the anticlinal and synclinal folding which have been induced in the sediments; although at practically all points where exposed the sediments show signs of intense crushing, it is exceptional to find such a good example of folding as that illustrated.

PHOTO. 15.—*Coastal Exposure of Pre-Silurian Quartzites and Slates.*

The rocky point illustrated is about 1 mile north of the mouth of the Little Henty River. The sediments consist here of quartzites, with alternating bands of slate, the whole series showing signs of intense crushing. There is a tendency all along this coast, where the rocks are developed along the sea-board, for such hard rocks to form projecting points. The hill in the middle-foreground is just north of the Little Henty River, and is of sandstone and grits, which are probably of Silurian age (*vide* text of report).

PHOTO. 16.—*Coastal Cliffs showing Granite-Slate Contact.*

About 1 mile north-west of Trial Harbour. The granite (on the left of the photo.) is of Devonian age, and is the coarse-grained pink variety. The slate (showing as a black outcrop on the right of the photo.) is of Pre-Silurian age, and is intensely metamorphosed, abundant amphibole, biotite, quartz, &c., being developed. The cliffs at this point rise to a height of 400 feet above sea-level.

PHOTO. 17.—*Xenolith of Slate included in Granite.*

This interesting occurrence is situated at the base of the coastal cliffs, a few feet above sea-level, about 1 mile north-west of Trial Harbour. In the right-hand top corner of the photo. the actual contact of granite and slate is shown; the actual granite contact is about 20 yards to the right (south) of the xenolith. The block of slate shown in the centre of the photo. has become detached from the overlying rocks while the granite rock-mass was still molten, has sunk some distance in the molten mass, and been enclosed therein when the granite consolidated. The block is completely included in the granite, its size being shown by the scale (12 inches vertical, 12 inches horizontal) photographed. The rock is intensely metamorphosed, as described in the text of the report. The granite is the coarse-grained pink variety of Devonian age, and the slate is Pre-Silurian.

PHOTO. 18.—*Western Portion of the Federation Tin Mine.*

The photo. shows the gorge cut by a branch of Packer's Creek into the granite, and also the button-grass covered hillslopes with abundant granite outcrops. The freedom from timber is noticeable.

- A The highest point on the Federation lease, about 1800 feet above sea-level, marking the position of Munro's shaft.
- B shows the position of the Whip Shaft.
- C the 500-feet (No. 3 Adit).
- D 570-feet (No. 4 Adit).
- E The top of the old haulage-line (the point from which Photo. 3 was taken) and the position of Yates' Level.
- EJ The old haulage-line by which ore was removed to the battery, now in a state of disrepair.
- F marks the position of the discovery of rich tin, which was afterwards worked by the tributers by an open-cut.
- G is the tributers' tunnel driven to communicate with the pipe workings.
- H Gray's lode.
- J The Federation battery and concentrating plant.
- KK Branch road connecting with the main road to Zeehan.
- L Alluvial workings from which some tin and also some good wolfram were won, as described in the text.

The group of workings shown are known as the Western Workings. The photo. is taken looking east. The ridge in the background slopes eastwards to the Cumberland Dam.

PHOTO. 19.—*South-Eastern Portion of the Federation Tin Mine and Cumberland Dam Plateau.*

From the ridge in the left background of the photo. the slope is westward to the coastal peneplain, as shown in Photo. 18.

- A The highest point on the Federation lease, marks the position of Munro's Shaft (compare Photo. 18).
- B The Air Shaft workings.
- C Talus heap, described in the report.
- D The Long Tunnel.
- E Site of residence of the manager of the old Cumberland Company.
- FFFF The old tramway of the Cumberland T.M. Company by which ore was conveyed from the Long Tunnel to the battery for treatment.
- G The Federation pack-track after crossing the embankment of the Cumberland Dam.
- HHH The Heemskirk Range.
- JJ Arms of the Cumberland Dam.
- K Eastern workings of the Federation Tin Mine.

PHOTO. 20.—*Radiating Black Tourmaline.*

These specimens were collected from the old Cornwall Mine on the sea-coast, which provides magnificent cabinet specimens of the mineral. The radiating habit from a central nucleus is well illustrated. Scale of inches is shown.

PHOTO. 21.—*Mayne's Tin Mine Workings.*

The photo. gives an excellent idea of the way in which work was carried out at Mayne's Tin Mine. This photo. should be compared with Plate VI., upon which it throws a good deal of light. Rich tin was found to occur at different points on the hillslope, and was extracted without any systematic method of working and treated in sluice-boxes. Most of the dump-heaps shown in the photo. carry fair tin values. The photo. was taken from No. 5 Cut, looking north. The various open-cuts are numbered to correspond with those shown on Plate VI. The country-rock in the foreground is Pre-Silurian sandstone and slate; that of the Heemskirk Range, in the background. Devonian granite.

A No. 1 Open-cut.
B No. 2 Open-cut.
C No. 3 Open-cut.
D No. 4 Open-cut.
E Shaft.
F Entrance of tunnel driven through the hill.
G Workings on pyritic formation.
H Position of winze from No. 2 Cut.
J Side cut from No. 2 Open-cut.
K Camp.
L Dam of the old Orient Company.
M Mt. Agnew, with other peaks of the Heemskirk Range to the left.
NNNNN shows the approximate course taken by the pack-track constructed over a saddle of Mt. Agnew.
O Approximate position of Cumberland Dam.
PPP Pyke's Creek.
R Approximate position of Healey and McIvor's Mine.
S Approximate position of Sweeney's Mine.

PHOTO. 22.—*Kelvin (Williams') Tin Mine.*

The photo. shows the plant of the Kelvin Tin Mine; the light three-head battery is driven by a water-wheel (on the far side of the shed), the pulp being fed on to a Wilfley table and slimes over short canvas tables shown in the right of the photo. Quartz-tourmaline outcrops occur on the summit of the hill in the left-centre of the photograph.

