

GS REP 6

Tasmania

---

DEPARTMENT OF MINES

---

---

GEOLOGICAL SURVEY REPORT

No. 6

---

---

Reconnaissance of the North  
Heemskirk Tinfield

BY

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

---

Issued under the authority of  
The Honourable J. E. OGDEN, Minister for Mines



Tasmania:

JOHN VAIL, GOVERNMENT PRINTER, HOBART

---

1915

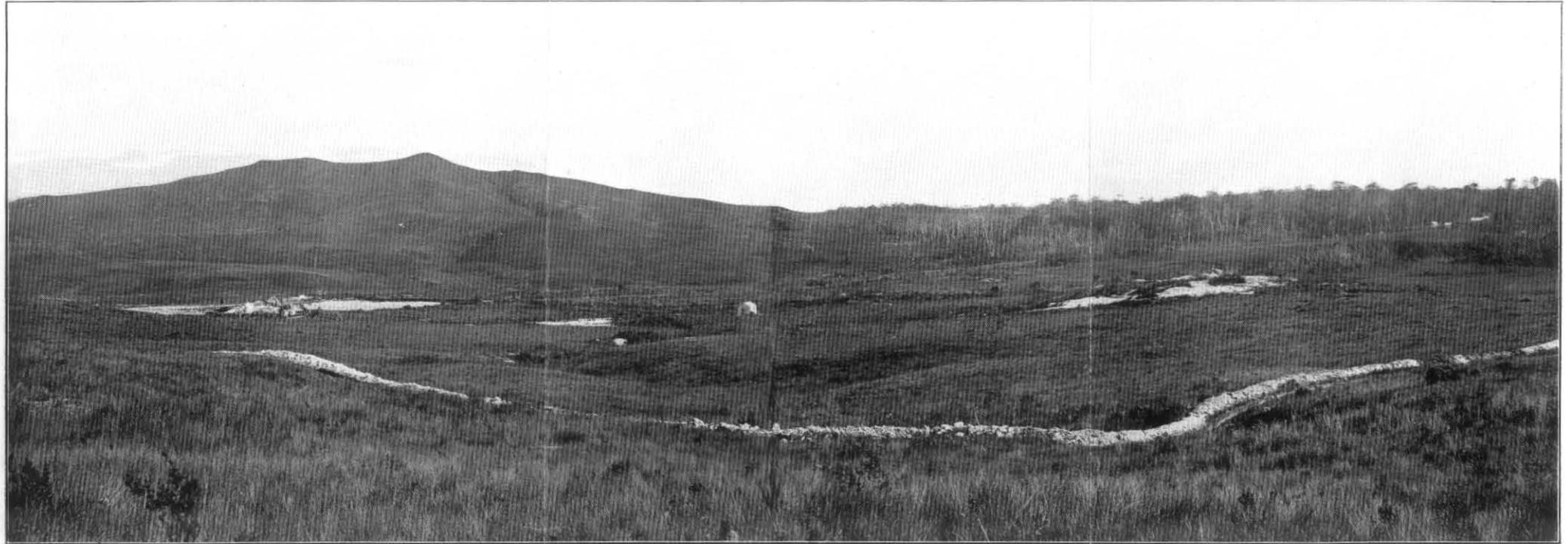


PHOTO 1.—DONNELLY'S LOOK-OUT, NORTH HEEMSKIRK, SHOWING HEEMSKIRK TIN SYNDICATE'S WORKINGS IN THE FOREGROUND.

*L. L. Waterhouse, Photo.]*

## TABLE OF CONTENTS.

	PAGE.
I.—INTRODUCTION AND TOPOGRAPHY ...	1
II.—GENERAL GEOLOGY ... ..	5
A.—Igneous Rocks ... ..	5
(1) Gabbro ... ..	5
(2) Granite ... ..	7
(3) Diabase ... ..	9
(4) Basalt ... ..	10
B.—Economic Significance of the Igneous Rocks ... ..	11
C.—Sedimentary Rocks ... ..	12
(1) Pre-Silurian Slates, Sandstones, and Tuffs ... ..	12
(2) Tertiary Sandstone and Conglomer- ate ... ..	13
(3) Tertiary Gravels and Alluvium ...	17
(4) Recent Detrital Material ...	19
D.—Summary of the Geological History of the District ... ..	19
III.—ECONOMIC GEOLOGY ... ..	22
A.—General Considerations ... ..	22
B.—Primary Ore-deposits ... ..	23
(1) Tin Ores ... ..	23
(2) Copper Ores ... ..	24
(3) Iron Ores ... ..	24
C.—Secondary Ore-deposits ... ..	28
(1) Tin Ores ... ..	28
(2) Copper Ores ... ..	32
(3) Iron Ores ... ..	33
IV.—THE MINING PROPERTIES ... ..	34
(1) The Heemskirk Tin Syndicate ... ..	34
(2) The St. Dizier Mine... ..	44
(3) The Peripatetic Mine ... ..	48
(4) Section 3512M, 40 acres, G. Smith ...	50
(5) Long's Iron Blow ... ..	51
(6) The Eureka Mine ... ..	54
(7) Tin Mine, East of Section 5883M, 5 acres, C. D. Finch ... ..	54
(8) A. Fitch's Sections ... ..	56
(9) P. P. Cook's Sections ... ..	57
(10) Other Tin Properties ... ..	57
(11) Granville Harbour Copper Mines ...	57
(12) MacArthur's Copper Mine and Vicinity ...	62
V.—SUMMARY AND CONCLUSION... ..	67

## APPENDICES, &amp;c.

Appendix I.—Explanation of Photographs ... ..	71
List of Publications of Geological Survey of Tasmania ...	73

## LIST OF PLATES.

PLATE I.—Locality Map ... ..	To face page 1
PLATE II.—Geological Sketch-map of the North Heemskirk Tinfield and Environs ... ..	End of Report

## LIST OF PHOTOGRAPHS.

PHOTO 1.—Donnelly's Look-out, North Heemskirk, showing Heemskirk Tin Syndicate's workings in the foreground ... ..	Frontispiece
PHOTO 2.—Mount Heemskirk, The Gap, and part of the North Heemskirk Spur ... ..	Facing page 2
PHOTO 3.—Hydraulic Sluicing, Heemskirk Tin Syndicate's property, North Heemskirk ... ..	Facing page 34
PHOTO 4.—Heemskirk Tin Syndicate's Plant and Workings (Nos. 1 and 2 Paddocks), North Heemskirk ...	Facing page 38
PHOTO 5.—No. 2 Paddock, Heemskirk Tin Syndicate, North Heemskirk ...	Facing page 40

5 cm



# LOCALITY MAP

Photo Algraphed by John Vail Government Printer Hobart Tasmania.

# Reconnaissance of the North Heemskirk Tinfield.

---

## I.—INTRODUCTION AND TOPOGRAPHY.

THE following report deals with an area extending from Mt. Heemskirk on the south to Granville Harbour on the north, and varying in width from about 6 miles on the south to about 1 mile on the north, the coast-line forming the western boundary. It includes the results of a field examination extending from March 2 to 18, 1914. The area adjoining to the south is being fully dealt with in Bulletin No. 21, and for a more complete and detailed discussion of the general and economic geology the reader is referred to that publication.

It has been deemed advisable to record the results of this examination as a Geological Survey Report rather than a Bulletin, mainly for the following reasons:—(a) The examination was comparatively hurried; (b) the work on the most important mining property in the district was insufficiently far advanced with prospecting work to enable any definite forecast to be made of its future; (c) only the fringe of an important strip of country was examined. The area east and north, bounded by the Pieman River, claims attention, but could not be examined on this occasion; the writer hopes to include the results of an examination of the whole of this area in a later bulletin.

Mt. Heemskirk rises to about 2700 feet above sea-level, and forms the northern extremity of the Heemskirk Range. Connected with the mountain by a comparatively low saddle, known as "The Gap," is North Heemskirk Spur, the highest point of which is known as Gap Peak. This range is really a spur of Mt. Heemskirk, which has suffered considerable denudation; it divides the drainage area of the Tasman River from that of Granite Creek and other streams flowing directly into the ocean. From this range the country to the west and north appears generally level, although on closer inspection it is found to be cut through by various consequent streams flowing direct to

the ocean. The ridges between these streams are of approximately equal height, giving the country its even appearance. Standing out prominently above the general level is a peak known as Donnelly's Look Out. This was originally portion of the North Heemskirk Range, but was gradually separated by the wearing down of the connecting saddle, under the long continued influence of weathering agencies. At this time there were streams flowing west into the ocean and east or north-east into the old Pieman River. At the present day North Heemskirk is separated from Donnelly's Look Out by a wide valley occupied by the Tasman River flowing westward into the ocean. This river receives various tributary creeks, of which the chief are the St. Dizier and Twelve Mile Creeks, both from the south. The former occupies the valley between Mt. Heemskirk and North Heemskirk, rising in the spur known as The Gap, which separates these two ranges.

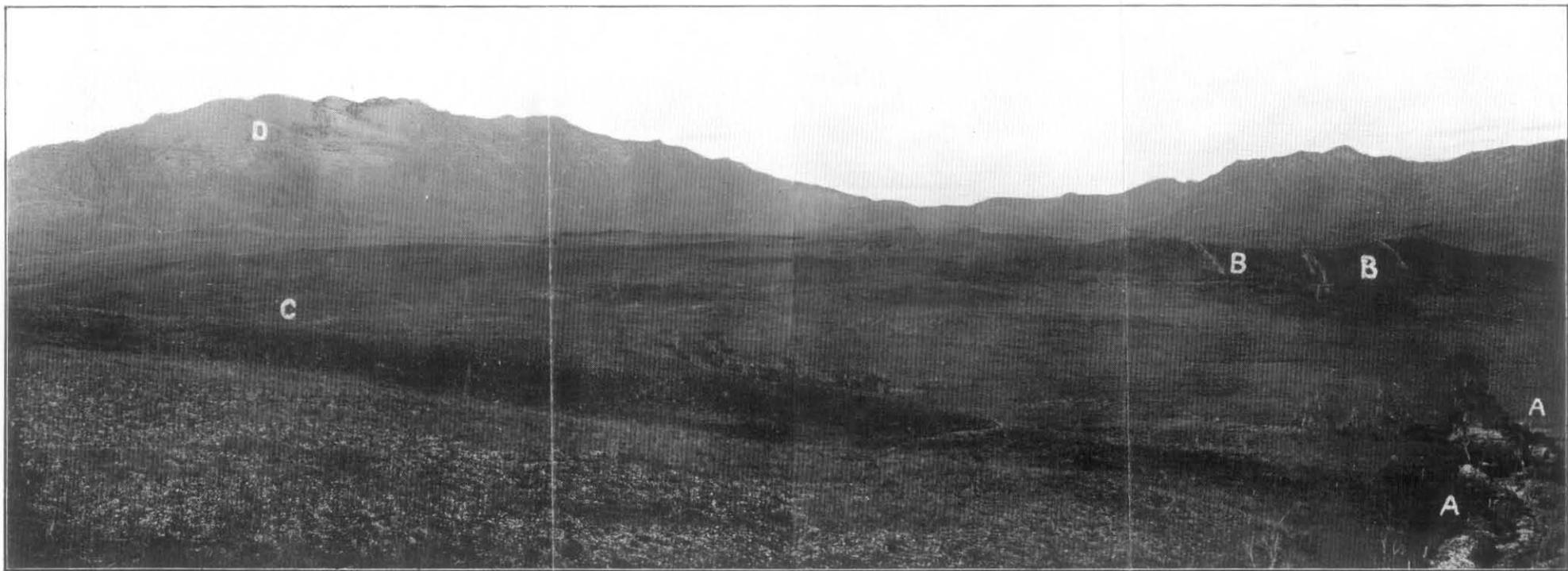
Reference has been made to the general level nature of the country to the west and north of Mt. Heemskirk and its outlying spurs. This area really forms an extensive peneplain, and represents an old land surface which was worn down under long-continued degradational agencies to base level. A subsequent uplift of the land surface rejuvenated the streams, which are at the present time once more engaged in cutting down their channels. This peneplain has a gradual slope seawards; insufficient aneroid readings were obtained to enable a true average of the slope to be obtained, although it appears to be over 100 feet to the mile.

*Access.*—One of the greatest drawbacks to the development of the district in the past has been its inaccessibility. In the past three routes have been available, all connecting with Zeehan, and all three have been used—

- (a) Road from Zeehan, *via* South Heemskirk.
- (b) Cattle track from Zeehan, over the Gentle Annie Hill.
- (c) Pack track from Zeehan, *via* the old Eureka Mine.

Of these (a) and (b) were continuously used; (c) sometimes used.

(a) *Road.*—This route is long and tedious; from Zeehan the Trial Harbour Road is followed to within about 2 miles of the old settlement of Remine, where the Corinna Road junctions, and the latter is followed for about 11 miles, when it is joined by a road recently constructed to



L. L. Waterhouse, Photo.]

PHOTO 2.—MOUNT HEEMSKIRK, THE GAP, AND PART OF THE NORTH HEEMSKIRK SPUR.

meet it, which winds over the North Heemskirk Spur towards its northern extremity. After leaving the Corinna Road the distance is about 3 miles to the Heemskirk Tin Syndicate's property. The total distance from Zeehan by this route is about 26 miles, and the condition of the road is far from satisfactory. The ruts in places are so deep that the cart-wheels sink in almost to the axles. The grade, too, is steep in places, and it is a matter for surprise that better grades were not sought in the first place. Loads of about 25 cwt. may be carted, and two days are usually taken on the trip from the mine to Zeehan. This is the only available method of carting heavy loads in or out, and all heavier machinery which could not be carried by pack-horse has necessarily been taken by this route. Hence it will readily be understood that the cost of getting machinery and supplies to the property, and of getting tin out, has been heavy.

(b) *Cattle Track*.—This track, as its name implies, is used when cattle (of which there are many in the vicinity of Granville Harbour) are to be driven to and from Zeehan. It is but a narrow track, and little attempt has been made to grade it, so that carting is quite out of the question. It is used, however, as a pack track, being much more direct than the road previously described; the distance between Zeehan and the Heemskirk Tin Syndicate's property is about 15 miles. The Pine Creek gorge, and the range known as the Gentle Annie Rise, where it is crossed by the track are formidable obstacles. This route is generally used by packers bringing in provisions, mail, &c., and provides the main line of communication between Zeehan and the North Heemskirk District, Granville Harbour, Corinna, and Pieman Heads.

(c) *Eureka Pack Track*.—This track is frequently used by men walking to and from Zeehan. It is often preferred because, although about 2 miles longer, it avoids the steep climb over the Gentle Annie Rise by winding round the end of the spur. It is occasionally used by packers. For some distance the tram under construction follows approximately the course taken by this track.

The road and both tracks referred to above are shown on the accompanying map, the two latter being approximately sketched in only.

In referring to tracks, mention should be made, in passing, of the old track through The Gap (a low ridge connecting Mt. Heemskirk with the North Heemskirk Spur),

and connecting the North and South Heemskirk fields. Although used a good deal in the earlier history of the field, the track is now a good deal overgrown in places, and is not available for horses; it is still sometimes used as a foot track, being very much shorter than the road previously described. The distance between the Federation Mine, South Heemskirk, and the Heemskirk Tin Syndicate's property, North Heemskirk, would be about 7 miles by this route. This track is really the old road from Trial Harbour (Remine) to Corinna.

The road and tracks described have provided the only means of communication with the district in the past, but owing largely to the success which has attended the efforts of the Heemskirk Tin Syndicate, a tram-line is being constructed at the present time which will immensely benefit this and the surrounding districts. This work is being carried out by the Government. The surveyed line is shown on the accompanying map, although it must be understood that the line is not yet constructed for the full distance as shown on the map. At the time of writing the rails are laid to about the 11-mile peg, and I am informed that the construction work is not far ahead of this point. The line connects with the steel tram-line constructed by the Zeehan Western Company, at about 2 miles from the town. It runs in a general westerly direction, the proposal being to ultimately extend the line to Granville. The grade is excellent, and several substantial bridges have been constructed. Some little difficulty was experienced in finding a suitable spot to cross the Pine Creek gorge, but this problem was solved, and the work successfully carried out. Wooden rails only have been laid, and although their life is not likely to be long, it is satisfactory to find that grade and curves would permit of these being replaced by steel rails at a later date if necessary.

If the line be continued beyond its present terminus it will undoubtedly stimulate prospecting and mining in the district. It is scarcely necessary to state that it will be possible to carry heavier loads and to travel more quickly than before, and therefore transport will cost considerably less than under the old conditions.

## II.—GENERAL GEOLOGY.

In dealing with the general geology of the district, the various rock formations will be described under the general headings of igneous and sedimentary rocks.

### A.—IGNEOUS ROCKS.

There have been at least three distinct periods of igneous activity, in connection with one of which the primary ore-deposits of the district were formed: the other two are of no direct economic value.

Into a series of previously consolidated sediments a mass of basic material was forced, and now forms the gabbro outcropping north of the Heemskirk Tin Syndicate's property. At a slightly later period the huge granite *masses*; now forming the Heemskirk Range was introduced: these intrusions took place in Devonian time. There was then a long period of quiescence until in late Mesozoic time large sills of diabase were forced up into the overlying rocks. There is no evidence of further activity until Mid-Tertiary time, when extensive flows of basaltic lava took place.

#### (1)—*Gabbro*.

As this is the oldest igneous rock represented, it will be described first. Its extent is not yet known, but the rock was discovered by the writer outcropping in the form of a low ridge covered with stunted timber and scrub, a little to the north of the Heemskirk Tin Syndicate's workings. It appears previously to have been mistaken for basalt, but a recognition of its true nature will be seen to be of direct economic importance, and it is essential that it should not be confused with the basalt so abundant in the same locality.

In hand specimens the rock is of a general greenish colour on freshly-broken surfaces. It weathers to a brownish colour. The rock is fairly coarsely crystalline, containing black crystals in a greenish ground-mass, with white felspars. Scattered magnetite and pyrrhotite are noticeable. This rock should be readily distinguishable from the olivine basalt found in the same locality, and from the diabase which occurs further to the north-east. Both of these rocks are described below.