APPENDIX III.

THE HEEMSKIRK MASSIF—ITS STRUCTURE AND RELATIONSHIPS.

By L. KEITH WARD, B.A., B.E.

(With Two Plates, Nos. XIII. and XIV.)

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I.—INTRODUCTION.

Most students of that branch of geological enquiry which is concerned with ore-deposits have within recent years come to believe that a large number of ore-deposits are genetically related to masses of igneous rock material which are to different degrees exposed in the immediate vicinity of the ore-bodies.

With the progress of systematic mapping it has become apparent that ore-deposits are distributed unevenly among the rocks of different ages, and that thus the periods of ore-deposition may be determined. For example, the majority of the ore-deposits in Tasmania are distributed through rocks of which the age ranges between the Pre-Cambrian and the Silurian. Looking at the matter in another way: those portions of Tasmania in which the Permo-Carboniferous, Mesozoic, and Cainozoic rocks are found at the surface (with the exception of one small region) (1) carry no primary metalliferous deposits of material importance.

By the comparison of the age of the ore-bodies and that of the associated igneous rocks it has been found that there is a definite time relationship between igneous invasion and ore deposition in many different parts of the world.

The statement of the historical aspects of ore deposition has been made for America by W. Lindgren,(2) for the British Isles by A. M. Finlayson,(3) for various regions in Europe, Africa, and Asia by L. de Launay,(4) and for Tasmania by W. H. Twelvetrees.(5)

In the discussion of this problem there are two rather different aspects which should for some reasons be kept distinct. The author would lay stress on the distinction between the "metallogenetic epoch" and the "metalliferous province"—the relation in time and the relation in space. This distinction must be borne constantly in mind when general problems concerning ore-deposition are under discussion; for in those cases in which ore-deposits have been formed in a single region at different periods a certain confusion may result.(6)

(1) The vicinity of Port Cygnet.
(2) "The Gold Production of North America" (Trans. A.I.M.E., Vol. XXXIII., 1903, pp. 790-845); also "Economic Geology." Vol. IV., No. 5, 1909.
(3) Q.J.G.S., Vol. 66, 1910, pp. 281-298.
(4) *Ibid.*, literature quoted in footnote on p. 281.
(5) Geol. Surv. Tas. Bulletin No. 9.
(6) A. M. Finlayson (*loc. cit. supra*) seeks to avoid such confusion by introducing such a term as a "metallogenetic inlier."

It is regarded by petrologists as an established fact that periods of igneous activity have been, throughout geological history, coincident with periods of crustal deformation, and that the sites of crustal movement have been the sites of co-ordinate igneous invasion.(7)

By a number of mining geologists a parallel claim is made, viz., that periods of ore-deposition have in like manner corresponded in time with the periods of igneous invasion.(8)

The coincidence of mineralised areas with areas marked by igneous invasions has already been referred to. Hence relationship in time must be considered with relationship in space. The igneous rocks which are found associated with ore-deposits are, in different places, products of different phases of igneous activity. In the present paper the author proposes to briefly discuss the form and relationships of certain products of the plutonic phase from the points of view indicated above.

The question is one requiring discussion in the light of data to be provided by many different metalliferous provinces. The present paper has been written in the light of the evidence presented by certain granite masses which play an important part in the geological history of Northern and Western Tasmania. Incidentally, the intrusive rocks which are to be referred beyond doubt to the same source as the plutonic rocks are mentioned, and all are shown together upon one of the sketch-maps which accompany this paper.

II.—The Proximate Source of Igneous Rocks and Metallic Ores.

Concerning the ultimate origin of igneous materials little can be said that is not based upon theories of cosmogony;(9) and since the primary source of all metallic ores must needs be igneous material,(10) the ultimate origin of the ores cannot be traced back with certitude through the more or less hypothetical stages of the early history of the earth.

We must be content for the present to accept only certain broad generalisations with regard to the composition of the earth as a whole. With respect to the distribution of heat and the physical conditions in the interior we are not, for the purposes of this paper, concerned. The author feels that we may safely accept the following statements as being substantially true:—

1. That the interior of the earth is largely composed of metallic ingredients—the "barysphere" of Posepny(11) or the "nife" of Suess.(12)
2. That these metallic ingredients are expelled from time to time into the outer portions of the earth's mass and thus come into place in the zones which are open to geological investigation.

(7) A. Harker: "The Natural History of Igneous Rocks," p. 13.
(8) This correspondence in time is in most cases really the most conclusive proof of the genetic relationship between the igneous bodies and the associated mineral deposits.
(9) *Vide* A. Harker: "The Natural History of Igneous Rocks," p. 13.
(10) *Vide* J. F. Kemp: "Genesis of Ore Deposits" (A.I.M.E., p. 684), and many other writers *passim*.
(11) "Genesis of Ore Deposits" (A.I.M.E., pp. 11, 73, 79).
(12) "The Face of the Earth," Vol. IV., p. 544.

Of the mechanical processes involved in the upward migration of the heavy metals but little can be inferred.

It is, in the opinion of the author, an indubitable fact that the metallic contents(13) of at least many ore-deposits have ascended in association with much larger masses of igneous material of different composition. From the ascending materials, in certain cases at least, three principal products are derived, viz.:—

1. The igneous rock masses (mainly non-metallic).
2. The metallic ores and many of their gangue minerals.
3. The juvenile or magmatic vapours and solutions.

Rather than state that the igneous rocks or vapours have served as carriers of the metallic ores, the author would affirm that all three groups together constitute the real essence of the magma.

The question of the relationship between the metallic ores and the igneous rock-masses demands a detailed discussion for each region in which the relationship may be declared to exist. A study of one such region(14) has been made by the author, and his conclusions stated elsewhere.

In some cases the metallic ores are disseminated through the igneous material with which they have ascended; in other cases they have been collected with the assistance of the magmatic vapours into certain foci, from which they are expelled during the final stages of consolidation.

In either case it is evident that the metallic ores and igneous rock materials have ascended together from the deeper portions of the earth's mass.

With regard to the separation of the metalliferous magma which ascended in the Heemskirk-Comstock-Zeehan district into its several component parts, the author has claimed that a very definite succession of events may be detected from the field evidence. In the evolution of the magma towards the solid state it appears perfectly certain that the granite is the earliest product and that the ore-deposits are the latest products of consolidation.

With the completion of the process of consolidation the period of igneous activity and the metallogenetic epoch closed. It is claimed by the author that *the period of complete solidification of the whole magma and the period of cessation of primary ore-deposition are coincident and co-ordinate for this region.*

It is highly probable that this statement, advanced with confidence for the region mentioned, is applicable also to the other occurrences shown on the maps, in which like igneous rocks are associated with like ore-bodies. With regard to the particular region mentioned the field evidence appears to be particularly conclusive.

III.—The Structure of the Heemskirk Massif.

(*a*) *The Visible Contours.*—From the progress of erosion in the region to which special reference is here made, we are enabled to form a reasonably complete mental picture of the

(13) With regard to the Tertiary andesitic goldfields, Dr. Malcolm MacLaren has put forward other hypotheses. *Vide* "Gold," 1908, p. 61
(14) The Heemskirk-Comstock-Zeehan region of Western Tasmania.

upper portion of the sum total of the consolidation products of the magma as they would have appeared before erosion—with all the intruded rock-masses stripped from them—in the district immediately adjacent to the Heemskirk Range.

The granite *massif* of Heemskirk appears to have possessed an arched or dome-like surface, from which certain tongues or narrow ridges (of granite porphyry) extended upwards.

Traversing the smooth surface of the granite, and even cutting across the apophyses of granite porphyry, the tabular dykes and veins of later date have formed ribs or flanges standing out far in relief above the granite boundaries. This much we may deduce from the study of the present features of the granite *massif*, its borders, and the immediately adjacent country.

(*b*) *The Invisible Contours.*—(i) In a horizontal direction.—When the immediate vicinity of the exposed *massif* is left, the mental construction of the form is to be made only by the application of inferences to be drawn from observation. The upper boundary of the granite dips below the intruded rocks and has not been encountered in mining operations. But the subterranean extension of the granitic portion of the magma beyond the limits of the exposed *massif* of Heemskirk may be, from field evidence, regarded as certain.

Dykes of granite porphyry are found at several points in the Zeehan district, and must of necessity imply an underground extension of the magma in that direction. No less significant, in the opinion of the author, is the distribution of the mineral veins, which are, according to his view, also derivatives from the same mother magma.

The horizontal contours of the invisible extensions of the granite *massif* may thus be to some degree determined by the observation of the distribution of the dykes and veins at the surface, if the hypothesis of the author with regard to the genetic relationship between the ore-bodies and the igneous rocks is true. The limitations of such a method of mapping the underground extensions are obvious. The amount of erosion subsequent to consolidation, the depth of the granite below the present surface, the vertical extent of the dykes and veins, and the ease or difficulty with which surface phenomena may be examined, all influence the degree of success which any such attempt may attain.

(ii) In a vertical direction.—With regard to the vertical extensions of the concealed portions of the granite *massif*, still greater difficulties are involved. Here we are confronted with the great problem of the structural features of a great plutonic intrusion—a problem to which more than one solution has been offered. One of the objects of this paper is to offer a brief discussion of one aspect of the question from the point of view of the student of one genesis.

The granite *massif* of the Heemskirk Range would, in all probability, be classified by different geologists under different names, according to individual taste and usage.

An admirable compendium of existing nomenclature has been given by Professor R. A. Daly, in his paper on the "Classification of Igneous Intrusive Bodies,"(15) to which reference is here made on several occasions.

(15) Journ. Geol., Vol XIII., 1905, pp. 485-508.

The igneous *massif* under discussion is one of which the outcrop occupies a considerable area (approximately 37 square miles), and which appears to descend with steeply sloping sides below the surrounding rocks. Such a mass would probably be termed by different geologists a stock,(16) boss,(17) or batholite,(18) and being thus named, one most important structural hypothesis would be implied, viz.: that with increasing depth, the area occupied by the igneous mass is ever increasing, and that the upper portion of the igneous material rests only upon the more deeply-seated part of its own mass.(19)

It is to this view that the author would demur from the consideration of the field relationships of the ore-bodies which are believed by him to be genetically related to the granite, as has been discussed elsewhere.

The grounds for the author's objections are largely hypothetical, but are based upon a hypothesis constructed from the evidence of actual occurrences.

The points upon which stress is here laid are four in number:—

(1) The ore-bodies of the region appear to constitute a genetically related series, of which the several types are on the whole distinct, but connected by "passage-types."

(2) The ore-bodies of one type are not known to intersect those of another type.

(3) The roots of the vein series appear to be, beyond all shadow of doubt, direct products of differentiation.

(4) The period of primary ore-deposition appears to have terminated abruptly.

While the cooling of the magma as a whole may well have extended over a long period, the metallogenetic epoch has been, according to the views of the author, of relatively short duration—beginning when consolidation was already far advanced, and itself marking the utter termination of consolidation.

If the batholitic structure exists, it is difficult to believe that existing facts of occurrence could have resulted. For then it appears probable that consolidation would have extended over a much longer period, and that from time to time the derivatives of successively deeper portions of the magma would have been extruded. The result would undoubtedly be a marked intersection of the older veins characteristic of one zone by younger veins characteristic of a higher zone, as the source of the vein-matter became deeper and deeper, through consolidation of the magma.