The microscopical examination of a thin section cut from a specimen collected from a low ridge about 12 chains

north of Section 6357-m, shows that the rock is a true gabbro, consisting essentially of the monoclinic pyroxene diallage, partly converted to light green uralite, and of labradorite felspar which is slightly clouded by decomposition products. Apatite, ilmenite (accompanied by its alteration product leucoxene), magnetite, and pyrrhotite are present as accessory minerals, while a little secondary chlorite is noticeable through the slide. The rock does not differ in essential features from that which occurs at South Heemskirk, on the Zeehan-Trial Harbour Road, about  $1\frac{1}{2}$  miles east of Mt. Agnew. This rock is more fully described in Bulletin No. 21 dealing with the South Heemskirk Tin Field.

The extent of this gabbro at North Heemskirk has not so far been determined. When the country to the north is examined, more information on this point will be forthcoming. The outcrop examined forms a low ridge, not rising appreciably above the general level of the peneplain. With the thick undergrowth and heavy cover of soil in this vicinity, the boundaries of the outcrop and the relation of the gabbro to the surrounding formations is not easy to determine. To the west it appears to be overlain by Tertiary basalt; to the south and east by sandstone, grit, and conglomerate, also of Tertiary age. Thus it does not seem possible to fix the age of the gabbro from this exposure alone. There is no doubt whatever in the writer's mind but that the rock is identical in age with similar basic rocks occurring at South Heemskirk, and at other localities on the West Coast; its similarity in general appearance, in mineralogical composition and structure when subjected to microscopical examination, and its occurrence near the margin of a huge granite mass, all indicate that a correlation with other occurrences is justified. If so, then the gabbro is of Devonian age, and slightly older than the granite forming the Heemskirk Range. For a fuller discussion of the relation of basic and acid igneous rocks, and the evidence for classing them as Devonian in age, the reader is referred to recent bulletins of the Geological Survey.

This gabbro, then, is the oldest igneous rock represented on the field, so far as is known at present.

No mineral deposits have so far been discovered in the gabbro, but there are certain possibilities which may here be briefly indicated to serve as a guide when prospecting is being carried on in the district.

Although at this point it does not appear very promising, considerable variations may be found in a short distance, as is the case in other occurrences of similar rock on the West Coast of Tasmania, and osmiridium may possibly be discovered: the serpentine in which this much-sought metal occurs at the Bald Hill and in the valley of the Wilson River, is but a variation of rocks of the same age and similar in every respect to that described above. On the other hand, occurrences of such rocks are known which have not so far been shown to carry osmiridium.

Deposits of copper and nickel may also be looked for.

Thus it will be seen that the identification of gabbro in this district is important.

#### (2)—*Granite.*

From the economic standpoint, the most important rock of the district is the granite, since all the primary ore-deposits of the district are genetically connected with it.

In appearance the rock is typically a pink granite, owing to the abundance of pink orthoclase felspar. In addition to this mineral, white plagioclase, quartz, black biotite mica, and sometimes black tourmaline are readily distinguishable in hand specimens. In texture the normal rock is medium grained, varying somewhat in particular localities. Aplite and granite porphyry are sometimes developed as particular types.

The granite herein referred to forms the northern extension of the great Heemskirk *massif*, described more fully in the writer's bulletin on South Heemskirk.

It extends northwards to Granville Harbour, where it forms the southern shore. From this point southwards to within about 1 mile of Trial Harbour the same granite forms a rocky coast line. From Granville Harbour the boundary of the granite runs about south-east for about 2 miles, then bends east past Donnelly's Look Out and beyond the Gentle Annie Rise, for about 10 miles, when it sweeps southward again.

North of the Tasman River the actual boundary is hidden for some distance, but from a casual examination it appeared that the Tertiary basalt to be described later was lying directly on the granite.

The age of the granite is assumed to be Devonian, not from direct evidence obtainable in this district, but from the fact that it is to be correlated with other occurrences where the age can be determined more exactly. This ques-

tion is discussed at greater length in Bulletin No. 21. In the North Heemskirk District the granite is intrusive into slates of Pre-Silurian age, and appears to be overlain by Tertiary basalt: beyond this there is no direct evidence of age.

Whenever a huge mass of acid igneous rock, such as the granite *massif* under consideration, intrudes an older series of sedimentary rocks, the contact metamorphic effects of the intrusion are considerable. The present case is no exception to the general rule. These contact effects must be noticed in passing. The most important results appear to have been silicification and tourmalinisation of the sediments near the contact, with the development of chiastolite, garnet, albite, and other minerals typical of the contact metamorphic aureole at other points. On the summit of Donnelly's Look Out, on the hill slope and in the bed of the Tasman River near the Heemskirk Tin Syndicate's pipe-line, along the St. Dizier Creek, and at various other points along the boundary, the silicification and tourmalinisation effects are well seen. Here, instead of the blue slates which form the normal country rock of the district, the outcrops are seen to be black and white banded rocks. The alternating bands of white quartz and black tourmaline reproduce exactly the folds and contortions of the original slate, which has been replaced under the action of highly superheated vapours introduced during the consolidation of the huge granite mass. Slight differences in the composition of different layers of the original sedimentary account for the fact that the replacing mineral is sometimes quartz and sometimes tourmaline, the latter taking the place of the more argillaceous material. Similar rocks occur at Mayne's Mine, South Heemskirk, and have recently been described by the writer from the Stanley River District.

At several points on the Heemskirk Tin Syndicate's race, and also on the flat at the head of the Twelve Mile Creek, at the foot of Mt. Heemskirk, was noticed a compact blue-grey rock, with abundant white lath-like crystals, up to  $\frac{3}{8}$ -inch long, in a fine-grained ground mass. A thin section examined microscopically shows that the rock is an andalusite slate, the white prisms proving to be andalusite, which has been developed as a result of the contact metamorphic action of the granite on the adjacent sedimentaries. Short prisms of tourmaline have also been developed, while in the ground mass is abundant carbonaceous material.

Although only two distinct types of contact rocks have been examined in detail, the alteration everywhere round the margin of the granite has been intense.

The granite is the most important of the igneous rocks of the district, since it is genetically connected with all the ore-deposits of the district, and the primary ore-bodies occur within or near its borders, while its disintegration has contributed most of the valuable constituents to the secondary ore-deposits.

### (3)—*Diabase.*

Forming the bulk of the north-western portion of the spur of Mt. Heemskirk which is crossed by the Cattle Track, and known as the Gentle Annie Rise, is a mass of a medium to fine-grained rock, of a general light greenish colour, and crystalline structure. The rock appears to be composed almost entirely of grey felspar and greenish pyroxene (augite), and proves to be diabase. It is similar in all respects to the diabase so widely distributed throughout the island, and which forms huge sills intrusive into the Permo-Carboniferous and older rocks. A detailed petrographical description of the rock is uncalled for here, as it has been fully described elsewhere.

The extent of the diabase is still undetermined, and the writer had no opportunity, on this occasion, of traversing and determining even approximately its boundaries. The area shown on the accompanying map is only sketched in. The writer was informed that the outcrop extends for some distance across the Pieman River. The old track to the Eureka workings traverses diabase for a considerable distance, and the Heemskirk River has cut its way through the same rock, which forms the cliffs at the Heemskirk Falls.

The rock was locally being called basalt, but is quite distinct from that rock, so common to the west, from which it should be carefully distinguished for reasons which will be pointed out in the course of this report. The age of the diabase cannot be determined in this district. It is intrusive into Pre-Silurian sediments, and is apparently overlain by Tertiary conglomerates. There can be little doubt, however, but that this occurrence of diabase is to be correlated with that which is so widely distributed throughout Tasmania, and which is regarded as being of late Mesozoic age. The thickness of the diabase must be at least 600 feet: the northern extension of the area was

not examined, hence this figure must be regarded only as an estimate. It is possible that faulting may be responsible for an apparent exaggeration of the true thickness, but no direct evidence was obtained to justify this assumption being made.

The mass of diabase described was not poured out at the surface as the basalt was, but forced up into strata since removed by denudation, in the form of huge sills. This was long after the granite had consolidated, the diabase itself, after consolidation, being penetrated by basalt.

The period of primary ore-deposition had ceased with the final consolidation of the Devonian granite, and the diabase was not responsible for the formation of any fresh ore-deposits, being in this respect of no economic importance.

The soil yielded by the diabase is moderately good, the area being fairly heavily timbered.

#### (4)—*Basalt.*

Covering a wide area north of the Tasman River, and yielding a soil covered with heavy timber and thick scrub, is another igneous rock materially different to any which has previously been described. This is dark-blue in colour, and is a hard, tough rock, which on weathered surfaces shows a reddish-brown crust. It yields a dark chocolate-red soil which invariably supports a luxuriant growth of scrub and undergrowth, with usually excellent timber as well.

The rock is dense and fine-grained: frequently no constituents can be recognised, although generally a closer examination will reveal the presence of olivine in clear greenish-yellow crystals. In places the rock is vesicular, and the vesicles may be filled with zeolites. The rock is an olivine basalt, and is quite similar to that so abundantly distributed on the north-west coast and various other parts of Tasmania. A more detailed description of the structure of the rock is uncalled for here.

The full extent of the basalt has not yet been determined. It occupies a considerable area north of the Tasman River, stretching northwards and eastwards towards the Pieman River, while at Granville Harbour and from this point northwards, it extends to the coast. The former extent of the basalt sheet has probably been considerably greater than present outcrops indicate. Towards its southern extremity the basalt now occurs in isolated

patches. An examination shows, however, that these patches are all at approximately the same level and there can be no doubt but that they originally formed one continuous sheet, which has been dissected by the various streams draining the area. Bedrock has been exposed in many of the creeks between these isolated patches, showing that the thickness of the basalt cover is usually small. In most places it is probably not more than 30 feet, and sometimes considerably less.

The basalt rests partly on river gravels of Tertiary age, with lignite and plant remains, partly on Devonian granite (and probably on Devonian gabbro), and partly on Pre-Silurian slates. Its age is late Tertiary.

Although not genetically connected with the ore-deposits, the basalt is important economically, for it has formed a protective covering to the secondary tin ore-deposits formed in the old river channels, which otherwise would undoubtedly have long since disappeared. On the other hand, since the outpouring of the basalt and subsequent uplift, degradational forces have done work which has been of great economic value, in that the basalt cover has been cut through, and in places entirely denuded, so that the tin-bearing gravels have been exposed without being entirely removed.

#### B.—ECONOMIC SIGNIFICANCE OF THE IGNEOUS ROCKS.

It seems advisable to briefly call attention to certain points which a study of the igneous rocks has made clear, and which do not seem to have been recognised by some interested in the development of the field. These remarks will involve a certain amount of recapitulation and repetition of what has already been said under different headings.

It is not proposed to refer in detail to the granite, although it is most important as being genetically connected with all the ore-deposits of the district. The rock is universally recognised, and the fact that primary deposits of tin ore are found within its borders or in the sedimentaries adjacent to the granite contact, is well known: also that secondary deposits of tin ore are derived from the above-mentioned primary lodes and may therefore be found within or near the borders of the granite.

It is mainly to the other three rock types—diabase, gabbro, and basalt—and their relation to the secondary ore-deposits, that the writer wishes to call attention at

this stage. The different rocks have been described, and it is believed that they will be recognised in the field. It has already been stated that the diabase is of Mesozoic age, the gabbro Devonian, while the basalt is Tertiary. The important point which it is desired to emphasise very strongly is that *the diabase and gabbro are older than the secondary tin ore-deposits, while the basalt is younger.* Obviously, then, while the basalt may, and often does, cover tin-bearing gravels, neither diabase nor gabbro can do so. If this important distinction be appreciated, the knowledge should be a guide to those attempting to trace the course of the old river channels, for where outcrops of either gabbro or diabase are noted, it will be realised that the old river must have taken a different course, and to attempt to bore such rocks for a lead which may have been traced for some distance by boring through basalt is worse than useless.

The useful purpose which the basalt has served by protecting the stanniferous gravels has already been referred to.

### C.—SEDIMENTARY ROCKS.

#### (1)—*Pre-Silurian Slates, Sandstones, and Tuffs.*

Very widely distributed throughout the district, and occupying most of the country between Zeehan and the Heemskirk Range, is a series of old sedimentary rocks. The most abundant members of the series are blue fissile slates, which have been much crushed. These are interbedded with white quartzites, representing old sandstones, and fine tuffs.

These rocks are the oldest represented in the district, and have been intruded by gabbro, granite, diabase, and basalt. In the area under review they are contorted and much disturbed in the vicinity of the igneous rocks, and no strike or dip can be assigned to the formation as a whole for this reason. The series, however, appears to be continuous with the older sedimentaries developed around Zeehan, which are older than the fossiliferous Silurian strata in the same vicinity, and have been classed by Messrs. Twelvetrees and Ward as Cambro-Ordovician.

These sedimentaries then are Pre-Silurian, and probably Cambrian or Ordovician in age. They have been intruded by the igneous rocks of the district, but form the bedrock upon which the Tertiary sediments rest. A

little north of Donnelly's Look Out they are covered by the flows of basalt of late Tertiary age, described elsewhere.

The contact metamorphic effects produced by the intrusive igneous rocks have already been referred to: tourmaline is abundantly developed, and in particular localities andalusite, garnet, and other contact minerals were noted.

No mines are being worked in this area, but mineralisation has taken place in certain localities, as one would expect, and it is likely that at any time ore-bodies of economic value may be located.

(2)—*Tertiary Sandstone and Conglomerate.*

A formation whose full extent was not proved during the reconnaissance, but one which may prove to be of considerable economic importance, is distinguished on the accompanying map from the area of Tertiary river gravels and alluvium, as sandstone and conglomerate.

A small outcrop of conglomerate was noticed on the brow of a low spur with a northerly aspect, about on the northern boundary of Section 4747M: this is approximately on the same level with, and about 15 chains south of the open-cut workings on unconsolidated wash in G. Smith's 40-acre Section 5312M. A few chains south of it are some old alluvial workings which have been described elsewhere: in these workings unconsolidated wash with fairly abundant lignite is exposed. This was the only occurrence of conglomerate noticed in this part of the field.

The rock is hard, and is a typical conglomerate. Rounded fragments of white quartz of varying sizes up to 2 inches in diameter are embedded in a matrix of quartz sand, the whole being cemented with silica. Occasional fragments of banded quartz tourmaline replacement rock were noticed, and a little black tourmaline occurs in rounded fragments in the ground-mass. A fragment of topaz was noticed in one specimen.

In freshly-broken specimens the rock is white, while on weathered surfaces it is usually stained black, probably with vegetable matter, the white quartz pebbles standing out in sharp relief.

About 2 miles to the north of this point is another more extensive development of a similar rock, associated with sandstone. The latter occurs approximately as shown on the accompanying map, but the occurrence has been sketched in only, as the boundaries could not be traversed

and accurately determined in the time available. Apparently included in the northern portion of Sections 6357M, 6349M, and 6114M, all held by C. D. Finch, is an area of sandstone, covered with button-grass. This occupies also the southern portion of Section 6881M, charted in the name of A. Fitch. This area in appearance is a paddock of button-grass, bare of timber, but surrounded completely on three sides and partly on the fourth by heavy timber and scrub: the line of separation is sharply defined, the difference in the vegetation being determined by the different soil: basalt occurs on the south and west, and gabbro on the north.

Further to the east, and exposed along the fringe of the timbered (basalt) country, sandstone occurs, alternating with bands of conglomerate. North of this is more conglomerate, while about a mile north of Sections 6114M and 6115M is a well-defined ridge, rising to about 150 feet above the plain, consisting of conglomerate towards the base, merging into beds of grit, and capped again by conglomerate.

In the area described, the various creeks expose sandstone and conglomerate on their banks, forming cliffs sometimes 25 feet high. To the east the Pre-Silurian sedimentaries outcrop, and no further occurrences of sandstone and conglomerate were noticed during the hasty examination of this country.

The beds appear to be horizontal, and would appear to be at least 100 feet thick at the ridge referred to: the base of the ridge is covered with talus and scrub: no bedrock is exposed in the creek beds, but the formation must be resting partly on Pre-Silurian slates, and partly on Devonian gabbro: it appears to be covered by basalt to the north.

In appearance the conglomerate is similar to that described above from the northern boundary of Section 4747M, excepting that no quartz-tourmaline rock was noticed among the pebbles, which apparently consist entirely of milk-white to glassy quartz. In the finer interstitial matter, however, particles of rounded black tourmaline are abundant, in places giving the ground-mass a general dark appearance. The rock is silicified, and the small cavities which sometimes occur are seen to be lined with chalcedony. The rock is hard and compact, always breaking across the pebbles.

The conglomerate grades in places into a grit, and this again into a sandstone. Excepting for the difference in grain-size, these rocks are similar to the conglomerate

already described, consisting of rounded grains of quartz, with black tourmaline cemented with silica. In the grits, chalcedony is present in occasional spaces between the larger grains. Usually to a depth of an inch or two from the surface the sandstone is partially weathered, and somewhat softened, but when fresh it is so hard that it is in reality more nearly a quartzite than a sandstone; it seems advisable, however, to retain the word "sandstone" in the case of a rock no older than Tertiary. The grainsize of the rock is wonderfully regular, and the distribution of the fine black grains of tourmaline in the specimens collected is very even, the mineral not being collected into definite layers.

The writer hesitated somewhat at first in referring such hard rocks to the Tertiary system, as they would pass for much older rocks when examined as hand specimens, although they show no signs of crushing. In the field, however, they are horizontally bedded, and are on the same horizon as the unconsolidated river gravels which are shown to be of Tertiary age by the impressions of leaves in the sandy beds, and the lignitised wood at various depths from the surface.