It appears to the author impossible, in view of the field evidence, to admit the alternative view of a batholitic mass in which the mineralisers and metallic ingredients have floated to the top and there collected in a reservoir, so that the metallogenetic epoch closed, not with the complete consolidation of the magma, but with the exhaustion of the reservoir of mineralisers and metals The observed facts point to a general, if

(16) *Ibid.*, p. 502.
(17) *Ibid.*, pp. 501, 502.
(18) *Ibid.*, pp. 503-505. Note: The English usage of a termination in '-ite' rather than '-ith' is here followed for all such words.
(19) *Ibid.*, p. 506. See also J. Barrell: "Geology of the Marysville Mining District, Montana"; Prof. Paper No. 57, U.S.A. Geol. Surv. 1907, p. 168; and E. Suess: "The Face of the Earth," Vol. IV., p. 551.

irregular, distribution of metallic ingredients and mineralisers throughout the whole mass of the magma, or at least through portions which have always possessed very different altitudes since they reached their *mise en place*.

We therefore appear compelled to adopt the view that the mass of the magma is limited. The substructure of the Heemskirk Range is not an ever-expanding mass of granite which is connected with the deeper portions of the earth. When once the limited mass of igneous material has passed into the completely solid state, all connection with the abyssal region has been effectively sealed up. This view implies the necessity for a very definite *bottom* to the greater part of Heemskirk *massif*, above which lie the magmatic foci whence the ore-deposits have been expelled.

What, then, are we to call the Heemskirk *massif*? The only term applicable appears to be that invented by Professor Daly—chonolite. The definition of a chonolite, according to the creator of the term, is(20):—

"An igneous body (*a*) injected into dislocated rock of any kind, stratified or not; (*b*) of shape and relations irregular in the sense that they are not those of a true dyke, vein, sheet, laccolite, bysmalite, or neck; and (*c*) composed of magma either passively squeezed into a subterranean or orogenic chamber or actively forcing apart the country-rocks."

The form of the particular mass under consideration is probably extremely complex. The visible outcrop resembles that of a batholite or stock; but as has been indicated above, it is highly probable that this particular outcrop is that of a mass possessing some of the features of an irregular transgressive laccolite.(21) It remains still to investigate the relationships of this chonolite to the other neighbouring outcrops of similar material, and to those masses which have not been revealed by erosion, but the existence of which we surmise from the observation of dykes and veins identical in character with those found in association with known outcrops.

IV.—The Relation of the Heemskirk Massif to Neighbouring Massifs of Similar Composition.

If the contention of the author with regard to the nature of the Heemskirk *massif* is sound, certain difficulties attend the discussion of its relationship to the other developments of granite at the North Pieman and the Meredith Range. These difficulties are not met with if the batholitic hypothesis with regard to the substructure of the Heemskirk *massif* is supported; for the outcrops mentioned (together with several others lying to the northward, and shown also upon one of the maps) may be regarded as the surface exposures of one great granite mass which underlies an extremely large proportion of Tasmania. All geological evidence supports the view that all these granites are derived from the same source, and that they attained their *mise en place* synchronously.

Yet if a chonolitic form be assigned to each *massif*, a continuous subterranean connection between all of them cannot

(20) *Loc. cit. supra*, p. 499.
(21) *Vide* A. Harker: "The Natural History of Igneous Rocks," p. 68, Fig. 11.

be assumed (except, of course, at an extreme depth below the surface).

An alternative hypothesis, which the author offers for consideration, as being of possible application to the region under discussion, is as follows:—

> The present visible outcrops of granite are the exposures of chonolites of limited extent, though possibly all of greater areal dimensions at some depth below the present surface than at this level. These chonolites extend in a horizontal direction below certain regions, and may in certain cases unite with others. The distribution of the several chonolites is determined by crustal or subcrustal stresses and their results. Hence the distribution tends to be more nearly lineal than that of the more symmetrical bodies (laccolites) which have been injected into unfolded or unfractured regions in other parts of the world. Chonolites, between which connections exist, are arranged along lines or zones of crustal weakness.

This hypothesis, since it states that any connections that may exist between neighbouring chonolites are distributed in accordance with zones of crustal weakness and even dislocation, demands some treatment of the question of the distribution of the igneous rocks and ore-bodies in space.

Without wishing to enter upon a full discussion of the metalliferous provinces of the region to which reference has been made, the author would draw attention to certain already ascertained facts which appear to have some bearing upon the question of the subterranean continuity of the granitic magma.(22)

Unfortunately, the study of the structural geology of the whole region is not yet sufficiently far advanced to permit of the discussion of the relation between structure and the distribution of the igneous rocks in detail. However, the distribution of the igneous rocks and the ore-bodies has been to some extent ascertained, and to this matter of distribution some reference should be made.

When the attempt is made on the assumption of the essential intimate consanguinity of the acidic igneous rocks and the ore-deposits,(23) to follow the course of the Devonian intrusions of the ore-bearing magma, according to the method indicated above, certain striking facts concerning the distribution of mining fields, granite *massifs* and granite porphyry intrusions arrange themselves before us with singular simplicity.

Taking the Heemskirk *massif* as our starting point, and following the mining fields, we pass along a zone which is absolutely continuous in one direction. From Heemskirk we pass to the Comstock, thence to Zeehan, and on through the Five-mile, North Dundas, Colebrook, Rosebery, and Mt. Farrell to Granite Tor. (Perhaps also the Barn Bluff field belongs to this mineralised zone.) Beyond Granite Tor the Dove River and Mt. Claude mineral fields carry on the line, which perhaps extends much further still.

(22) The words "granitic magma" are used to imply the magma from which the granite, *inter alia*, is derived, and has been explained above.
(23) The consanguinity of the ore deposits cannot be doubted. A specimen of typical first-class galena ore, with its characteristic blebs of chalcopyrite, is of constant habit, whether it be obtained from Mt. Zeehan, the Five-mile, Mt. Farrell, or Mt. Claude.