Again, the actual composition of the rocks is so nearly akin to that of certain horizons of the unconsolidated gravels that one is struck by the close resemblance: the presence of tourmaline also is suggestive. But any doubt which may have remained was dispelled by the discovery in the grits and conglomerate at several points, of what are undoubtedly fragments of wood corresponding exactly in structure with the lignitised wood found in the unconsolidated drifts. These fragments are quite white, being apparently completely replaced by silica: the structure is perfectly preserved. The outer portion of the fragments is rather harder than the central portion, and in one weathered specimen obtained only the outer crust remained, and the appearance was peculiar, somewhat resembling a bone. Pieces of this silicified wood up to  $2\frac{1}{2}$  inches long and  $\frac{1}{2}$  inch in diameter were obtained.

Thus the age of the sediments is without doubt Tertiary, and the writer is of opinion that they are really fluvial deposits, contemporaneous with the unconsolidated gravels. The silicification has taken place through the infiltration of waters carrying silica in solution, and the subsequent precipitation of this silica. The source of this silica is somewhat uncertain, but it may possibly have been derived from the basalt upon decomposition. There is

clear evidence that the basalt sheet was once far more extensive than it is at the present time, and that it has gradually decomposed and been denuded. In this decomposition a certain amount of silica must have been set free, and may have been carried in solution into the porous beds below. There still remains the difficulty of explaining why some sediments are cemented and others of a similar age are not, but certain factors such as the former extent of the basalt sheet are still unknown.

The exact nature of these rocks does not seem to have been understood in the past, nor has their occurrence even been recorded so far as the writer is aware. Obviously, if the assumption that they have been formed under similar conditions to the gravels known to be stanniferous be correct, and they are simply consolidated alluvial deposits, there is good reason to believe that they themselves may be stanniferous. The presence of tourmaline lends colour to this belief. In the course of his examination of the area in which the rocks are developed, the writer did not observe any locality where there was a concentration of tin ore, but it must be borne in mind that this examination was but cursory and was in reality only a reconnaissance. Samples taken at random, however, from three different points were submitted to Mr. W. D. Reid, Government Assayer, to be assayed for tin, and the results are interesting. A sample taken from the outcrop of conglomerate described above as occurring near the northern boundary of Section 4747M gave—

Tin (metallic), 0.19 per cent.

A sample of sandstone was taken from the outcrops near the northern boundary of C. D. Finch's Section 6115M, and also carried tin, the return being—

Tin (metallic), 0.14 per cent.

A third sample was taken from the ridge referred to, about 1 mile north of the previous one, and consisted of silicified conglomerate. This assayed—

Tin (metallic), 0.17 per cent.

The above results show conclusively that the conglomerate and sandstone are both tin-bearing at widely different points, and the result is important. Further reference will be made to the matter under the heading of Economic Geology, in dealing with the secondary tin ores.

(3)—*Tertiary Gravels and Alluvium.*

As the Tertiary gravels and alluvium form the secondary tin-ore deposits of the district, they will be dealt with under that heading in the chapter on Economic Geology, and little need be said here concerning them.

The gravels are of fluvial origin, the material composing them being derived from the various rock-formations cut through by the old streams. The deposits were formed by streams belonging to a drainage system very different from that of the present time. Insufficient evidence is available to enable the course of the old rivers to be traced with any degree of detail. It is clear, however, that the stream which deposited the gravels being worked by the Heemskirk Tin Syndicate must have flowed for some distance in a northerly direction. After getting into basalt country, obviously the only way to trace the course of the old stream is by prospecting. The nature of the basalt should be kept in mind, and where there is reason to think the gravels are below, boring should be undertaken. Results of the boring done by the Heemskirk Tin Syndicate are not available to the writer, but should clearly indicate the direction of the old stream. The channel probably bends north-west round the base of Donnelly's Look Out, and then it may either bend westward again and enter the ocean, or continue in a general northerly direction towards the Pieman River. The writer inclines towards the latter opinion, but practically no evidence is available, and no examination was made of this country.

The nature of the wash is fully dealt with elsewhere, and need not be again referred to here. It is obviously derived partly from the granite and partly from the country-rocks near the granite contact. The source of the tin is also dealt with elsewhere; it is derived mainly from the granite, but partly also from the adjacent country-rocks, where lode-formations are developed. Associated with the tin is pyrite, a little monazite in places, garnet, spinel, a small amount of magnetite, and some topaz. It is interesting to note that at least one obsidian button, of an oval shape, has been found in the drifts on the Tasman River; these bodies, while of no economic value, are of extreme scientific interest, and a report of their discovery at any time, with full particulars of the locality, would be welcomed by officers of the Geological Survey.

It is evident, from the wash occurring at different points, that there have been various tributary streams which have all carried more or less tin. It is only to be expected that the accumulations of gravel and silt left by these streams will not in all cases be payable, for some may have been formed by streams flowing through country-rock which carried no lode-formations. All deposits should, however, be carefully tested. It is probable that as further evidence accumulates it will be found that a comparatively large tributary stream joined the old Tasman (the main lead now being worked) from the east, somewhere north or north-east of Donnelly's Look Out, perhaps where the lead takes a bend to the north-west.

With regard to the age of the deposits, in some of the finer sandy layers which actually carry a little tin are impressions of undoubted Tertiary plant leaves. In the coarser drift, too, lignitised wood occurs. This is light to dark brown in colour, and occurs up to 15 inches in diameter. While sometimes compact, it is noticeable that in several instances the lignite disintegrated on being dried. These woods have been examined by Mr. H. H. Scott, Curator of the Victoria Museum, Launceston, to whom the writer is much indebted for the following notes:—

*Notes upon Fossil Pines.*

“ Four specimens of fossil pine were submitted for microscopical examination by Mr. L. L. Waterhouse, and duly passed in review, with the following results:—

- No. 1.—Proved to be a soft-grain pine belonging to the more modern division of the Coniferous order. The tissues, which were well preserved, suggested a wood of similar character to that of the common *Pinus palustris*. It is not suggested that the specimen had any taxonomical relationships with the modern timber-tree named, but the comparison is instituted by way of a standard.
- No. 2.—A modern pine—that is, not older than Tertiary—of much more compact structure than No. 1. The tissues are not well preserved, being much more carbonised than those of the previous specimen. This was evidently a highly resinous tree.

No. 3.—This is part of a branch. Owing to exposure, and also to its small size, the specimen has lost much of its characteristic weight. It evidently came from a tree whose wood was of uneven texture, viz., with very wide, hard, and soft bands of tissue. This indicates good summer and compact autumnal growth.

No. 4.—Is manifestly a piece of the same tree that supplied No. 2, the breaking up of the old tree and the redistribution of the fragments accounting for its being collected as a fourth specimen."

(4)—*Recent Detrital Material.*

Little need be said under this heading, as the deposits of recent detrital material are small and comparatively unimportant. A small amount of cutting through and regrading of the older Tertiary deposits has taken place in certain instances, but these are not detrital deposits.

In a branch of the St. Dizier Creek, joining it near the mine of the same name, after flowing westerly, is a comparatively shallow accumulation of detrital material, carrying apparently fair tin values. The valley through which the creek flows is wide and mature, and the material alluded to has been derived from the rocks in the immediate vicinity.

In the Twelve Mile Creek, for some distance, are shallow detrital accumulations occurring under exactly similar conditions, and also carrying some tin-oxide. A little work has been done here, but usually there is not sufficient water available for ground-slucing, and the ground does not warrant the outlay involved in bringing water on to the ground.

In the upper part of the Tasman River, too, are shallow deposits of limited extent, but of no economic value.

SUMMARY OF THE GEOLOGICAL HISTORY OF THE DISTRICT.

It appears advisable to summarise the events which have resulted in the present geological structure.

The oldest rocks in the district are the Pre-Silurian slates, sandstones, and tuffs, which were laid down on a floor not now distinguishable. The period of sedimentation must have been a long one, and deep and shallow water conditions prevailed alternately.

Then followed a period of uplift, and a time of diastrophism, when the rocks already formed were intensely crushed and folded, and modified in structure by the earth movements which took place.

Whether another period of sedimentation followed, is not clear; if so, the sediments have long since been removed. The next important event of which any record is preserved was the introduction of a huge mass of molten igneous material, still deep below the crust. Differentiation *in situ* resulted in the partial separation of the more basic material of the magma towards the edges of the gradually cooling mass. Owing to a partial relief of pressure this basic material was forced up into the overlying strata, and cooled and consolidated to form the gabbro described elsewhere. Differentiation processes were still active as the more acid material slowly cooled; while still at an exceedingly high temperature, this huge mass of molten matter was forced upwards along a plane of weakness in the overlying rocks. It did not reach the surface, but cooled and solidified deep below the crust, to form the granite of the Heemskirk Range. With the acid magma, all the metallic minerals forming the ore-deposits of the region were introduced. The contact-deposits of iron ore were probably formed before the consolidation of the magma, and the primary tin-ore deposits during the final stages of consolidation, by the action of highly superheated gases. After the main mass of granite had consolidated, contraction cracks in the outer crust of granite and in the surrounding sedimentaries permitted the escape of still fluid rock-material to form veins of pegmatite and of granite porphyry.

This Devonian period of intense igneous activity was followed by a period of quiescence, during which time degradational forces were active. It is uncertain whether any sediments were formed in Permo-Carboniferous times, although it is not unlikely that such was the case; if so, however, all trace of such rocks has now been removed, and the thick cover of sedimentary rocks under which the granite consolidated has also disappeared. It is evident that the degradational forces must have been operative for a long period, for not only has a considerable thickness of sedimentary rocks been removed, but the granite itself has been deeply dissected.

The next event of which any record is preserved occurred towards the close of the Mesozoic era, when huge sills of diabase were forced up into the overlying strata. Pro-

bably this rock did not reach the surface. Weathering agencies again became active in modifying the contour of the surface, by wearing down and cutting deeply into the older rocks. It was at this time that the secondary deposits of tin ore, so important in the district, were formed, by the natural concentration of the cassiterite derived from the denuded rocks, in the existing river channels of the district. The drainage system at this time was very different to that of the present day. The course of the old Pieman River has not yet been traced in detail, but was approximately similar to that followed at the present day. In the case of some of the tributary streams, however, it was different, these streams flowing in an opposite direction to that taken under existing circumstances. The grade became very flat and flood-plains were formed, over which the load of detrital material was distributed, as it could not be transported to the parent stream by the sluggish tributary stream. These conditions prevailed up to late Tertiary times, when there occurred another period of volcanic activity marked by the outpouring of immense quantities of basaltic lava which poured out in sheets over the land surface, filling up the old river valleys. Hence the new streams took fresh courses, determined by the slope of the modified land surface, and at once commenced cutting down fresh channels. The basalt cover effectually preserved the deposits of the old rivers for a considerable time against the attacks of the new streams. During the long period which has elapsed since this volcanic activity in Tertiary time, weathering agencies have been constantly at work, and the streams have gradually cut their way down, in many cases cutting right through the sheet of basalt. As a result of this action, the basalt, which originally formed a continuous sheet, now occurs in isolated patches. It is noteworthy that in certain localities where the basalt has covered the stanniferous gravels accumulated by the old river systems, degradational forces have operated long enough to cut through this protecting cover of basalt, and expose the gravels below, but not long enough to remove the deposits. The degradational forces referred to have continued operating from Tertiary up to the present time; there are no recent deposits of importance in the district, although at favourable spots small amounts of detrital material derived from the older formations have accumulated.

### III.—ECONOMIC GEOLOGY.

#### A.—GENERAL CONSIDERATIONS.

In the preceding chapter a description has been given of the various rock types represented on the field, and their relations to each other. In this chapter reference will be made to the relationships of the ore-bodies to the different rocks before describing briefly the ore-deposits themselves under the headings of primary and secondary ores of the several metals.

The outstanding feature in considering the ore-bodies is their association with the granite now forming the Heemskirk Range. As the principal metal of importance is tin, its association with granite is quite in accord with known occurrences in various mining fields of the State. It has been pointed out in various publications of the Survey in recent years that although the exact type of rock represented is not always the same, yet the occurrence of acid igneous rocks is constant on Tasmanian tinfields; also that the association is not an accidental one, but that tin-ore deposits are genetically connected with the acid rocks.

As well as with normal granite, tin occurs with aplite in this district.

Deposits of iron ore, and also of copper, occurring in the sedimentaries near the contact with granite, are also genetically connected with the latter rock.

There is no genetic connection between the diabase or basalt and any of the ore-deposits of the district.

#### *Osmiridium.*

No osmiridium has yet been recorded from North Heemskirk, but a sharp look-out should be kept when prospecting north of the Tasman River, as basic rocks of Devonian age occur, and in other parts of the State osmiridium is present in allied rocks of the same age. These basic rocks have been described elsewhere in this report.

#### *Molybdenite.*

A fragment of quartz-tourmaline stone was picked up in the St. Dizier workings, showing flakes of molybdenite. As the mineral is known to occur in connection with the granite at South Heemskirk, the chances of finding some in this district are good, and a close look-out should be kept when prospecting.

The fragment found must have come from some formation in the drainage area of the St. Dizier Creek.

The ore-deposits will be dealt with as primary or secondary, under the headings of the different metals of which they are ores.

#### B.—PRIMARY ORE DEPOSITS

The primary ore deposits of the North Heemskirk district are of less importance economically, at the present time, than the secondary ones. Under this heading it is proposed to deal with ores of (1) tin, (2) copper, (3) iron.

##### (1)—*Tin Ores.*

At the time of the writer's visit, no work was being done on any primary deposit of tin ore. Although ore-bodies have been discovered at several points, and a little prospecting work carried out, in no case has a fair trial been given. The deposits are mostly simple in type, with cassiterite as the metallic mineral, and quartz and tourmaline, and sometimes muscovite mica as well, as gangue minerals. They would belong to the quartz-tourmaline-cassiterite vein type. It is unfortunate that no ore-bodies of any size have so far been located. From the specimen stone which occurs in the wash, it is evident that a good deal of the tin in the Tertiary drifts has been derived from veins of this type.

A quartz-tourmaline-cassiterite vein was worked for a short time on a ridge about 30 chains east of C. D. Finch's Section 5883m; its position is approximately charted. From the specimen stone collected it is evident that some rich stone occurs, but the vein appears to be narrow; the only minerals present are those named in the type description.

At the base of Mt. Heemskirk, and also at a spot at the foot of the North Heemskirk spur, a little work has been done on narrow veins which apparently belong to the same vein type.

In the district the pyrite-cassiterite vein type also is represented, two formations on the St. Dizier Mine apparently belonging to this class. In one of them pyrite, cassiterite, and quartz appear to be the only minerals present, while in the other mispickel is abundant. There is a little

doubt about the latter vein, but it most likely belongs to this class. At the Peripatetic Mine also there is a lode-formation belonging to the pyrite-cassiterite vein type.

One instance is known of a stanniferous contact metamorphic deposit, viz., in the St. Dizier Creek, in which cassiterite occurs associated with magnetite, pyrrhotite, arsenopyrite, mica, steatite, and probably lime silicates; the outcrop is poorly exposed, but a description has been given under the heading of iron ores, and the opinion expressed that the cassiterite is not likely to prove of economic importance.

### (2)—*Copper Ores.*

Primary copper ores are of no economic importance. Two so-called copper mines have been discovered, but in neither case is the name justified. At MacArthur's Mine, secondary enrichment near the surface resulted in the formation of a little rich ore. What appears to be the primary ore (the formation could not be examined, the workings being full of water) is almost too poor to be classed as ore, consisting of a slight impregnation of pyrite, with a little chalcopyrite, in chistolite slate.

In the second instance, at Vincent's Copper Reward, Granville Harbour, secondary ore has also been formed, the primary ore consisting mainly of pyrite and magnetite in a quartz gangue, the pyrite being slightly cupriferous.

It is quite possible that discoveries of copper ores may be made in the district north of Donnelly's Look Out.

Although the two deposits referred to above belong to such different types, they are of great interest, since they are genetically related to the tin deposits, both being derived from the same parent magma.

### (3)—*Iron Ores.*

In dealing with the South Heemskirk District in Bulletin No. 21, the writer has described the contact-metamorphic deposits of iron ores, sometimes with other metals, which occur round the southern margin of the Heemskirk granite *massif*. Deposits of similar origin occur at North Heemskirk in several localities, notably at the St. Dizier Mine and near the head of the Twelve Mile Creek.

The deposits consist essentially of magnetite, which varies considerably in texture. It occurs massive, granular, crystalline, and radiating. Vughs in the more massive

ore are often lined with magnetite crystals. Massive red haematite was noted in the Twelve Mile Creek deposit, intimately associated with fine granular magnetite, which is sometimes present in sufficient quantities to render the haematite magnetic. Limonite is present in small amount at the surface, as a decomposition product. Mica occurs as a gangue mineral in both deposits in small crystals and crystal aggregates, but never very abundantly. Doubtless many of the small patches of limonite which occur scattered through granular magnetite represent original mica which has weathered.

A little pyrrhotite was noticed in St. Dizier deposit, accompanied possibly by pyrite. A radiating white mineral is fairly abundant in fine needles throughout the magnetite of the same deposit. This was not examined microscopically, but is probably tremolite. A soft, greenish mineral suggests the presence of chromium in small quantities, probably as chromite. Steatite is also present. Cassiterite is present in the St. Dizier deposit.

Thus it will be seen that although small quantities of secondary minerals are present in the deposits, they are essentially primary ore-deposits, and are treated accordingly.

It seems advisable to describe the deposits separately.

*Iron Ore in the Twelve Mile Creek.*—Towards the head of the Twelve Mile Creek, at the foot of Mt. Heemskirk, is a deposit of iron ore which does not seem to have been described previously. The opinion has been expressed above that the formation is a contact-metamorphic deposit, genetically connected with the intrusion of the adjacent granite. Thus, the magnetite so abundant is regarded as a primary mineral.

No attempt has been made to open up the deposit, which occurs in a boggy flat, about 70 chains east of Section 5883m, 5 acres, charted in the name of C. D. Finch. The approximate position is shown on the accompanying map of the district. The outcrop is covered with scrub and stunted timber, while the surrounding country is button-grass. The northern and southern ends of the deposit rise but a few feet above the level of the surrounding flat, while portions are quite covered by button-grass.

The main outcrop showing through the button-grass covering is about 8 chains long, and from  $\frac{1}{2}$  to 2 chains in width. In plan it is the shape of a dumb-bell, the main axis being about north and south. About 2 chains

west of the northern extremity, and almost certainly connected with it (although not visibly so on account of the button-grass cover), is another roughly circular outcrop of iron ore, about 2 chains in diameter. About 2 chains north of this again is some granite-porphry, apparently *in situ*, and forming an approximately circular outcrop, less than 1 chain in diameter.

The bulk of the deposit is massive and granular magnetite, with a little haematite and limonite showing at the surface, and scattered mica in small plates, and aggregates through the ground mass.

The ore-body very strongly affects the magnetic needle, and it was this property which led the writer to suspect its presence. While making a traverse along the boundary of the granite, the prismatic compass behaved in such an erratic manner that an investigation was necessary to discover the cause of the disturbance, and resulted in the location of this body of magnetic iron ore.

The country-rock is slate, much altered by the intrusion of the granite mass, a projecting tongue of which is distant only 6 chains to the south-west. About 10 chains due south of the deposit, and within 2 chains of the edge of the granite, a trench has been cut in the flat, and exposes chialstolite slate. The rock is bluish in colour, lath-shaped crystals of white chialstolite being abundant, with a little mica and tourmaline distinguishable.

No work has been done on the deposit.

The outcrop was not systematically sampled, but exposes a deposit of high-grade iron ore. True primary ore (unweathered) was not exposed, but nothing was seen at the surface to indicate that deleterious substances are present in the ore, while the abundance of magnetite—which certainly is primary—indicates that the percentage of iron will be high.

Apart from quality, however, it is necessary to consider other factors before such a deposit can be regarded as of commercial value. The deposit is not in a position from which it could be economically worked. Open-cut methods would be impracticable; the deposit outcrops in a boggy flat, and it would be necessary to work from a main shaft, where water would most likely be troublesome.

Again, unless the quantity of ore proves to be much greater than that indicated by the outcrop at present visible, the tonnage available is too small to warrant the expenditure of the large amount of money necessary, for

it must be borne in mind that the deposit is situated in an inaccessible locality. It is about 14 miles from Zeehan, *via* the Granville tram (under construction), and about 8 miles from Granville Harbour, the nearest point on the coast from which shipments could be despatched.

Thus, the deposit cannot at present be said to be of economic importance.

*Iron Ore in the St. Dizier Creek.*—Near the eastern boundary of Section 6141M (see reference in description of that section), and a few chains south of the north-eastern corner of the section, is another contact-metamorphic deposit, essentially of iron ore.

Being composed essentially of magnetite, the prismatic compass could not be used in the vicinity of the deposit, either for determining its exact position by means of a traverse, or its strike.

It outcrops in the bed of a small creek joining the St. Dizier Creek from the east, and appears to be just outside the eastern boundary of G. Leppard's Section 6141M, and therefore in the vacant Section 4383M. Its position is shown approximately on the accompanying plan of the district. The outcrop is about 7 chains from the edge of the granite, the country-rock being contact-metamorphic slate, in which quartz and tourmaline have largely replaced the original sedimentary rock. Within a few chains of the deposit typical chistolite slate is developed.

The deposit appears to be well banded, and to strike about N. 85° W. The width is not exposed, but it may be 20 feet or more.

Reference has previously been made to the mineralogical composition of the ore, which consists essentially of magnetite, sometimes very dense, but usually granular, with a little mica, steatite, and partially decomposed minerals, which probably represent lime silicates in the fresh ore. The ore exposed is all partially weathered, and no microscopic examination of ore material was made. A few shots have been put in to expose the nature of the ore, but the hole is full of water and rubbish, and with thick scrub encroaching round the edges of the outcrop, a detailed examination was difficult.

A sample of the ore was broken across the outcrop as far as exposed, but in the nature of the occurrence, this could only be regarded as approximate. Reasonable care was taken to take primary material, the oxidised crust of

limonite being broken off as far as possible. This sample was assayed by Mr. W. D. Reid, Government Assayer, with the following result:—

Iron ... ..	47.4	per cent.
Tin ... ..	0.97	per cent.

The presence of tin is of especial interest. It was recorded by Mr. G. A. Waller in his report of 1902, who stated that a sample of the stone assayed by Mr. A. D. Wilson yielded 3 per cent. of tin. The tin is present as grey cassiterite: none was observed in the stone, but it will probably be found to be present in small irregular veins, and in the writer's opinion is scarcely likely to become of economic importance.

One fact worthy of special note is the presence of sulphides of iron in small quantities throughout the deposit. No perfectly fresh specimens were obtained, but pyrrhotite seems to be the sulphide represented, although probably there is a small amount of pyrite as well. There is also a little arsenopyrite. The exact sulphur content has not been determined by analysis, but its presence would be detrimental to the use of the material as an ore of iron, even were other factors favourable. The deposit is inaccessible, being about 16 miles from Zeehan by tram, or about 6 miles from Granville Harbour. Again, there are no facilities for economical working by open-cut methods: being low-lying, any work attempted would necessarily be carried out from a shaft. But there is another grave objection to the expenditure of capital in developing the deposit as an iron ore, for the quantity of ore available for extraction, so far as any opinion can be formed, is too small, even were the quality excellent. Thus, the deposit cannot be regarded as a source of iron ore of commercial importance.

#### (C)—SECONDARY ORE-DEPOSITS.

##### (1)—*Tin Ores.*

So far as they have been prospected up to the present time, the secondary tin ores have proved to be of far more commercial importance than the primary ores in the North Heemskirk district. The ores consist of cassiterite with or without attached gangue minerals, disseminated through unconsolidated or partially consolidated masses of river gravels. The tin oxide is usually black in colour,

and varies considerably in grainsize. Although there is a certain proportion of fine tin, most of that won in sluicing is of medium grainsize, sub-angular to rounded, with a proportion of aggregates of crystals and well-rounded nuggets, and some specimen pieces of ore, with attached quartz, tourmaline, or muscovite. Associated with the cassiterite is a little monazite, also pyrite, a little magnetite, garnet, spinel, and topaz. Little difficulty is experienced in producing a high-grade concentrate by sluicing in the usual way.

The cassiterite occurs partly disseminated throughout the accompanying gravels, partly concentrated in certain layers and patches. The wash, so far as exposed, carries no large boulders, but abundant pebbles, generally well-rounded, of quartz, quartz-tourmaline veinstone, banded quartz-tourmaline (slate replaced by quartz and tourmaline in alternating bands), and occasional fragments of granite. Where faces have been exposed, it is seen that the layers of wash are stratified, alternating layers varying somewhat in texture and composition. Some layers consist of sand, indicating a considerable variation in the conditions under which deposition took place. Included in some layers are plant remains and pieces of lignite, showing the deposits to be of Tertiary age.

A striking feature is the presence of iron pyrites in the basal beds of wash exposed in the Heemskirk Tin Syndicate's workings. It forms the cementing material in which are included gravel and sand, and a good deal of tin oxide. From this source a certain amount of pyrite finds its way into the sluice-boxes. It was noticed that this pyrite was unstable when exposed for a time to the air, for it rapidly oxidised. Lignite was also noted on the same horizon. This pyrite has probably been derived from iron-bearing solutions: ferrous sulphate in solution coming into contact with decaying organic matter would be precipitated as disulphide of iron (pyrite), and these conditions would actually exist here, the original iron content of the solutions being derived from surface oxidation of primary sulphides. As soon as the reducing conditions under which precipitation took place were replaced by oxidising conditions, oxidation would again take place, and this also was actually observed. After being exposed to the air for a few days, the pyrite rapidly decomposed, and became coated with a white incrustation of ferrous sulphate. The rapidity with which this change took place suggests that perhaps marcasite is present.

*Source of the Tin.*—From what has already been said of the past geological history of the district, it is fairly obvious that the source of the tin is not far to seek. It has been derived from lode formations in the rocks through which the old streams have cut their way. These lodes have occurred both in the granite itself and also in the surrounding sedimentary rocks. As the rocks have been denuded under the long-continued action of weathering agencies, the lighter rock material has been gradually carried off by the streams, while the heavier tin oxide has accumulated as a natural concentrate. The composition of the pebbles in the drift indicates that both granitic and contact sedimentary rocks have been cut through. Granite is almost entirely absent from the wash, but this is only to be expected from the nature of the rock: the felspar and mica decompose with comparative ease under the attacks of weathering agencies, freeing the harder and more resistant quartz, which is abundant in the form of sub-angular gravel in the old river deposits. On the other hand, the abundance of pebbles of quartz-tourmaline in the wash is easily explained: veins and dykes of quartz-tourmaline rock are of frequent occurrence both in the granite and in the surrounding sedimentaries. Fragments of these formations broken off in weathering accumulate because both component minerals strongly resist the attacks of weathering agencies, and both are very hard. Boulders are frequently well rounded owing to the continued grinding and pounding action they have received in the stream beds.

It is important to try and anticipate the behaviour and possible extent of these secondary tin ore-deposits, as so little work has been done up to the present time. Considering the deposits in a general way, it is at once obvious that prospecting alone can prove the actual course of the old river valley or valleys. Such prospecting should be carried out intelligently, with due regard to geological features, as indicated elsewhere in this report. It is scarcely necessary at this stage to state that the tin is unequally distributed through the wash, both vertically and laterally. Tin occurs almost to the grass roots where there is no basalt covering, and to the basalt where this occurs, but is usually more concentrated in the bottom layers of wash owing to natural concentration and to the tendency of the heavy mineral to work its way downwards under the influence of gravity through the moving mass of gravel. As layers of finer sand and silt sometimes occur,

it will probably be found that in some cases these have acted as false bottoms, and that the tin content will be higher just above them.

It is to be expected that the bottom on which the wash rests will be found to be uneven, and that this will to some extent influence the lateral distribution of values in the lower layers: thus where there is a pot-hole, the scour will probably have been sufficient to prevent the concentration of tin, while a bar of rock may act as a natural riffle, and assist concentration. A projecting tongue of rock from one or both banks of the old river may have caused a rapid current at one point, which would allow of no deposition of tin, but it is quite likely that a widening of the stream may have occurred just beyond the obstruction, which would cause a slackening of the current, and consequent deposition of tin. Another favourable locality for the occurrence of a richer patch would be at the point of confluence of two streams.

With reference to the lateral distribution of the tin oxide, obviously a larger amount of the heavy mineral would be expected nearer the source whence it was derived, and in this district, the further down stream (considering the old drainage system which existed when the gravels were deposited) the more disseminated the cassiterite is likely to be.

Without discussing them at further length, these considerations should be kept in mind while prospecting, for they emphasise the importance of carrying out such work systematically, and not putting too much reliance on isolated results, should they be good or bad.

*Tertiary Conglomerate and Sandstone.*—The nature of these rocks has already been dealt with in the chapter on General Geology, but a little remains to be said with regard to the economic possibilities of the formation.

It has been pointed out that the rocks are really consolidated beds of wash, similar in mode of origin and in general constitution to the unconsolidated gravels which are being treated successfully for their tin contents. They are similar in age, and in fact form part of the same series of deposits, the consolidation being in one sense an accidental feature. In this connection reference in passing may be made to the occurrence on a creek bank on the eastern boundary of Section 5652M, held by C. D. Finch, 13 chains from the north-eastern corner peg, of similar wash cemented to form a hard rock.

It has been shown that the conglomerate and sandstone are tin-bearing at the three localities whence samples were taken, the actual assay results being 0.19, 0.14, and 0.17 per cent. of metallic tin for the respective samples. It need scarcely be said that if this were the value to be expected throughout, the sediments would not pay to work, but there is nothing to show that this is an average value. Being alluvial deposits, whose source is not clear, deposited and distributed by an old river system probably very different to that existing at the present time, it is quite possible that concentrations may occur in certain localities, and the area is worth prospecting, as the preliminary work can be done at comparatively small expense in the open button-grass country, with good outcrops in the creek beds. The rock is not one which would tempt the average prospector, unless its nature were understood or suspected, and hence it is quite possible that any rich patches which occur may have been overlooked.

The nature of the sediments has already been explained, and the fact emphasised that they are hard rocks. Thus, although the deposits really are secondary, and the tin occurs in alluvial drifts, higher values will be required to pay for treatment, as the rock will have to be crushed and concentrated as would be the case if it really occurred in lode form. Sometimes open-cut methods could be employed, and thus mining costs kept low. As it is just possible that if found to be payable at all, the area of ground may be large over which these higher values exist, the venture is worth looking into. Warning must be given, however, that there is no proof whatever that payable stone will be found, and that if found at any one spot, further prospecting, probably by systematic boring, will be necessary to prove the extent of such ground, before any attempt be made to erect treatment plant.

#### (2)—*Copper Ores.*

The secondary copper ores which occur in very limited quantities in two localities on the field have created a little excitement locally by the sensational assays which have been recorded. These are now known to be due to secondary minerals developed at or near the surface, these minerals resulting from the precipitation of small amounts of copper from solution: the primary ore is low grade in each case, but on decomposition has yielded its copper content, and thus on precipitation, we have rich secondary

minerals developed from a low-grade primary ore—a common feature in connection with copper ores, and frequently an extremely important one.

At MacArthur's Mine the secondary minerals developed are covellite, tenorite, and chalcantite, none being very very abundant, a little chalcopyrite being noticed. The primary ore apparently is very low grade, consisting of a little pyrite and chalcopyrite disseminated through blue slate. The deposit is too small to be regarded as of importance: little more need be said here, as a description has been given of the property elsewhere in this report.

At Vincent's Copper Reward at Granville Harbour, the occurrence is very different. As described in the chapter on "The Mining Properties," the primary ore consists of pyrite, magnetite, and quartz. No chalcopyrite was noticed, but the pyrite is apparently cupriferous. In decomposing the copper goes into solution, and goes to form secondary minerals. The secondary minerals present are native copper, tenorite, malachite, chalcocite, and chalcantite. These minerals all occur in small quantities only, several of them in only just sufficient quantity to be recognised. As shown by assay results the primary ore is low grade, and being complex, is not likely to prove of economic value: the deposit is a contact metamorphic body, and the copper present is really to be regarded as an accessory. The formation of the secondary minerals is interesting, but their nature does not appear to have been understood.

No other secondary copper ores are known in the district.

### (3)—*Iron Ores.*

No true deposits of secondary iron ores occur. Secondary minerals are present on the oxidised outcrops of the primary iron ores, but in comparatively small amount. Thus haematite and limonite are developed in the Twelve Mile Creek deposit, and a little limonite in the St. Dizier Creek deposit: these have been described as primary ores.

Stray lumps of limonite occur in the St. Dizier Creek and in the Twelve Mile Creek, derived from the known deposits by a process of solution and precipitation.

Gabbro has been recorded from the northern portion of the area mapped: as prospecting is carried on, it is likely that small deposits of secondary iron ores will be found in connection with this basic rock, derived from the iron-bearing minerals as weathering proceeds: no deposits of importance are likely to be found in this connection.

#### IV.—THE MINING PROPERTIES.

##### (1) *The Heemskirk Tin Syndicate.*

The leases held by this syndicate include 585 acres, comprised as follows:—Sections 472M 40 acres; 6265M 5 acres; 3806M 5 acres; 635M 10 acres; 6307M 10 acres; 6327M 10 acres; 1784M 10 acres; 5649M 40 acres; 5650M 40 acres; 5651M 40 acres; 5652M 80 acres; 5653M 10 acres; 5654M 40 acres; 6114M 80 acres; 6115M 40 acres; 6349M 40 acres; 6357M 80 acres; and 5883M 5 acres. These sections are all charted in the name of C. D. Finch. With the exception of the lastnamed, these sections are adjacent one to the other, and form a group on and near the Tasman River. Section 5883M is isolated, being situated about 60 chains south-east of 472M, the most southern section of the main group.

In addition to the above, the syndicate holds water-rights 1282w and 1444w for 10 sluice-heads from two sources, 5 sluice-heads from Rocky Creek, a tributary of the Heemskirk River, and 5 heads from the Heemskirk River itself. There is also a water-right, 1353w, for 15 sluice-heads and a dam-site of 56 acres on the Heemskirk River, near its junction with the Pieman River. These rights are also charted in the name of C. D. Finch.

The property now owned by this syndicate comprises mining sections formerly held by different lessees. On one of these sections, No. 472M 40 acres, several attempts were made to treat the wash in a small way, but appear to have been unsuccessful on account of the heavy water encountered. A steam donkey pump was taken on to the ground, but was not powerful enough to do the work expected of it. This property was previously known as the Granville Mine, and the late Mr. George Smith, one of the pioneers of the district, was the principal shareholder.

Prospecting shafts had been sunk at different points, and it was realised that tin-bearing gravels existed beneath the button-grass cover, but only when the present syndicate took over the property was prospecting commenced in a thoroughly systematic manner, and an attempt made to trace the extent of the deposit of tin-bearing gravels. As has been previously mentioned, a widespread flow of basalt in Tertiary time covered a large tract of country, and in filling the old river valleys preserved the deposits of gravel which had accumulated therein. Boring through this basalt cover has shown that tin values do exist in the gravels below, and that the deposits will be payable in certain localities.



PHOTO 3.—HYDRAULIC SLUICING, HEEMSKIRK TIN SYNDICATE'S PROPERTY, NORTH HEEMSKIRK.  
*T. C. Goodall, Photo.*]

The area originally held was much smaller than that leased at the present time, and after being satisfied by careful sampling with the prospects, a plant was purchased, carted from Zeehan at considerable expense, and erected on the property. Work was commenced, the values found to be quite up to expectations, and prospecting work pushed ahead, other leases being taken up to include more of the tin-bearing gravels, which were found to bear to the north-west.

The 5-acre section previously referred to, No. 5883M, which lies to the south-east, includes a separate run of drift.