The continuity is as remarkable as are the features of similarity between different ore-bodies in the mining fields mentioned. From point to point structural features vary in detail. These variations are, for the most part at least, introduced by local conditions, and have no genetic significance.

On the other hand, restricting our attention to the distribution of the acidic igneous rocks of Devonian age, we find, on following the same course from the Heemskirk *massif*, that dykes of granite porphyry occur at Zeehan and North Dundas [24], and that granite itself outcrops massively at Granite Tor. Beyond these, and in general line with them, lie the granite porphyry at the foot of Bond's Peak, near the western boundary of the V.D.L. Company's Middlesex block, and the granite mass north of the Dove River and west of Mt. Claude. Then, after a great interval, but still in line, comes the aplitic and pegmatitic granite of Anderson's Creek, near Beaconsfield. This coincident lineal extension of the acidic igneous rocks and mining fields appears to the author to be of the greatest significance, and to imply the existence of some lineal direction of weakness in the crust.

Some confirmation of this view is afforded by the general parallelism of distribution of the consolidation products of an earlier igneous invasion—that of Cambro-Ordovician time. The keratophyric tuffs and the spilite of Zeehan,[25] the keratophyric tuffs and breccias of North Dundas,[26], the schistose keratophyres or porphyroids and porphyrites of North Dundas, North-East Dundas, Rosebery, and Mt. Farrell are on this belt. The granite porphyry which extends from the north-west of Granite Tor to the Dove River, the schistose porphyry of Mt. Roland, and possibly even the epidote porphyrite of Beaconsfield, are to be taken into consideration with these others. The distribution of these related rocks is, at least, significant in support of this hypothesis. Along this line, or rather zone, are situated some of the most important mining fields of Western Tasmania.

The relation of other mining fields and igneous rocks to those which have been mentioned demands passing notice.[27]

A prominent feature in the geology of the West Coast region is the distribution of certain old igneous rocks—schistose tuffs, porphyries, porphyrites, syenites, and granites, some of which occur along a meridional zone which extends from Mt. Darwin to the north of Mt. Black. Plutonic, intrusive, and effusive phases are all represented in this group (that of Cambro-Ordovician age already mentioned), the present distribution of which is clearly axial, even if the lineal arrangement has been accentuated by orogenic disturbances subsequent to consolidation.

The distribution of the Mt. Darwin, Mt. Jukes, Mt. Huxley, Mt. Lyell, Mt. Read, and Chester mineral fields, is, in general, coincident with that of this belt, but in the opinion of the author the ore-bodies belong to the Devonian metallogenetic epoch. The reasons for this statement cannot be here fully discussed. It suffices to state that the author believes that the

(24) Aplite has been also recorded in Zeehan, Geol. Surv. Tas. Bulletin No. 8, pp. 27-28. A doubtful case of the occurrence of pegmatic has been observed to the south of Mt. Farrell. Annual Report Sec. Mines, Tas., 1909, p. 93.

(25) Geol. Surv. Tas. Bulletin No. 8, pp. 15-19.

(26) Geol. Surv. Tas. Bulletin No. 6, pp. 16-18.

(27) For they, too, extend along restricted zones. Between the zones of intrusion by igneous materials there are no known mineral fields.

mineralogical character of the ores of this belt of orogenic disturbance points most strongly to the necessity for classifying them with the Devonian ore-bodies. Hitherto there have not been found any igneous rocks along this belt which may be assigned to the Devonian intrusion. The author anticipates that these will yet be recognised, but he believes that the characters of the ore-bodies themselves are sufficient evidence of the existence of the Devonian granitic magma along this zone below the surface.

The two zones already mentioned appear to unite in the neighbourhood of Rosebery, not far from Mt. Black. These two zones do not include within their limits a number of the important outcrops of granite and granite porphyry of Tasmania, nor do they embrace some well-known mining fields. Of these other mining fields the author has no detailed knowledge.

Having, however, indicated that there is one very well defined zone of intrusion and mineralisation between Heemskirk and Middlesex, it is interesting to observe that the outcrop of granite at the Meredith Range and Heazlewood, the granite porphyry at Mt. Bischoff, the outcrop of granite on the Blyth River to the east of the V.D.L. Company's Hampshire Hills block, and again that of the Dial Range, are disposed in a zone which is approximately parallel to the former. The further investigation of this zone cannot at present be made.

There remains the North Pieman *massif*, which is not a prominent one, its surface being barely exposed by the total effect of successive cycles of denudation. With it are to be grouped the dykes on the coast-line to the south of the Pieman Heads. The relationship of this *massif* to that of Heemskirk and that of the Meredith Range cannot be said to have been definitely recognised in any particular.

Whether the Meredith Range *massif* has any connection with the Heemskirk-Middlesex zone remains to be proved. Should the hypothesis here put forward be sound in principle, it will be of interest to investigate in the future the already recognised zone of intrusion, marked by the basic rocks which extend from the Colebrook Hill towards the Parson's Hood, for signs of the acidic magma.

V.—Conclusion.

From the several considerations discussed, the author would affirm that the relationships of the Heemskirk *massif* to its immediately surrounding rocks, to the associated dykes and ore-bodies, to certain other similar *massifs* and other ore-bodies, and to certain of the main structural features of Tasmania are approximately known. These relationships may be briefly summed up as follows:—

(1) *The Relationship to the Surrounding Rocks.*—The granite outcrop is that of a massive transgressive intrusion of irregular form, but limited mass—that is to say, of a "chonolite" or irregular transgressive laccolite.

(2) *The Relationship to Associated Dykes and Ore-bodies.*—The granite is one of the products of the consolidation of a magma which gave birth, during its passage into the solid state, to a definite succession of fractional parts, all of which, taken together, constituted the essence of the magma at the time of irruption. Of these fractional parts the granite is the greatest

in mass. The ore-bodies formed within the limits or in the immediate neighbourhood of the *massif* are the latest-born products of the parent magma, and are zonally disposed with regard to the granite. The temperature of the granite at the period of ore-deposition has exerted a potent controlling influence upon this zonal distribution of metallic ores.