The writer's examination of the property was made at a rather unfortunate time, and consequently his report is very incomplete, and can really do little more than deal with generalities. This is owing to—

- (a) The paddocks which had been worked being inaccessible, as work had ceased and the water allowed to fill the excavation.
- (b) The prospecting work being carried out at the time being of such an important nature that results could not be given to the writer, since the publication of the information might have resulted in the syndicate being unable to secure for itself the ground which it was entitled to, on account of the expense incurred in carrying out the necessary prospecting operations. It was known that others were closely watching the results, and were waiting to secure the valuable ground if any indication could be gained as to the trend of the old river valley.

The main group of leases is situated about 4 miles from the coast in a direct line, and about 6 miles east of Granville Harbour. As will be seen by reference to the accompanying general map of the district, the leases are grouped round the foot of Donnelly's Look Out, being to the south-east, east, north-east, and north of that peak. The area included forms portion of the old Pieman plain, situated about 200 feet above sea-level. The surface is in reality slightly undulating, and the present streams are gradually cutting their way down into the formerly level surface. The present drainage system is that of the Tasman River, which flows south-west into the South Pacific Ocean. Although there is no very decided

ridge to mark the divide, just north of the leases the drainage is north into the Pieman River. The Tasman River and its tributaries are all small streams in this locality.

The country is partly open button-grass plain and partly covered with heavy timber and dense scrub. We have here a fine illustration of the influence of soil on the nature of the vegetation, for the basalt areas are invariably well timbered, while slate and alluvial formations support only button-grass, with scrub in the water-courses.

As indicated in the accompanying map of the district, all the northern sections of the group are basalt covered, excepting where the streams have cut through the basalt cap, while the Tertiary deposits are covered only with soil and peaty button-grass in Sections 1784M, 635M, 3806M, the southern portions of Sections 5649M, 5653M, and 5654M, the central and eastern portion of 6307M, the south-eastern corners of 6327M and 6265M, the western and southern portions of 5654M, and the central and north-western portions of 472M. The slate country-rock outcrops in the south-east of 472M, the west of 6327M, 6307M, and 5654M, while most of Section 6265M is on granite.

The boundaries of the various formations have been approximately mapped, and are shown on the accompanying map, but it must be understood that the boundaries are approximate only. In the time available it was not possible to run traverses to accurately fix the boundaries of all formations.

Up to the time of the writer's examination the only work done had been carried out on Section 472M, 40 acres, the most southern of the syndicate's sections. In speaking of work done, prospecting operations are excluded. It was on this section that attempts had been made to work the ground before the present syndicate took over the property. Two paddocks have been worked, measuring nearly 4 acres, in the south-western corner of the section. The Tasman River runs through the section about its centre, bearing a little west of south; the paddocks worked have been on the western bank of the stream, and extend almost to its bank. The western edge of one paddock extends a short distance across the boundary into the adjoining 10-acre section, 6265M.

The tin occurs disseminated through the whole thickness of wash, right to the surface, although naturally some layers are much richer than others, and the best values seem to be in the lower layers. Unfortunately, as work

was not being carried on at the time of the writer's visit, and the paddocks were inaccessible, No. 1 paddock being filled with tailings from No. 2, which itself was full of water, no detailed description can be given of the wash exposed in the face.

The wash consists of fluvial gravels and sands, and rests on a bottom partly of granite (in the south-west of No. 1 paddock) and partly of soft white clays representing slates which have decomposed *in situ*. These clays are banded, corresponding with the cleavage-planes of the slates, strike N. 75° W., and dip south at 60° at one point where observations could be taken. These clays are cut through in places by fissures filled with black tourmaline and with quartz, these minerals remaining fresh after the remainder of the rock has decomposed to clay. There are also nests of tourmaline in places, and sometimes in place of a banded clay is a banded quartz-tourmaline rock, showing that the replacement by these minerals of the original rock has been complete. No large boulders appear to be present in the wash, although there are many of medium size (4 or 5 inches diameter) and grading down to fine sand. Amongst the boulders were noticed many fragments of banded quartz-tourmaline replacement rock, of slate, and of quartz-tourmaline veinstone, some of the latter carrying tin. Greisen is also present, and abundant quartz. The latter has been derived from lodes in the granite, the quartz-tourmaline veinstone from veins both in the granite and in the country-rock adjacent to the contact. It is noticeable that the larger boulders are usually sub-angular, the smaller being well rounded. Two facts worthy of note are, (1) the presence of lignite at various horizons, fixing the age of the deposits as Tertiary; and (2) the presence of abundant iron pyrite in certain of the lower layers, forming a cement in which are embedded fragments of quartz, tourmaline, &c., and also grains of cassiterite. The pyrite has probably been precipitated from solution, as suggested in an earlier part of this report.

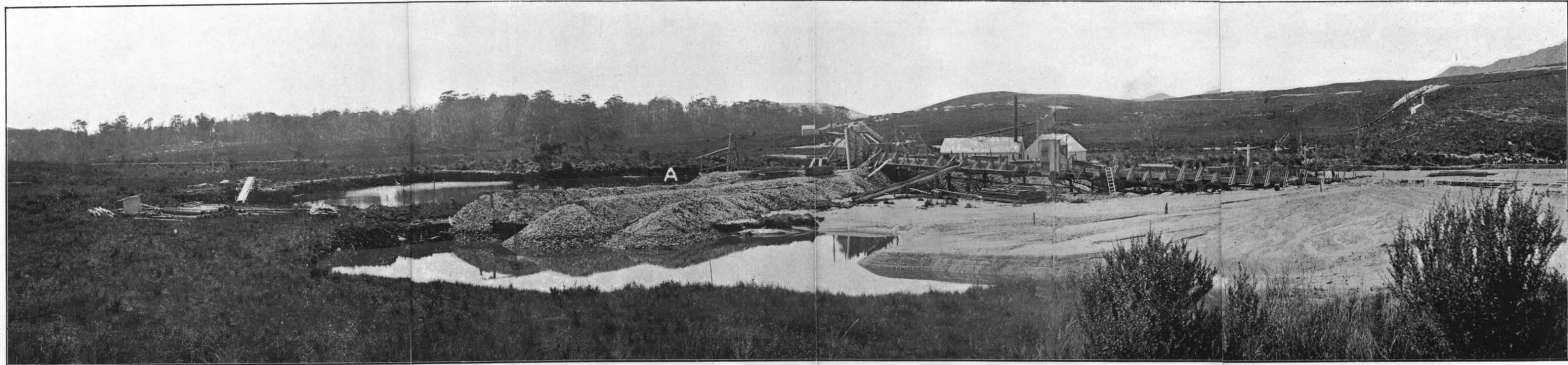
Some of the layers of wash are of fine sand, representing, doubtless, deposits of silt from flood-waters. These layers carry a little tin, and sometimes distinct impressions of leaves of Tertiary plants were noticed.

In the paddocks already worked the overburden has been slight, consisting of black soil from a few inches to about 2 feet in depth, covered with button-grass, but no timber. The same conditions prevail on Sections 472M,

635m, 3806m, 1784m, and part of 5653m. Just north of the two latter sections basalt makes its appearance, and on the remaining sections to the north different conditions prevail. The basalt soil is so rich that it supports a luxuriant growth of timber and undergrowth; consequently this will have to be dealt with before the basalt soil can be removed. No information is available to the writer as to the results of the boring carried out by the syndicate, but from surface indications it appears that in most places the thickness of solid basalt covering the gravels will be slight. What was formerly an extensive sheet has been cut through by the streams, and the residual patches of basalt have in most cases thoroughly decomposed to a rich red soil, in which are still to be found boulders of comparatively fresh basalt. This overburden is, of course, barren, and must be removed before the underlying tin-bearing gravels can be treated, and in planning future work arrangements must be made accordingly. The campaign of systematic boring recently carried out will prove of immense value to the syndicate in indicating the nature as well as the thickness of the overburden. The expense of removing the timber can fortunately be counterbalanced to some extent by utilising the timber so removed as firewood for the generation of power.

Little can be said with regard to the depth of wash or as to its values. In the southern end of the No. 1 paddock worked it appears not to have been more than about 10 feet, but in the face of No. 2 paddock, when sluicing was discontinued, the depth had increased to about 30 feet; here the bottom layers were said to carry the best values. Some chains further ahead (north) of this again, in one bore at least the thickness was 50 feet, but information is not available as to whether this can be regarded as an average figure, or whether the bore bottomed on an unusually deep pocket in the old river bed. It is at least clear that on proceeding further north the ground becomes deeper. It is rather to be expected that the tin will be more disseminated, *i.e.*, that the average value of the dirt will decrease, but the writer cannot say whether prospecting operations have proved this to be the case in reality.

*Plant and Treatment.*—The gravels are treated by hydraulic sluicing. The plant includes one 10-inch gravel pump, by Thompson & Co., Castlemaine, with removable liners. This is a centrifugal pump, with 15 to 18 feet suction-pipe, the total lift being 45 to 50 feet. The pump is belt-driven by a Robey compound portable engine of



*I. L. Waterhouse, Photo.]*

PHOTO 4.—HEEMSKIRK TIN SYNDICATE'S PLANT AND WORKINGS (NOS. 1 AND 2 PADDOCKS), NORTH HEEMSKIRK.

40 indicated horse-power. The steam-pressure is 145 lb. per square inch, and the number of revolutions per minute 135. The fuel used is wood, which is delivered at the plant from horse-trams running into the timbered country comprised in the more northern leases. Thus a double purpose is served by utilising this timber, which is abundant, and which would necessarily have to be removed before the tin-bearing ground ahead could be worked. The manager informed me that in actual practice the average quantity of dirt moved by the pump had been 19 cubic yards per hour; that this figure was low, as there had been several unforeseen stoppages for various reasons, and under present conditions the pump could move 21 cubic yards per hour. With more power the capacity of the same pump would be increased to 25 cubic yards per hour.

The ground is broken down in the usual way by nozzles. Water is brought from the Heemskirk River by a race about  $5\frac{3}{4}$  miles in length, carrying 10 sluice-heads of water. This race utilises portion of the old Eureka Tin Mining Company's race, which had fallen into a state of disrepair. The uneven nature of the country, although appearing generally level, is indicated by the tortuous course of this race, which is shown on the accompanying map. The head available is 85 feet to the grass at the No. 2 paddock, or an effective head of about 105 feet. Obviously, this amount will be increased slightly as the workings become deeper.

The machinery is carried by a covered barge, which rests on a prepared bed when working. When it is decided to commence opening up a fresh paddock, a new bed is prepared near the old face, several poles erected to mark the exact position of this bed, and the old paddock allowed to fill with water. The barge floats, is pulled over to its new position, water turned off from the paddock, and the pump started. As the water is pumped out the barge settles into its new position, and is ready for another run, the old excavation being extremely useful as a dumping-ground for the tailings from the new paddock.

In working, the ground is broken down and carried to the sump by water from the nozzles, elevated by the centrifugal pump to a grizzly, the oversize trucked to spoil from a side-chute, the finer gravel and sand run through a long sluice-box where the heavy cassiterite is concentrated behind riffles in the usual way. The concentrate

is dressed to remove pyrite, of which there is always a certain amount present, and the tin sent away is of high grade.

*Prospecting.*—When it was realised that the plant installed was incapable of dealing with the deep ground unexpectedly encountered, sluicing was stopped, and a prospecting campaign vigorously prosecuted. Several shafts which had previously been sunk were cleaned out and resampled, and as much information as possible gleaned from these. Several drills were brought on to the property, and these also were utilised. Plans of the leases were prepared, and these were divided up by two sets of surveyed lines at right angles, the transverse lines being 200 feet apart, and the longitudinals 150 feet. These lines were set out on the property, tracks being cut through the scrub where necessary, and bores put down at their intersections. By this systematic method a quantity of information concerning the lead, its extent, width, depth, values, the nature and amount of overburden, &c., was obtained which will prove invaluable to the syndicate in planning future work. Such a method of prospecting is to be highly commended.

The drills used are of the usual type of hand-drill. A tripod derrick is erected to carry a pulley-wheel, over which passes the rope carrying a large block of wood to act as a monkey and drive the tubes into the ground. The contents of the tubes are removed by a sand-pump, and examined, and careful records kept of the material passed through, which is vanned when necessary to determine the tin content.

No figures are available to the writer relative to the value of the ground ahead.

With regard to the actual tin produced, Messrs. Gibbs, Bright & Co. have kindly supplied the information that since the Heemskirk Tin Syndicate took over the property 68,150 cubic yards of ground have been sluiced, averaging in value 1.981 lb. of stream tin per cubic yard, the total content being 60 tons 5 cwt. 2 qrs. 3 lbs. of tin oxide.

Apart from the main run of wash described, there are some old workings on the hillside overlooking the flat on Section 472M where sluicing has lately been carried on. These old workings are about on the eastern boundary of the above section, and 70 or 80 feet above the flat. The ground has been worked for several chains, but only for a limited width, and the writer was informed that 10 tons of tin oxide were won. The dump heaps show



PHOTO 5.—NO. 2 Paddock, HEEMSKIRK TIN SYNDICATE, NORTH HEEMSKIRK.

*L. L. Waterhouse, Photo.*]

abundant fragments of sub-angular and angular white quartz, usually about 6 inches across, with a subordinate amount of sub-angular banded quartz-tourmaline replacement rock, and tourmaline. No quartz-tourmaline vein-stone was noticed. Sand and gravel are practically absent, and no well-defined stratification can be distinguished. The material appears to be detrital, and the deposit is from 2 to 4 feet in thickness, with a few inches of overburden covered with button-grass.

As this detrital material is below the water-race, it may prove that there is an extension of this ground which could be profitably sluiced at some time when the water was not required for the nozzles on the flat below. Prospecting is required to determine the value of the ground. Should this material be treated, a sharp look-out should be kept on the exposed bottom for lode-formations. The country-rock here is slate, and the nature of the detrital material seems to indicate that it may be derived from tin-bearing quartz veins in the vicinity.

*Future of the Property.*—In spite of the fact that at present the property is idle, the prospects for the future are bright. The present stoppage is temporary only, and was rendered necessary by the unexpected nature of the ground met with. I am informed that values are sufficiently encouraging to justify the erection of a more powerful plant, which will be capable of treating the deeper ground, which is now known to exist ahead of the present workings, and that preparations are now being made to instal this plant. The increased tonnage which may be expected to be treated by such a plant should result in an appreciable decrease in working costs per cubic yard, enabling a lower-grade dirt to be treated, if the price of tin be maintained.

There can be little doubt but that the bottom of the lead slopes north for some distance, and that the old river flowed in that direction. The previous workings have then been down-stream, and it is a question for the management to decide whether it will not be more economical to work in the opposite direction, and so take advantage of the slope of the bottom, which in that case would be towards, and not away from, the sump. Sufficient information is not available to the writer to enable a definite opinion to be expressed on the point. The information furnished by the prospecting work which has been carried out will enable an opinion to be formed. The grade of the head-race from the face to the sump must be suffi-

cient to enable the loosened material to be transported, and if the natural slope of the old river bed be great, then by working down stream, the head-race will have to be cut deep, and the length of the suction-pipe be increased if an extensive paddock be worked; and it is scarcely necessary to add that if only a small paddock be worked from one position of the barge, the working expenses are considerably increased.

Recommencing work from a new position further down the course of the lead would necessarily entail the opening up of a new paddock on virgin ground, with the initial difficulty which must be faced in every new venture of the kind, viz., the disposal of the tailings before an excavation is available from older workings in which to dump them.

In future work there are increased costs to be faced in certain particulars. When once the edge of the basalt country is reached, there will be timber and overburden to be removed before sluicing will be possible. The length of pipe-line will also be increased as the distance from the race increases. On the other hand, the cost of firewood will be less, and the actual working costs with a larger treatment plant will be less than with a small one. The nature of the wash is likely to be similar to that already met with.

The Zeehan-Granville tram, now in course of construction, will facilitate the working of this property by reducing considerably the cost of transport of necessaries to the mine, and of tin from it.

Nothing definite can be said of the actual values in the virgin ground, but from theoretical reasoning one would expect that the tin would become rather more disseminated on proceeding down-stream, and further from the main source (granite) from which the tin was derived. Other factors, however, come into play, rendering a prediction impossible. For instance, other lode-formations in the country-rock may have been cut through by the old streams and contributed their quota. Tributary streams may have joined the parent one and contributed to the tin content. Concentration may have been affected by factors, such as the nature of the bottom, and the nature of the sides of the valley. As these considerations have been previously discussed under the heading of the "secondary tin ores," nothing more need be said at this juncture.

Another factor which must influence the future of the property is the price of tin, but as this cannot be foretold, nothing further need be said about it.

From what he has seen of this property the writer cannot but express the opinion that it has a bright future. There is a considerable area of ground included in the leases which, if economically worked under efficient management, should return handsome profits for several years to come.

Section 5883m, 5 acres, charted in the name of C. D. Finch, is situated about 60 chains to the south-east of Section 472m, which has been described. It is about on the granite-contact, which is not exposed exactly, but appears to run about diagonally from south-west to north-east through the section. The Heemskirk Tin Syndicate's water-race is between 6 and 7 chains to the north of the section. Included within the boundaries of the section is a deposit of alluvial gravel, which is said to carry good tin values. Several attempts have been made to work portions of the deposit in the vicinity of the section, but there has been a difficulty in getting water on to the ground, as some of the wash is on a spur, and the whole deposit has not been worked.

On the western boundary, near the north-western corner of the section, a small paddock has been worked. The wash here has an essentially granitic facies, containing fragments of granite, quartz-tourmaline veinstone, quartz and tourmaline. It is all well rounded, and no boulders were noticed, the pebbles being up to about  $1\frac{1}{2}$  inches in size. The depth of wash round the edges of this paddock varies from 12 to 30 inches, with a few inches of overburden. The bottom is mainly blue slate, with some bands of crushed sandstone; in places a certain amount of mineralisation has taken place, pyrite being developed in the slates, while in some specimens small but distinct crystals of chiastolite are noticeable. The development of chiastolite is not surprising, seeing that the intrusive granite is only a few chains distant to the south-east.