(3) *The Relationship to Other Similar Massifs and Other Ore-bodies.*—The Heemskirk *massif*, with its apophyses and cognate dykes and veins, is genetically related to the similar invading materials which made their irruption into many parts of Tasmania shortly after the close of the Silurian period. They are most directly related with the igneous dykes and ore-bodies arranged along a zone extending from Heemskirk through Middlesex (perhaps even to Beaconsfield). Along this zone the granite itself outcrops at several points, the granitic apophyses at intermediate points, while the ore-bodies are distributed along a practically continuous belt of mineral fields. At some depth below the surface there is possibly complete continuity of the granite along the zone.

(4) *The Relationship to Certain of the Structural Features of Tasmania.*—While the actual form assumed by the Heemskirk *massif*, its apophyses, and its associated dykes and veins are all to be ascribed very largely to local structural conditions, the general distribution of these derivatives of the ascending magma has been decided by the existence of an old zone of crustal weakness. For no less remarkable than the lineal definition of this zone is its geological persistence. The granite of Heemskirk lies upon an axis of at least two igneous invasions, viz., those of Cambro-Ordovician and Devonian time. Still another invasion (of gabbro, norite, and serpentine) affected some portions of this zone at a period which is of Post-Silurian but pre-granitic age.

With the acceptance of this statement of the structure and relationships of the granite of the Heemskirk Range, many problems of interest and of economic importance suggest themselves. The author cannot here undertake the discussion of such problems, but desires to lay stress upon the necessity for regarding the granite *massifs* of Western Tasmania as being themselves of limited extent in a vertical direction, and extending horizontally along lines of crustal weakness which are axes of igneous invasion.

The author desires to acknowledge the receipt of no small amount of information with regard to the distribution of the rocks here mentioned from Mr. W. H. Twelvetrees, from whom he has obtained permission to publish the accompanying maps.

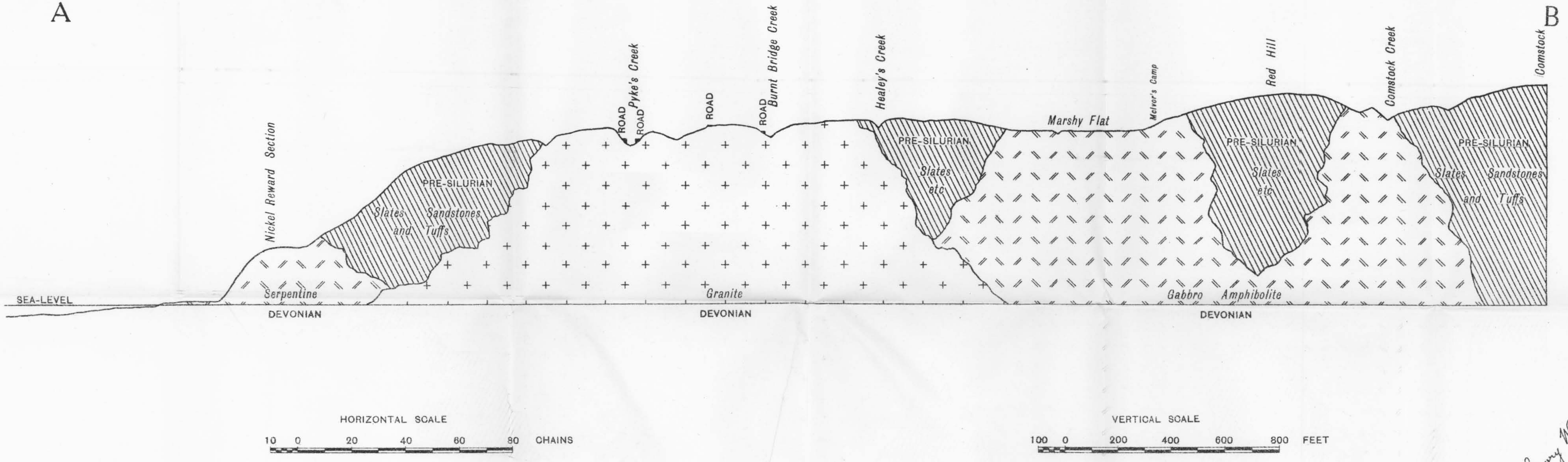
KEY TO NUMBERS OF MINERAL SECTIONS

Number of Section	Acres	Lessee
3917-M	268	J. H. S. Munro
5765-M	40	
124 M	18	
3915-M	2	
6660-M	20	E. Mulcahy & M. Bullen
1141-M	20	D. Sweeney
1142-M	20	
1187-M	21	D. B. Sweeney
1188-M	19	
3276-M	2	R. Clarke
6206-M	80	J. Campbell
4653-M	5	J. Campbell & H. Castle
6922-M	80	Lipscombe & Hutchinson
6095-M	40	H. V. Williams, C. O'Brien, & T. Buckley
6240-M	80	R. W. Horsburgh
6743-M	80	C. Brumby
6667-M	80	H. D. Marsh
6715-M	80	
463 D.C.		R. Clarke