Near the south-eastern corner of the section is a small dam; this exposes granite *in situ* in the bottom.

About 4 chains east of the eastern boundary a little more work has been done. On the summit of a low hill is a paddock where the wash exposed is sub-angular to rounded, consisting mainly of banded quartz-tourmaline replacement rock, and a little quartz-tourmaline veinstone,

with quartz and tourmaline. There is practically no overburden, the depth of wash varying from about 4 feet on the western to 1 foot on the eastern edge of the excavation.

A short distance to the north-west another small patch has been worked, while a few feet north of the northern boundary of the section are other workings. The latter workings and those on the hill disclose sub-angular material, which is practically non-granitic in character, the constituents being mainly of contact rocks. This material is not stratified, but is arranged irregularly, and is apparently detrital rather than true alluvial. In the bottom is granite with much aplite. On the dump-heaps were found several nuggets of cassiterite of a greyish black colour. From the position of the workings, scarcity of water before the Heemskirk Tin Syndicate's race was brought in, seems to have prevented the further working of the ground.

The five-acre Section 5883M had not been worked at the time of the writer's visit, but with the help of the water from the race, now so convenient to the spot, may pay to ground sluice. The nature of the ground is likely to be quite similar to that in the old workings described above, but the tin content is not known. The thickness of wash is likely to be small, probably varying from 1 to 4 feet, with but a few inches of overburden, the latter supporting a growth of button-grass. Although water cannot be spared from the race when sluicing is proceeding on the main group of sections, this ground will probably be found useful by the Syndicate for employing a few hands, and so keeping them on the mine, and occupied at useful work during any temporary stoppage.

## (2) *The St. Dizier Mine.*

The property to be described comprises two mineral sections, each of 20 acres—Nos. 5673M and 6141M, both charted in the name of G. Leppard. The sections are situated partly on the St. Dizier Creek, partly between that creek and the Tasman River, and are half a mile due south of the Heemskirk Tin Syndicate's Section 472M.

There are three units to be considered, which may conveniently be treated separately—(a) shallow alluvial ground, (b) deep lead, (c) lode formations.

(a) *Shallow Alluvial Ground.*—This ground seems to have been comprised in the first mineral section taken up

on the Heemskirk field, about the year 1876. At the present time there is little ground remaining to be worked.

The wash, which rests partly on granite and partly on contact slate, consists mainly of quartz-tourmaline vein-stone, well rounded, much of it in the form of pebbles, but some boulders being up to 12 inches diameter. There is also a little banded quartz-tourmaline rock, which is sub-angular, and quartz, the two latter being derived from the contact rocks. These workings are on Section 6141M, and have yielded a considerable amount of tin in the past. Although a few small patches may remain, this shallow alluvial ground is practically exhausted.

(b) *Deep Lead.*—To the west of the old shallow alluvial workings, and on Section 5673M, are the workings on the St. Dizier deep lead. The occurrence is different to that seen anywhere else in the district, and is rather puzzling. Workings in the form of a tail-race of about 5 chains, leading to the Tasman River, connecting with a cut about 10 chains long,  $\frac{1}{2}$  to 2 chains wide at the top, and about 35 feet deep, have exposed a formation whose presence would not have been suspected from surface indications. The whole occurs within the borders of the granite. There is a bed of wash apparently varying in thickness from 2 to 9 feet, with an average, as exposed, of about 4 feet, associated with sandy shales and clays, and partly overlain by basalt. Both the wash and the shales, &c., carry lignite and carbonaceous material, but particularly the latter, a log about 12 inches in diameter, converted to lignite being noticed in one place. The deposit is evidently of Tertiary age. The nature of the wash varies from point to point, and appears to carry more pebbles and boulders of typically granitic facies, as it extends further west. Typically the wash contains sub-angular banded quartz-tourmaline replacement boulders of medium size, with well-rounded pebbles of quartz-tourmaline vein-stone and quartz: some layers contain a good deal of quartz sand. The wash is sometimes stained black, and is sometimes iron-stained, probably with solutions derived from the basalt. The bed of wash is dipping south on the north side of the excavation, and north on the south side, the main excavation bearing almost due east and west. The bed of wash forms a synclinal fold, and there is evidence of faulting having taken place at certain points.

No details are available with regard to the value of the wash or the tin won from the workings.

The above are the general facts of the case. The occurrence was described in detail by Mr. G. A. Waller, Assistant Government Geologist, in his "Report on the Tin Ore Deposits of Mt. Heemskirk," 1902, this report being accompanied by a plan of the property, and as no work at all has been done since this report, the description given therein still holds good, and the reader is referred thereto for further information.

The writer agrees with Mr. Waller in his expressed opinion as to the probable course of the lead.

As to future work on this part of the property, the suggestion made that prospecting should be carried out to the south-west to try and locate the extension of the lead in that direction is sound, and should be followed. This is a case in which boring could be employed with advantage after locating the outcrops by surface trenching; the latter should not be very difficult to trace, and all possible information should be secured from near the surface before attempting to pick up the extension at a depth.

A suggestion was made at the time of the writer's examination to drive a tunnel from a bend in the Tasman, to cut the wash at the bottom of the syncline or trough-like bend, and stope the wash therefrom. The length of drive required would apparently be about 300 feet, and as Mr. Waller has pointed out, mining methods would have to be employed for extracting the wash, and timber to support such excavations would be an expensive item. Although indications are favourable for the wash to carry good tin values towards its eastern extension, nothing definite is known as to these values, and so there would be a good deal of risk attached to such a venture. Values are said to have been patchy in the wash previously worked, but it is still an open question as to whether the average values will be sufficient to cover the additional cost of mining. Again, as faulting appears to have taken place further west, the possibility that such may also have disturbed the beds further east must be considered.

The position then is that while there is much to commend such a tunnel, and good tin values may be found, there is a certain element of risk attached to the work. In face of the evidence available, the writer would recommend that further prospecting from the present face be undertaken first, and if satisfactory, that a few bores be put down east of the face, to get an idea, not only of values, but of the depth of the wash below the surface,

and therefore of the probable extent of ground which the proposed tunnel would serve.

The ground is worth a further trial.

(c) *Lode Formations*.—There are three distinct lode-formations on the property, to which reference should be made.

One is a stanniferous pyritic body occurring on Section 6141m, near its western boundary, and a short distance from the western edge of the old shallow alluvial workings. It was intersected in cutting a race, but no further work has been done upon it, hence little can be said about it at this stage. It belongs apparently to the pyrite-cassiterite vein type, the only minerals noticed being pyrite and cassiterite, with quartz as a gangue mineral. The total width of the formation is about 20 feet. The country-rock is slate, but the granite contact cannot be more than a few yards distant to the south. The formation consists of bands of pyrite replacing slate, some bands of the latter rock being unreplaced. Some of the pyrite bands are of dense mineral, but carry good tin, which is very fine, and grey in colour. Geodes lined with small quartz crystals sometimes occur in the pyrite. The strike cannot be very definitely determined from this one exposure, but appears to be about N. 79° W. The formation deserves a little prospecting; a few trenches would show whether it is continuous, and would give an idea of its nature and size; samples could then be taken, and these would show whether further development was warranted.

Exposed towards the north-western corner of the old shallow alluvial workings, about 2½ chains from the head of the deep-lead workings, is a vein on which a little work has been done. It occurs in granite, and is from a few inches to about 1 foot in width where exposed. The granite is rather decomposed on either side of the vein proper. The vein-filling is composed almost entirely of crystalline arsenical pyrites (mispickel), with a limited amount of a soft yellowish mineral in fine scales and aggregates; the latter is probably pinitite. The vein is said to carry good tin values, and this would not be surprising, for it belongs to the pyrite-cassiterite type of vein, which typically carries arsenopyrite; the latter mineral certainly predominates at the point exposed, but might be found to take quite an insignificant place, giving way to other sulphides on further exploration.

The third ore-deposit on the property is a very different type to the two preceding, being a contact-metamorphic

deposit of the "Kristiania" type. It occurs in the bed of a small branch creek of the St. Dizier, flowing in from the east, and is about on or just without the eastern boundary of Section 6141m. The deposit consists largely of magnetite, and has previously been described under the heading of "Iron Ores." The presence of cassiterite, recorded by Mr. Waller in 1902, has been verified, but it is doubtful whether the deposit is of commercial value; the tin oxide is likely to be distributed through the deposit in narrow seams, and the complexity of the ore will militate against its successful extraction, especially in view of the fact that it does not offer special facilities for mining, and transport charges to and from the property are high.

Another trench might be put in to disclose the nature of the deposit and to enable it to be sampled, as little is to be seen at the present time.

### (3) *The Peripatetic Mine.*

This property is charted as Section 5755m, 10 acres, in the name of G. Leppard. It is situated on the western slopes of the North Heemskirk Range, and about 3 miles south-west of the Heemskirk Tin Syndicate's property. It is only about  $1\frac{1}{2}$  miles from the coast, and is connected with the Trial Harbour-Corinna Road by a short branch-road.

The Peripatetic Mine is one of the old properties of the North Heemskirk Field, and a 10-head battery was formerly erected on the mine, with concentrator, although very little stone was crushed. The plant has long since been removed, and no work has been done on the property for a considerable time. The old workings are falling into disrepair, and some of them could not be examined. At the time of my visit I was unable to secure the services of anyone familiar with the property, and was compelled to look over the mine without a guide.

There is every indication that a body of stone exists which will pay for treatment under modern conditions. The tin appears to be contained partly in a definite lode, having been introduced from a central fissure and impregnated the stone on either side to some extent, and partly in a dyke of aplite which is characterised by abundant quartz-tourmaline nodules. These outcrop on the south-eastern slopes of a low spur, and have been opened up by several shallow adits and winzes therefrom. A little

stopping has been done. Some of the ore is pyritic, and the probability is that all will prove to be so below ground water level. Much of the surface stone, however, is oxidised and will need no special treatment. Much of the tin seems to be finely disseminated, but with a modern treatment-plant under proper supervision a fair recovery should be obtained. Some specimens picked up on the dump-heaps showed fairly coarse tin, well crystallised, while others showed veins and impregnations of fine brown cassiterite in pyritic material. Other specimens, again, in which no tin could be distinguished, showed veins filled with crystallised pyritohedral pyrite, prismatic quartz, and black tourmaline.

With regard to the mine workings and details of the lodes, an excellent description accompanied by a plan will be found in Mr. G. A. Waller's "Report on the Tin Ore Deposits of Mt. Heemskirk," 1902, and as no work has been done on the property since Mr. Waller's examination was made, and the workings are not now so accessible as they were at that time, the reader is referred to that report for fuller particulars.

The Peripatetic Mine certainly deserves a further trial. There is some good ore showing, and further development to ascertain the extent of the ore-bodies is warranted.

Certain problems will need careful consideration when planning future work. For instance, there will be the sinking of a main shaft, and carrying out of work therefrom, as the topography of the country does not permit of working for any length of time from adits. In this connection it may be stated that water is not likely to be met with in any great quantity. The question of power, too, must be considered. In his hurried examination of this portion of the field, the writer did not notice any specially suitable spot for a reservoir at such an elevation as would allow of the impounded water being used to advantage for the generation of power. A limited supply of firewood is available near at hand. If quantity and quality of ore are proved to be available, and not before, the treatment will need consideration. Certain aspects of this particular question have already been touched upon in the course of this report. Transport difficulties, too, will have to be overcome, but these are no worse than confront some of the other properties in the district. The property is at present connected with Zeehan by road, *via* South Heemskirk, about 22 miles, but if the Zeehan-Granville tram be continued to the Heemskirk Tin Syndicate's property, the

Peripatetic Mine would be within about 6 miles of it by road, and could be connected by a branch line of about the same length if prospects were good enough later on to warrant the expenditure.

(4) *Section 5312M—40 acres.*

This section is charted in the name of G. Smith, and in the southern portion of it some work has been done on a deposit of stanniferous alluvial gravels. These workings are about 60 chains east of the Heemskirk Tin Syndicate's workings on Section 472M.

A tributary of the Tasman River flows north through the western portion of the section. The work carried out has been with the aid of water brought in by a race about 60 chains long from the Twelve Mile Creek. The water-right is charted as 1301w, in the name of G. Smith.

The section includes a comparatively large area of alluvial ground, consisting of Tertiary river gravels, and this ground is seen to be approximately on the same level as that previously described to the south, in the vicinity of C. D. Finch's 5-acre section, 5883M. These two areas are separated by a creek flowing into a branch of the Tasman River.

The main work done has been in the form of an open-cut a few chains from the southern boundary of the section. The wash consists almost entirely of rounded pebbles of quartz and of banded quartz-tourmaline replacement rock, in distinct layers. The overburden is only a few inches in thickness, the surface of the ground being covered with button-grass. The depth of wash varies from 5 to 12 feet. The main paddock worked is about 40 feet wide and 130 feet long. The south-western wall of the cut, which is worked into the hillside, shows 5 feet of banded wash, medium to fine in size, resting on 5 feet of sandy loam with occasional bands of gravelly wash, resting on a slate bottom. In the face the thickness is about 12 feet. Here the main run of wash appears to narrow somewhat, the upper 3 feet being gravelly wash. On the north-eastern wall the upper layer is composed of 5 feet of medium to coarse wash, tailing out to 2 feet in the face, resting on 7 feet of pebbly wash. The tail-race has been cut to a depth of about 6 feet into the bottom, which consists of blue chialstolite slate, striking about east and west, cut through by veins of quartz.

About 1 chain to the east another paddock has been worked, smaller than the preceding. The width is 9 feet, and length 20 feet. The nature of the wash exposed is exactly similar to that already described. The bottom layer is of fairly coarse sub-angular to rounded fragments, succeeded by finer layers right to the surface, the whole being stratified. Although the talus covers the lower layer in the face, the thickness of wash is about 10 feet. The bottom is soft blue slate, showing white chialstolite crystals.

Above the main paddock a shaft has been sunk on top of the hill, showing 8 feet of wash.

Trenching further north has shown the existence of similar wash, although the depth has not been exposed.

There is undoubtedly a considerable extent of wash on the property, probably extending also into Section 5674M to the north, this section being held by G. Leppard. One of the difficulties to be faced is the bringing on to the property of an adequate water-supply to enable the ground to be economically treated. Before any attempt be made to effect this, however, the ground needs careful sampling. No figures are available as to the value of the ground, but from a study of the nature of the wash it appears that it has been derived largely from the wearing down of country-rock by degradational forces, rather than of granite. The comparative absence of fragments of quartz-tourmaline veinstone is marked. As a good deal of the tin found in the alluvial deposits of the district is derived from veins of this character, the scarcity of this wash is not a promising sign. The evidence available indicates, to the writer's mind, that tin values are likely to be lower than in the gravels further to the west. Systematic prospecting is recommended.

#### (5) *Long's Iron Blow.*

High up on the northern slopes of Mt. Heemskirk, and standing out so boldly as a black rocky outcrop that it is visible for miles from the surrounding plains, is the formation known in the district as "Long's Iron Blow." A hurried visit only was paid to the spot, and the general characters of the formation noted.

According to an aneroid reading taken, the outcrop is over 900 feet above the Heemskirk Tin Syndicate's Mine. The mountain side is covered with thick button-grass, with

scrub in the watercourses, and bold granite outcrops forming cliffs at different points. The surrounding country-rock is granite, with developments of granite-porphry and aplite in places.

Even when examined closely, the outcrop is seen to be very dark, and sometimes quite black in colour, due to the abundant haematite present. This mineral, with black tourmaline and quartz, form the bulk of the lode material.

The outcrop stands up boldly about 20 feet above the surface, which is here covered with button-grass. The length of the main outcrop is about 3 chains, and its width about 50 feet. No attempt seems to have been made to trace it along the line of strike, which in the main outcrop is about N. 50° W.

The ore varies somewhat in composition and texture from point to point, but consists essentially of haematite, tourmaline, and quartz in various proportions, with, at times, a small amount of a soft, greenish-grey mineral, apparently pinite. In some specimens there are crystalline aggregates of black tourmaline scattered through a groundmass of quartz and disseminated haematite. This groundmass is cut through by veinlets filled with crystalline black tourmaline and massive haematite, the latter occupying the central portion of the veinlets, which are about  $\frac{1}{4}$  inch in width. Sometimes small cavities occur lined with minute prismatic crystals of quartz and of tourmaline. In certain portions of the outcrop tourmaline and haematite occur almost to the exclusion of quartz; from such localities specimens were obtained showing veinlets of massive haematite in a groundmass of tourmaline. One specimen shows a vein of haematite up to  $1\frac{1}{2}$  inches in width, with tourmaline on either side, the vein enclosing radial aggregates of minute prismatic black tourmaline crystals. It is a striking fact that haematite occurs in definite crystals, up to  $\frac{1}{2}$ -inch across, of a brilliant black colour, and showing combinations of the scalenohedron and rhombohedron. The mineral is slightly magnetic.

It is stated that in the early days of the field when the outcrop was discovered, it was taken for a wonderfully rich outcrop of tin ore, the haematite being mistaken for cassiterite. This is not altogether to be wondered at, for the outcrop occurs in granite, which is known to be tin-bearing in the locality; the mineral itself is black, with almost an adamantine lustre when crystallised, and occurs

with quartz and tourmaline, which are constant associates of tin oxide in the district. Deposits of alluvial tin ore, limited in extent, have been worked in the creeks at the foot of the spur (one of the heads of the St. Dizier Creek), and this would fully justify the search for the mineral on the hillside, and would strengthen the illusion. The occurrence of haematite in a quartz-tourmaline lode is not very common, particularly in such quantities as it occurs here; from its mode of occurrence it certainly seems to be a primary mineral.

To the west of the main outcrop, and about 20 feet lower down the hill, is an old shaft. This is quite inaccessible. The depth is not known, but judging from the material dumped round the collar of the shaft, it may be about 50 feet. It has been sunk partly in granite and partly in somewhat decomposed lode material, which appears to be pyritic. The shaft may be a good deal shallower than the estimate given, and a drive may have been put in eastwards to cut the main outcrop, but the writer was unable to gain any information on the point. It is difficult to understand why a shaft should have been sunk at all on such a steep hillside, with such excellent facilities for prospecting by means of crosscut drives of moderate length. In such a formation one would expect to find a certain tin content, and it would not be surprising to find it present in payable quantities. To try and get an idea as to whether the formation really is stanniferous, the writer broke a fairly large sample across the full width of the outcrop, and quartered down. This was submitted to Mr. W. D. Reid, Government Assayer, who reports—

Tin . . . . . 0.29 per cent.

The actual value is low, but it proves that tin really is present, and indicates that the deposit belongs to the quartz-tourmaline-cassiterite vein type. In view of the above result, a little surface prospecting of the outcrop is recommended. Two or three trenches to prove the extension of the outcrop are merited. If surface samples systematically taken give any encouragement for further work, prospecting by means of crosscut drives can be arranged for, and carried out without great expense. From the size of the outcrop, and the facilities it affords for economic mining to a considerable depth, work on the lines suggested is strongly recommended.

(6) *The Eureka Mine.*

The property held by the old Eureka Company could not be visited in the time available. No work is being done in a systematic way, although several men and small parties were working small patches of alluvial wash in the vicinity, apparently with satisfactory results.

(7) *Tin Mine East of Section 5883m—5 acres, C. D. Finch.*

In making a traverse along the contact of the granite, some old workings were noticed which did not appear to be included within the boundaries of any charted section. Their position is shown approximately on the accompanying map (Plate II.), but the exact position could not be verified in the time available. The workings are on a spur about 25 to 30 chains east of C. D. Finch's Section 5883m, 5 acres. On the flat below are some old alluvial workings. The material is of shallow depth, and is detrital, consisting of angular and sub-angular quartz, schist, and banded quartz-tourmaline replacement rock, resting on a bottom of contact-metamorphic slate.

The workings on the hill above are within the granite, but within a few chains of the contact. They consist of a shaft and trenches on a very promising quartz-tourmaline-cassiterite vein.

No information is available from the shaft, which is in a state of disrepair, and partly full of water. Judging from the heaps at the collar of the shaft it may be 50 to 60 feet in depth. These heaps show decomposing granite, with a certain amount of white quartz and radiating black tourmaline. This may be derived from nodules in the country-rock, which in the vicinity is a nodular quartz-tourmaline aplite. On the tip is a little veinstone showing green tourmaline and cassiterite. The width of the vein on which the shaft was sunk is not evident, but would appear to be narrow. A few feet east is a trench, and although the vein does not show, unless it be very narrow—some very rich tinstone is lying about on the surface. This is dark-green in colour, owing to the abundance of green tourmaline present. Dark-brown cassiterite in dense aggregates is scattered through the groundmass, which also shows a little quartz, while vughs lined with prismatic quartz crystals and idiomorphic crystals of dark-brown tin oxide, are common. Crystals of quartz and cassiterite are almost invariably associated, and have evidently

been formed contemporaneously. Judging from the specimens, the vein must be at least 4 inches in thickness, and it may be considerably more. About 2½ chains south-east is another trench on the hillside. The trench is now partly filled up, and is shallow, but the continuation of the vein was not noticeable; it may be very narrow, as several fissures filled with tourmaline occur. In the surface debris, however, along the edges of the trench, some very rich specimens were picked up, consisting of angular pieces of pure cassiterite, quartz and cassiterite, and tourmaline with cassiterite. This trench does not appear to have been continued far enough, as some specimen stone was picked up beyond the head of the trench, towards the top of the spur, and more on the opposite fall.

On the summit of the spur is a vein running about parallel, probably, to the one on which work has been done. This strikes N. 52° W., and dips south-west at 55° to 60° where exposed. The outcrop has been broken in one or two places, but no other prospecting work appears to have been done. It has been traced for about 12 chains north-west, where it widens from a few inches to 3 feet. There is usually a very well-defined vein of fairly fine-grained quartz-tourmaline, composed of quartz and black and green tourmaline in about equal amounts, with a width of about 12 inches. On either side of this vein is quartz-tourmaline stone of somewhat different texture, coarser grains of quartz with abundant aggregates of needle-like prisms of green tourmaline. This is evidently granite in which the felspar and mica have been replaced by tourmaline introduced from the central fissure. There are also vughs in this stone lined with prismatic quartz crystals, indicating a probable addition of silica as well. No cassiterite was noticed in the stone, but it certainly is very promising, and deserves sampling at different points along its outcrop.

Although the main vein from which the rich tinstone on the surface has come appears narrow, a little more surface work is certainly justified to determine whether it does not widen. Unless surface work gives good reason for believing that a widening does take place, prospecting by means of underground work is not to be recommended.

The granite in the vicinity is fine-grained at several points, resembling granite-porphry with phenocrysts of

quartz and felspar, and shows coarser pegmatitic segregations in places. Nodular tourmaline aplite also occurs in the vicinity, and this is worth testing for tin contents.

(8) *A. Fitch's Sections.*

There are five sections charted in the name of A. Fitch—6878M, 40 acres; 6879M, 40 acres; 6880M, 40 acres; 6881M, 80 acres; and 6882M, 40 acres. These sections were all taken up after the writer's examination of the district. Their potential value depends upon the continuation of the deep alluvial ground being prospected by the Heemskirk Tin Syndicate, to the north-west and west, as these sections adjoin 6357M, 80 acres, held by C. D. Finch.

The southern portion of 6881M comprises Tertiary sandstones, which will probably be stanniferous, though to what extent remains to be proved. The northern portion of the section, however, must approximately include the ridge of gabbro described under the heading of the "Igneous Rocks" in this report. If this be so, there is no chance of alluvial gravels occurring below, for reasons explained elsewhere. In prospecting in this vicinity particularly the igneous rocks must be carefully distinguished, and their relation to the secondary tin ore deposits kept in mind.

The other sections, however, which are drained by a branch of Rocky Creek, are rather more promising. The scrub is extremely thick along the western boundary of Section 6357M, and several unsuccessful attempts were made to penetrate it. The conclusion arrived at, however, was that the country in this direction was basalt covered. If so, the basalt may or may not cover alluvial gravels, and the latter will have to be finally decided by boring. Such boring is justified, for it is probable that the lead will be found to continue in this direction. The gabbro ridge referred to must have barred the outlet to the north, and the question is whether the old river flowed north-east or westerly. Tertiary conglomerates and sandstones lie to the north-east, but it is still somewhat uncertain as to whether these form a continuation of the main lead or represent a branch from the north-east; the writer rather inclines to the latter opinion at present. Boring on the sections under consideration may be expected, therefore, to give valuable information. If gravels do exist, the ground is likely to be deep, and values somewhat disseminated, but no forecast can be made as to whether payable values are likely to exist.

(9) *P. P. Cook's Sections.*

There are two sections charted in the name of P. P. Cook, approximately shown on the accompanying map. These are numbered 6626M, 40 acres; and 6627M, 40 acres. No work had been done on them at the time of the writer's examination.

Pre-Silurian slate outcrops in the southern portion of both sections, while there are several patches of basalt in 6627M.

The sections could not be exactly located in the field, and consequently the formations shown on the map are approximate only. There are possibilities which should encourage prospecting, for it would seem that a branch lead must have joined the main one somewhere in their vicinity. Tin-bearing gravels exist to the south, and although denudation has removed portion of the deposit which existed here, it is not unlikely that portions may remain which will pay to work. Prospecting is recommended, but little can be said at present as to the extent of the wash.

(10) *Other Tin Properties.*

A little work has been done in other localities at various points, but the sections were not held, and so were not visited in the short time available.

Several sections have been taken up since the writer's visit, but no examination having been made, little can be said concerning them.

(11) *Granville Harbour Copper Mine.*

This property is also known as Vincent's Copper Reward Mine. It comprises an 80-acre section, 3716M, charted in the name of H. H. Vincent. There is an adjoining section held by H. H. Vincent and T. Wilson, on which no work has been done. Copper was discovered in a creek-bed by Mr. H. H. Vincent, and a reward section applied for in May, 1908, and granted. The occurrence is about  $1\frac{1}{2}$  mile due north of Granville Harbour.

The surrounding country is mostly covered with basalt, representing remnants of a sheet which formerly spread over a considerable area in the vicinity. The basalt, on decomposition, yields very rich soil, which supports a luxuriant growth of vegetable life (as referred to elsewhere in this report), and its value for agricultural pur-

poses is beginning to be recognised. Hence several hundred acres in the neighbourhood are held as purchased blocks. Actually the 80-acre section includes portion of one block charted in the name of J. Hunter, and another in the name of J. C. Meredith.

A few hours only were spent in this vicinity, and hence careful mapping was impossible, and the description given is more general than would have been possible after a more detailed examination.

The formation is enclosed in slates and sandstones, much crushed and hardened; these belong probably to the Pre-Silurian series so extensively developed further to the east. On the south-east of Granville Harbour, forming the coast, and forming a ridge just north of the harbour, granite outcrops. These outcrops form the north-western extension of the Heemskirk granite *massif* of Devonian age, and the deposit to be described is undoubtedly genetically connected with the intrusion of this huge mass of igneous rock. It is a contact metamorphic ore-body.

In the immediate vicinity of the lode outcrops, which occur in creek-beds, the basalt cover has been denuded, and the true country-rock appears at the surface.

Very little work has been done, and there is little more than the outcrop to be seen. A small hole was sunk to a depth of 3 or 4 feet, almost in the bed of the creek, and a trench cut partly across the formation a few feet back from the creek.

It was in the creek-bed where the formation crosses that native copper was discovered. It occurs in grains, flat flakes, and arborescent masses of crystalline structure sometimes 1 inch across. This is associated with a certain amount of magnetite derived from the ore-body, and with black copper oxide (tenorite). The metallic copper, as washed from the detrital matter, is sometimes free, and sometimes crystallised in the crevices of, or attached to, quartz. It occurs in certain bands of the ore-body adjacent, and its derivation is easily explained, although in the past the occurrence seems to have been misunderstood. It will be well to describe the ore-body itself before touching on the source of the metallic copper.

The formation is well banded, and the strike of the bands agrees with the strike of the enclosing slates at this point. The fact is significant. The strike is apparently about N. 50° W. here, although the presence of abundant magnetite renders great caution necessary in the use of the

compass. The dip is north-east, at about  $65^{\circ}$ . The width exposed is 27 feet. It is rather doubtful, however, whether the full width of the formation has been exposed.

An examination of the section exposed by the trench, from south-west to north-east, shows that on the footwall side the slate is impregnated with pyrite at the extremity of the trench; the latter should have been extended at least a few feet in this direction. For a distance of 8 feet 6 inches the ore is banded, and consists of magnetite, haematite, pyrite, and quartz. Some bands appear to be composed entirely of finely granular magnetite with disseminated pyrite, but a close examination with a magnifying glass reveals the fact that a small amount of quartz is usually present in the groundmass. Other bands carry more abundant quartz, which has the appearance of a series of veins in a groundmass of magnetite. Pyrite becomes more abundant, scattered in cubical crystals up to about 4 millimetres in size, throughout both quartz and magnetite. Some of the narrower bands consist essentially of pyrite, with subordinate amounts of magnetite and quartz. The iron oxide here sometimes takes a rather unusual form, which is worthy of note. It occurs in lamellar masses of thin plates, the plates being usually parallel to the banding of the ore-body. The structure is therefore best observed when a specimen is split off parallel with the strike of the formation. The tabular plates have a perfect cleavage; sometimes they are curved. On a freshly-broken face, and judging by general appearances only, the mineral might be mistaken for blende. It is black in colour, and has a metallic lustre. The hardness is about 6, and the tenacity is brittle. The mineral is opaque. The streak is reddish-brown to bright cherry-red. The mineral is strongly magnetic. But for the last characteristic the mineral would undoubtedly be called haematite. The latter mineral, however, is usually non-magnetic, sometimes feebly magnetic. The mineral under consideration, however, is very strongly attracted by the magnet. Its physical characters do not correspond with magnetite, and the mineral must therefore be classed as an unusual form of haematite. Although none can be detected, a small amount of magnetite may be included in the haematite, giving it this striking property.

The surface of this magnetite-pyrite band is covered with a thin coating of reddish-brown limonite, derived largely from the decomposition of pyrite. Some of the quartz bands carry abundant cubical cavities, indicating

that the cubical crystals of pyrite so common in the less weathered stone have decomposed and been removed.

This band, measuring 8 feet 6 inches, is succeeded by 7 feet, mainly of quartz with veins of pyrite, and many cubical cavities. Much of this quartz is stained with limonite derived from the decomposition of pyrite.

Proceeding towards the hanging-wall side of the formation, there is a band about 6 inches in width of soft black decomposing mineral, with a certain amount of massive iron pyrite, the band being very copper-stained. There is a certain amount of tenorite present, with malachite, chalcocite, and chalcantite, the soft black mineral being largely decomposing pyrite.

The following band, with a width of 2 feet, consists of quartz with iron pyrite, and shows copper stains in places.

The remaining 9 feet to the hanging-wall side of the trench consist of quartz, banded and fissured in places, with decomposing pyrites in veins throughout and copper stains in places. Native copper occurs in soft veins of decomposing mineral in this portion of the formation, and from a shallow hole sunk here good prospects of metallic copper can be washed.

No primary copper minerals were noticed in any part of the deposit. Nothing was to be gained by taking samples of the portion of the ore-body which has undergone alteration and secondary enrichment, for obviously there is no quantity of ore available. A sample was broken over a width of 8 feet 6 inches on the footwall side of the formation. The ore consists of banded magnetite and quartz with pyrite and haematite. This sample was handed to Mr. W. D. Reid, Government Assayer, who reported:—

Copper	Trace
Zinc	1·6 per cent.
Gold	Nil
Silver	Nil

A second sample was broken across the more quartzose portion of the ore-body, on the hanging-wall side, over a width of about 10 feet, but avoiding the narrow veins of decomposing material with secondary copper minerals, *i.e.*, primary ore was taken. For this sample the Government Assayer reported:—

Copper	1·9 per cent.
Gold	Nil
Silver	6·6 dwts. per ton.

The results of these samples are interesting. They indicate that the primary ore is really low-grade, and it is the primary ore which is, after all, of importance. It is useless deceiving oneself by reckoning on narrow rich patches of secondary ore, which are not likely to extend to any depth, and are only to be measured by inches in width. The low silver value is of no importance, while the presence of zinc-blende is demonstrated, although the mineral is not visible to the eye.

In the bed of a creek a few chains east of this occurrence is another outcrop rather poorly exposed. A little stone has been broken down from the creek bank, but otherwise no work has been done at this point. The width appears to be about 30 feet, but is not fully exposed. The dip is north-east.

The features appear similar to those of the ore-body at the outcrop described above. There is a belt on the footwall side of dense magnetite cut by veins of quartz and pyrite, the latter partly decomposed and leached out from near the surface. This is followed by a belt of white glassy quartz with some disseminated pyrite, showing copper stains (malachite) in places, and small amount of native copper. The latter occurs in thin sheets filling minute fissures in the quartz.

A sample of this pyritic quartz was assayed by Mr. W. D. Reid, Government Assayer, who returned—

Copper	0.14 per cent.
Gold	Nil
Silver	Trace

The result is not encouraging, but confirms those from the main trench.

In view of the nature of the ore, its structure, its inaccessibility, and its low value, the writer cannot recommend further expenditure upon it.

Exposed in the low ground at the junction of two creeks, about 6 chains a little west of south from the main outcrop described above, is another deposit somewhat similar in general characters to it. It also is a contact metamorphic ore-body. Its mineralogical composition appears to be similar to the main formation, consisting of magnetite, haematite, and fairly massive pyrite with quartz. It has a banded structure, and appears to strike about north and south. No signs of copper minerals were noticed, although it is probable that the pyrite here, too, will carry small quantities of that metal.

The formation appears to be distinct from that previously described, although obviously of the same nature. No attempt has been made to open it up, and its true strike and dip cannot definitely be stated.

It is worth while exposing it a little, and then sampling it, to determine whether values are present, but if these preliminary trials are unsatisfactory, further work is not to be recommended. From its nature and mode of origin the deposit is not very promising for copper.

(12) *MacArthur's Copper Mine and Vicinity.*

This is situated on Section 5345M, in the south-eastern portion of the property. The section is not held at the present time. The existence of copper ore at the surface has been known for some years, and a little work was done on the deposit, which was eventually abandoned. Quite recently a section was reserved which included this outcrop, and some work was done by a Government prospecting party under the direction of the State Mining Engineer. As this did not prove satisfactory, the property has once more been abandoned.

There is little to be seen at the present time, and the writer was unable to get first-hand detailed knowledge as to what had been done.

The outcrop occurs almost on the divide between the St. Dizier and Twelve Mile Creeks, but slightly on the St. Dizier fall, in a depression forming the head of a branch creek. It is about 5 chains west of the Heemskirk Tin Syndicate's race, which is on the Twelve Mile Creek fall.

The country rock is blue slate of Pre-Silurian age, altered owing to the intrusion of the Devonian granite, which occurs about 9 chains south of the workings. To the east chialtolite is developed, and to the south much of the country rock has been replaced by quartz and tourmaline.

A little trenching was done and an old shaft sunk, now collapsed, all the excavations being full of water. The water is slightly coloured by copper leachings from the dump-heap, and in one place a slight deposit of metallic copper was noticed on a fragment of scrap-iron.

The older workings were in the hollow, while the shaft sunk by the Government prospecting party was a few feet further up the slope. This was full of water at the time of my examination. The State Mining Engineer's report

on this work on 6th January, 1914, states:—“ . . . .  
The lode dips out of the shaft at 15 feet. The lode is well  
exposed in a cut a few feet from the shaft. Here it is a  
well-defined body 4 feet wide. A bulk sample taken across  
the lode at a depth of 5 feet gave on assay—

Gold . . . . .	Trace
Silver . . . . .	9·6 ozs. per ton
Copper . . . . .	26·8 per cent.
Tin . . . . .	Nil.”