Photo Algraphed by John Vail Government Printer Hobart Tasmania

PLATE III

GEOLOGICAL SKETCH SECTION ON THE LINE A B

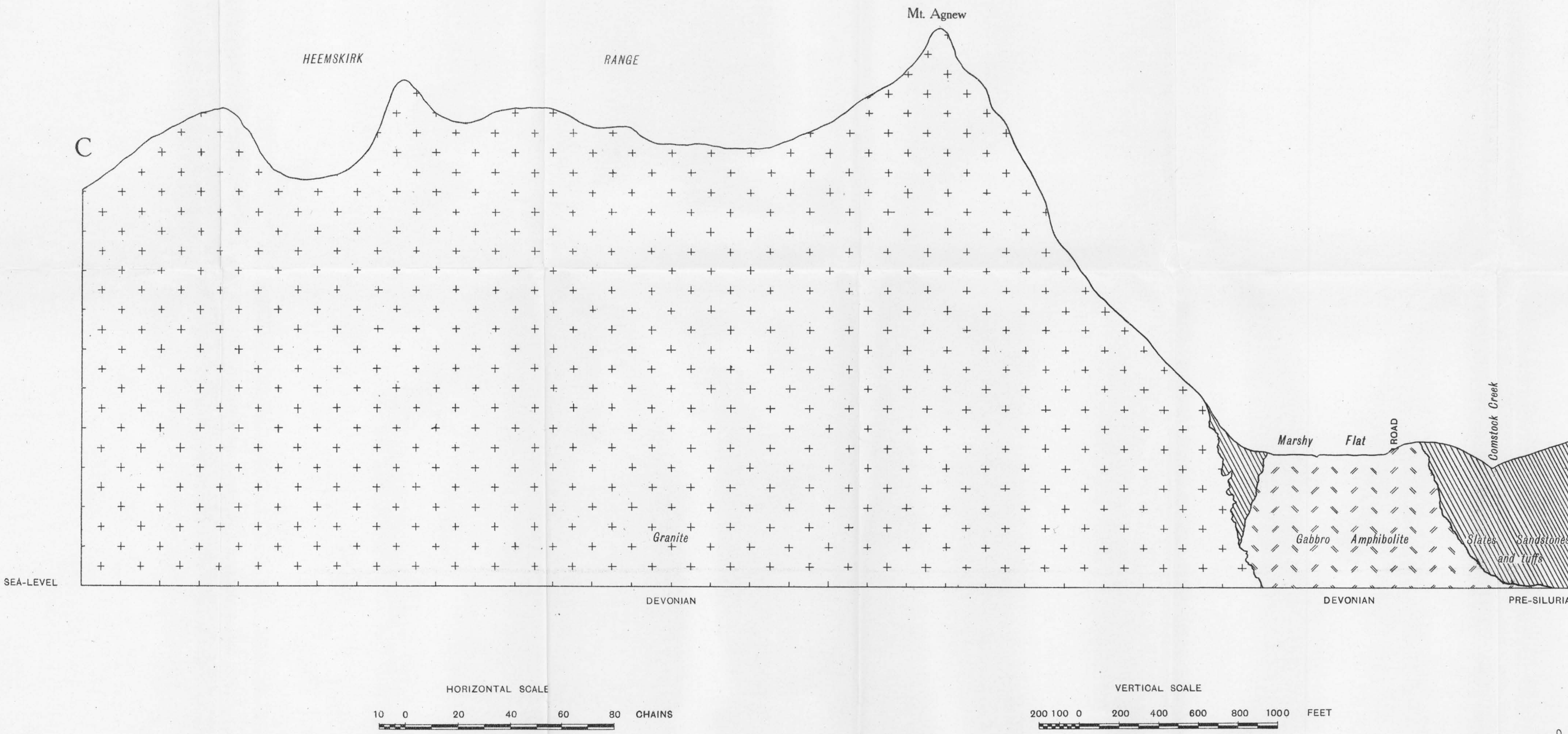


L. Lawry Waterhouse B.E.
Assistant Government Geologist
15th October 1915.

Photo Algraphed by John Vail Government Printer Hobart Tasmania

PLATE IV

GEOLOGICAL SKETCH SECTION ON THE LINE C D



L. Lawry Waterhouse B.E.
Assistant Government Geologist
15th October 1915.

Photo lithographed by John Vail Government Printer Hobart Tasmania

PLATE V

MINERAL CHART OF THE HEEMSKIRK TIN FIELD

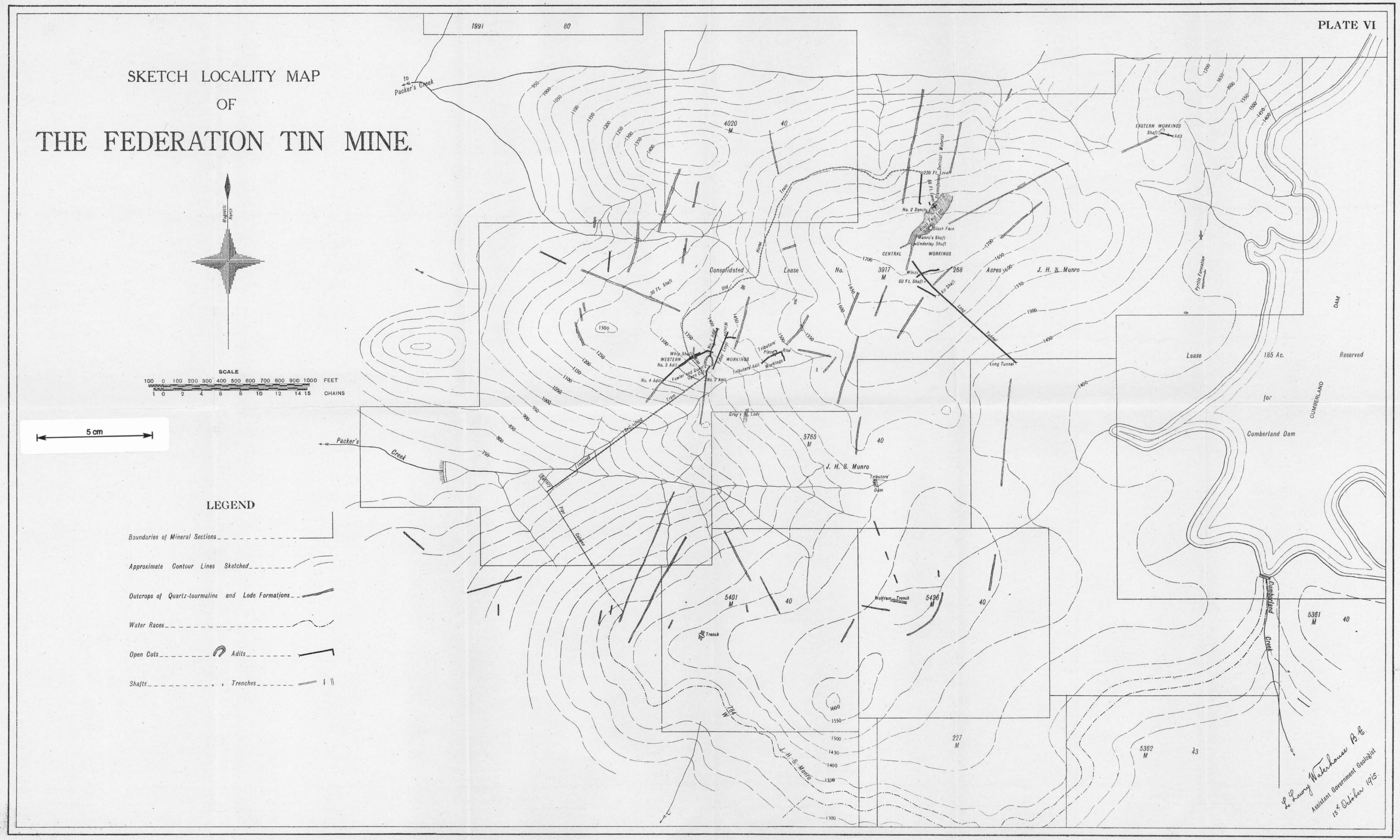


Photo lithographed by John Vail, Government Printer, Hobart, Tasmania.

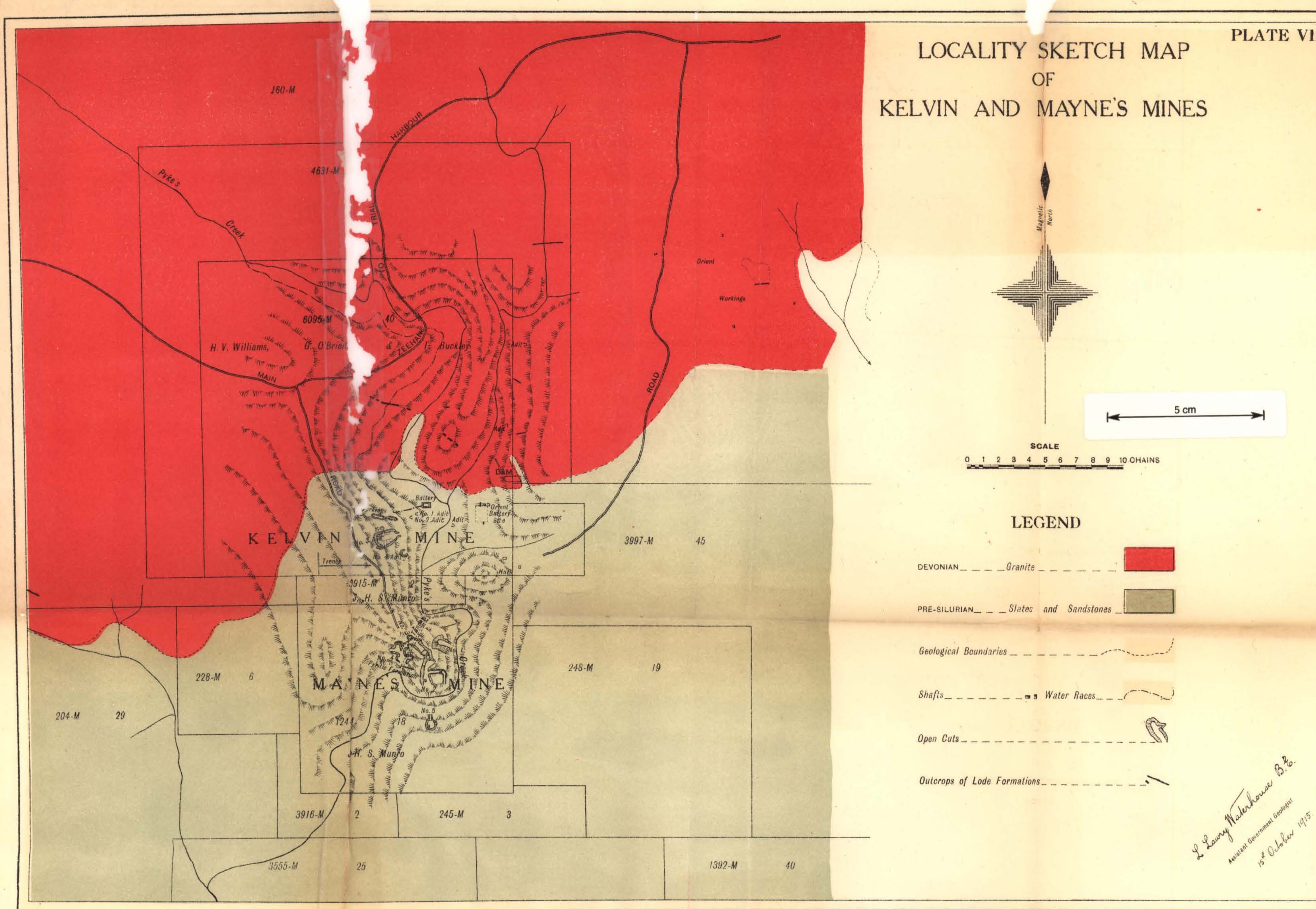


Photo Algraphed by John Vail Government Printer Hobart Tasmania.