In his report dated 6th February, 1914, the same officer  
stated:—“ The shaft has been sunk to 53 feet and a drive  
put out under the copper lode. The lode proved to be a  
surface enrichment, and not of economic value in depth.”

This is the only information available concerning the  
work carried out.

In the present state of the workings the width of the  
formation cannot be determined. The strike appears to  
be about N. 77° E. Where they are cut in the race, about  
5 chains to the east, the slate country rock, in which tour-  
maline and chiastolite are developed, strikes N. 85° E. A  
careful examination of the dump-heaps showed that in  
the ore, which apparently came from near the surface,  
being much weathered and decomposed, several distinct  
minerals are present. Arsenopyrite is abundant, and  
occurs in crystals and crystal aggregates. Massive pyrite  
is noticeable in some specimens, and a good deal of blende.  
Chalcopyrite is present in comparatively small amount,  
usually associated with pyrite. A little covellite is to be  
seen also. From the open texture it is evident that some  
constituents have been leached out. The gangue is usually  
thoroughly decomposed, although aggregates of mica occur  
in places.

Bornite has been reported from the property, but none  
was seen by the writer: possibly the fact that the blende  
present is usually tarnished, sometimes to an iridescent  
purple colour, has caused that mineral to be mistaken for  
bornite. This ore has evidently been exposed to oxidising  
agencies, and apparently contains a little oxide and sul-  
phate of copper in places. This would doubtless account  
for some rich assays having been reported. A grab sample  
was taken by the writer from the material lying about the  
surface, and assayed by Mr. W. D. Reid, Government  
Assayer, who reports:—

Copper . . . . .	2·15 per cent.
Zinc . . . . .	13·5 per cent.

The same value cannot attach to a sample of this kind as to one carefully broken from an exposed face of ore, but it indicates that a considerable zinc content would have to be reckoned with in considering treatment, and also that high copper values do not always obtain, even in this secondary ore.

The dump-heaps round the collar of the Government shaft referred to were examined, and the last material raised is a soft decomposed black slate, while the material which seems to have been regarded as ore is a bluish-black slate which has been impregnated, to some extent, with very fine pyrite. This occurs especially in the cleavage planes of the slate. The aggregates of finely divided pyrite suggest that it may have been a spotted (contact metamorphic) slate which has been partially replaced.

This may represent the primary ore from which the richer ore near the surface has been derived by the processes of leaching and re-precipitation. A sample was taken from the heap and assayed by the Government Assayer, who reports—

Copper ..... Trace

It is not to be expected that all the sulphides excepting iron pyrite, which occurred at the surface, have disappeared at 53 feet, as several of them appear to be primary minerals. Whether the ore struck has been covered over or removed, whether the vein has pinched, or whether it has not really been cut, are questions which the writer cannot answer. In the vicinity of such a deposit as that described it is only to be expected that the country rock would be more or less impregnated, and would carry traces of copper; hence the material assayed may really be country rock.

However, secondary enrichment has undoubtedly taken place, and considering all the circumstances, the writer would not advise further work at depth.

A few chains west of this mine, and near the western boundary of the section, 5343M, an old shaft was sunk on the hillside, at the head of a small creek flowing south into a westerly branch of the St. Dizier Creek. There is some alluvium along the bed of this branch creek which should pay to work. The bed of the small creek referred to has been worked, and specimens of tin oxide, of tin oxide in pyrite, and of tin oxide in white quartz, were found here. At the head of the creek an adit has been driven to connect with the shaft referred to, the collar of

which is about 30 feet above. There is no information available as to whether a connection was made, the drive being dammed up at the entrance and used as a reservoir for water, which was released from time to time to sluice the alluvium in the creek bed below. In the creek bed are contact metamorphic sandstones, with a good deal of black tourmaline developed. These sandstones are seen to be cut through by veins carrying pyrite, and by greisen veins; these are narrow, but have probably shed some of the tin found in the alluvium lower down.

The shaft is in a state of disrepair; it is sunk in banded quartz-tourmaline rock, representing a sedimentary replaced by quartz and tourmaline developed by the action of heated vapours from the adjacent granite. The strike of the bands is N. 70° E. No sign of any lode formation was seen, although the country is very favourable for tin, and it is probable that the shaft was sunk on a narrow vein. White mica is developed in some of the banded quartz-tourmaline stone at the collar of the shaft, and this stone looks promising.

It is probable that narrow veins of tin ore will be located at various spots in this vicinity, but unless lateral exploration along the line of strike shows that there is any improvement in width, sinking on a narrow vein which is obviously not payable at the surface is not to be recommended in most cases.

From 15 to 20 chains south of the shaft described above, and on the side of the hill on the opposite side of the wide valley of a creek flowing west and joining the St. Dizier in Section 6141m, some prospecting trenches have been cut, apparently quite recently. The specific object for which these trenches were cut is not clear, as no lode formation is to be seen. There are three long trenches about 1½ chains apart, from 1 to 3 feet deep. They are all on the edge of the granite. The trenches run about north and south. The western exposes banded quartz-tourmaline replacement rock, and cuts granite at the south end. The central trench exposes a similar section, cutting the edge of the granite on the crown of the hill. In this trench there are some promising seams of white quartz and black tourmaline: in several instances there are veins and vughs of crystallised quartz and tourmaline, apparently vein fillings, and not simply replacements like most of the surrounding rock is. No tin oxide was seen. The eastern trench is extended just to the edge of the granite.

In the bed of the creek, between the two sets of workings previously described (a creek flowing west into the St. Dizier and joining it in Section 6141m, G. Leppard), a little work has been done on detrital material which has accumulated. This is on Sections 4383m and 5449m. The valley is comparatively old, geologically, being broad and of shallow gradient. The detrital material resulting from the wearing down of the ridges on either side has gradually accumulated, and with it a certain amount of tin oxide. The deposits are of Recent rather than of Tertiary age. The deposits have been worked for 6 or 7 chains along the creek bed, for a width of 20 feet. The detrital material is from 12 to 18 inches in depth, with 18 to 24 inches of overburden: it is all angular and sub-angular in shape, fragments being medium to small in size, and consisting mainly of sandstone, quartz, quartzite, and slate. Tin crystals and crystal aggregates were noticed at several points, and rich specimens of tin ore picked up at intervals: the tin has been derived mainly from veins in the immediate vicinity, though doubtless many of these were small.

There has been a difficulty in getting water on to the property, but if the Heemskirk Tin Syndicate's race could be utilised at any time when full power was not required on the Tasman River property, it is probable that this ground could be profitably ground-sluiced. The extent and depth are not great, but would probably be sufficient to pay for treatment. Pyrite was noticed in the wash, and in one place the slate bottom was seen to be impregnated with pyrite, a little quartz also being present.

## V.—SUMMARY AND CONCLUSION.

It may be well to briefly summarise before concluding this report.

Although it is nearly 40 years since the first mineral section was taken up on the field, the work carried on has been somewhat spasmodic, and it is only within the last two or three years that any attempt has been made to seriously exploit the known alluvial deposits. The result of this attempt has been highly satisfactory, and has once again brought the field into some degree of prominence.

Work up to the present time has shown the field to be essentially an alluvial, rather than a lode, mining district. Several tin lodes have been discovered at different times, and in some cases attempts have been made to work them; some have proved rich, but too small to be payable. In one or two cases further prospecting is justified, and recommendations have been made accordingly. Conditions are certainly favourable for the occurrence of tin lodes, and further prospecting may at any time disclose ore-bodies of importance. Such prospecting is most likely to be successful if carried out within reasonable distance of the line of contact of granite and slate, and should be extended to both rock types.

With regard to alluvial tin mining, undoubtedly valuable deposits do exist. These deposits consist of gravels which have been accumulated and brought to their present positions by the various streams belonging to a river system which was probably very different to that of the present day. With these gravels, tin oxide gradually accumulated, being derived from the rocks denuded, and owing to its weight and resistance to the attacks of chemical agencies, it became concentrated as time went on. The alluvial deposits probably accumulated on a base-levelled and slowly sinking land surface. An extensive outpouring of basalt covered and preserved many of these deposits, which would otherwise long since have been denuded.

The full extent of the gravels has not yet been determined, hence no estimate can be given of the length of life of the field.

Some misapprehension seems to exist with regard to the Heemskirk Tin Syndicate, which stopped work at rather short notice early last year. In ceasing operations when they did, the Syndicate took the only reasonable course open; the ground proved so much deeper than was

anticipated that the plant was unable to treat it. Rather than continue working the upper layers of wash, leaving the lower layers to be covered with barren tailings, work was stopped until arrangements could be completed for installing a more powerful plant. In the meantime, prospecting operations were carried out in a very thorough and systematic manner. The results of this work have not been revealed, but everything points to this syndicate having very bright prospects.

In no other instance has any serious attempt been made to work any of the deeper ground. Shallow alluvial ground has been worked in various parts of the district for years past, sometimes with marked success, but most of the shallow ground is now exhausted.

Reference has been made in the course of the report to the various rock types represented in the district, their significance, and the importance of carefully distinguishing between them.

Attention has also been called to the existence of a considerable area of cemented sands and gravels, now forming sandstones, quartzites, and conglomerates. Their significance does not seem to have been realised in the past. They are of approximately the same age as the unconsolidated gravels now being opened up with such marked success at the Tasman River, and although subsequently cemented, are of similar origin. The presence of tin in these sediments, at several widely different points, has been demonstrated, and this fact may prove of the greatest importance. Payable tin has not been shown to exist, but the writer believes that its presence has not previously been suspected, and hence prospecting is not likely to have taken place. While there is no call for undue excitement, prospecting at various points to determine whether concentration may not have taken place is certainly justified. The discovery of *payable* tin in the area indicated would be of the utmost importance to the district.

With regard to ore-deposits other than those of tin, none of any importance have so far been discovered. In two instances rather sensational assay results of copper ores have been reported from different localities, but it has been shown that both have been due to secondary enrichment, and neither is likely to be of any economic value. Occurrences of iron ores have been discussed, and the opinion expressed that under existing conditions none of the known deposits are of commercial value.

The district has possibilities other than those of mining. There are several belts of timber which will doubtless be exploited with the advent of the Zeehan-Granville tram, now under construction. On the eastern slope of the Heemskirk Range there appears to be some good timber, but no opportunity occurred of making an examination. In the vicinity of Granville Harbour, however, and between that point and Donnelly's Look-out, is some excellent land, which will one day be utilised. Up to the present its inaccessibility has hindered its development. There are some thousands of acres of basalt soil, which at present supports a heavy growth of first-class timber, particularly blackwood and gums, with luxuriant undergrowth in places. This land, if cleared, would make first-class agricultural land, the distance from market being the main argument against its development. The heavy charges and rough handling incidental to about 25 miles by pack-horse, has been a serious hindrance. That the land will produce vegetables second to none, even in the much abused West Coast climate, is proved by what was being done in that respect on his 10-acre farm by Mr. T. Wilson, at Granville Harbour, at the time of the writer's visit. The weather conditions here are said to be far milder than in the mountain country further inland. Such land as that referred to will naturally require clearing before anything can be done in the agricultural line, and with the heavy timber carried, this is no light matter. At present several hundred acres are privately owned, and some of these paddocks are used for fattening cattle. Even when the land is only partially cleared it is found that an excellent crop of grass can be grown with practically no trouble. It is a matter for great regret that in the process of clearing, the timber is burned or allowed to rot, and it was a deplorable sight to see hundreds of noble blackwood trees, which would have furnished thousands of super. feet of valuable timber, lying half burned. Unfortunately, the distance from market necessarily condemned them to such an ignoble fate. If the tram under construction be continued to its suggested temporary terminus at the Heemskirk Tin Syndicate's property, it will be between 5 and 6 miles from the country referred to, but will be in a timbered belt from which some good trees should be obtainable, while there is also some heavily timbered country between the temporary terminus and Granville Harbour. The country around Granville Harbour is, as described in the foregoing report, a portion of an

old peneplain, and viewed from a distance appears flat, but in reality undulating, and well-watered. Undoubtedly the time is not very far distant when the value of such land will be realised; probably Granville Harbour itself will be utilised to some extent, although it has the disadvantage that it is exposed to westerly weather.

Thus, while the North Heemskirk Tinfield has an era of prosperity to look forward to from the treatment of its alluvial tin ores, it is hoped that this prosperity will be materially strengthened and consolidated by the utilisation of its resources other than those of mining.

It is hoped that the accompanying map of the district will be of some little use. It is very incomplete, but it must be borne in mind that little more than a fortnight was spent in the district. The surveyed route of the Zeehan-Granville tram has been shown, and its connection with Zeehan itself by way of the Zeehan-Western tram included. The map incorporates information gained from the mineral charts of Zeehan, Heemskirk, North Heemskirk, and Granville Harbour. In several cases the boundaries of geological formations have been merely sketched in, and so are very approximate, but it will be noticed that a distinction is made on the map in the method of indicating those boundaries which have been traversed and plotted, and those which have been merely sketched. In some instances—as, for example, in the case of the diabase, which was only passed over once—no attempt has been made to define the boundaries on the map. General topography only is shown. With all its faults, it is believed that the map will serve a useful purpose.

In conclusion, the writer would express his appreciation of the kindness shown him by all with whom he came into contact. He would especially thank T. C. Goodall, Esq., manager of the Heemskirk Tin Syndicate, for help given, and the manager and directors of the Syndicate for placing a hut at his disposal during his stay in the district.

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

Launceston, 27th February, 1915.

## EXPLANATION OF PHOTOGRAPHS.

**PHOTO. 1.**—Donnelly's Look Out, North Heemskirk, showing Heemskirk Tin Syndicate's workings in the foreground.

The photo. is taken looking north-west across the valley of the Tasman River, which flows from right to left in the picture. Portion of the Heemskirk Tin Syndicate's race is shown in the foreground, while the Syndicate's plant and workings appear towards the left of the picture at the base of Donnelly's Look Out. Towards the right terrace workings appear from which some good tin was won. The timbered country to the right is basalt, granite forming the low spur of Donnelly's Look Out on the extreme left behind the plant and workings. Donnelly's Look Out and the country in the foreground is Pre-Silurian slate. Most of the low-lying ground shown in the photo. carries good alluvial tin, and will be sluiced in the near future.

**PHOTO. 2.**—Mt. Heemskirk, The Gap, and part of the North Heemskirk Spur.

Mt. Heemskirk, forming the northern culminating point of the Heemskirk Range, is shown on the left, while the low saddle in the centre is known as "The Gap." This saddle connects the North Heemskirk spur on the right of the picture with Mt. Heemskirk. "The Gap" forms the divide between the drainage of Granite Creek and the St. Dizier Creek, the latter draining the whole of the country shown.

A. Alluvial workings referred to on page 66.

B. Prospecting trenches referred to on page 65.

C. MacArthur's Copper Mine.

D. Long's Iron Blow.

The country in the foreground is Pre-Silurian slate; that in the background, Devonian granite.

**PHOTO. 3.**—Hydraulic Sluicing, Heemskirk Tin Syndicate's property, North Heemskirk.

The photo. shows the method of sluicing employed at the Heemskirk Tin Syndicate's property, No. 2 paddock being worked. The gravels are broken down by the nozzle, washed to a sump, and elevated to the sluice-boxes.

**PHOTO. 4.**—Heemskirk Tin Syndicate's Plant and Workings (Nos. 1 and 2 paddocks), North Heemskirk.

At the time the photo. was taken the plant was not working, but, as the photo. shows, was actually being dismantled. The barge has been floated round from its working position (A) to a position of rest in a corner of No. 2 paddock. The No. 1 paddock, worked, is shown in the foreground, generally filled with tailings from the sluicing of No. 2 paddock in the middle foreground. The syndicate's race is shown winding round the spur to the right, with the pipe-line leading from it to the plant. The timbered country in the background is basalt, that to the right Pre-Silurian slate; while in the foreground and to the left are Tertiary alluvial deposits. The manager's residence and Company's huts are shown at the edge of the timber near the left of the photo. A spur of Mt. Heemskirk appears in the background on the extreme right.

**PHOTO. 5.**—No. 2 paddock, Heemskirk Tin Syndicate, North Heemskirk.

The photo. is taken facing about north-east. Although the paddock was fast filling with water when the photo. was taken, some of the topmost layers of wash are clearly seen along the exposed edge of the paddock. The three posts indicate the position of the bed prepared for the new barge, and it is from this position that it is proposed to recommence sluicing operations very shortly. The manager's residence appears in the background.

# GEOLOGICAL SKETCH MAP OF THE NORTH HEEMSKIRK TIN FIELD



2618-93M	2629-93M	2679-93M
80	80	80
2676-93M	2621-93M	2669-93M
80	80	80
2617-93M		
80		

SCALE  
0 10 20 30 40 50 60 70 80 CHAINS  
1 MILE

L. S. Waterhouse, B. E.  
Assistant Government Geologist  
27 February 1915

KEY TO NUMBERS OF MINERAL SECTIONS	
Number of Section	Acres
472-M	40
6265-M	5
8006-M	5
639-M	10
6307-M	10
6327-M	10
1784-M	10
5649-M	40
5650-M	40
5651-M	40
5652-M	40
5653-M	10
5654-M	40
6114-M	80
6115-M	10
6349-M	40
6357-M	80
5683-M	5
6878-M	40
6879-M	40
6880-M	40
6881-M	80
6882-M	40
5312-M	40
5673-M	20
6141-M	20
5710-M	20
5674-M	5
5755-M	10
6626-M	10
6627-M	40
6750-M	5
6028-M	5
6877-M	40
3718-M	80
4441-M	10

LEGEND	
<b>SEDIMENTARY</b>	
Recent	Detrital Material and Alluvium
Tertiary	River Gravels and Alluvium
Tertiary	Sandstones and Conglomerate
Pre-Silurian	Sandstones and Slates
<b>IGNEOUS</b>	
Tertiary	Olivine Basalt
Mesozoic	Diabase
Devonian	Gabbro
Devonian	Granite and Granite Porphyry

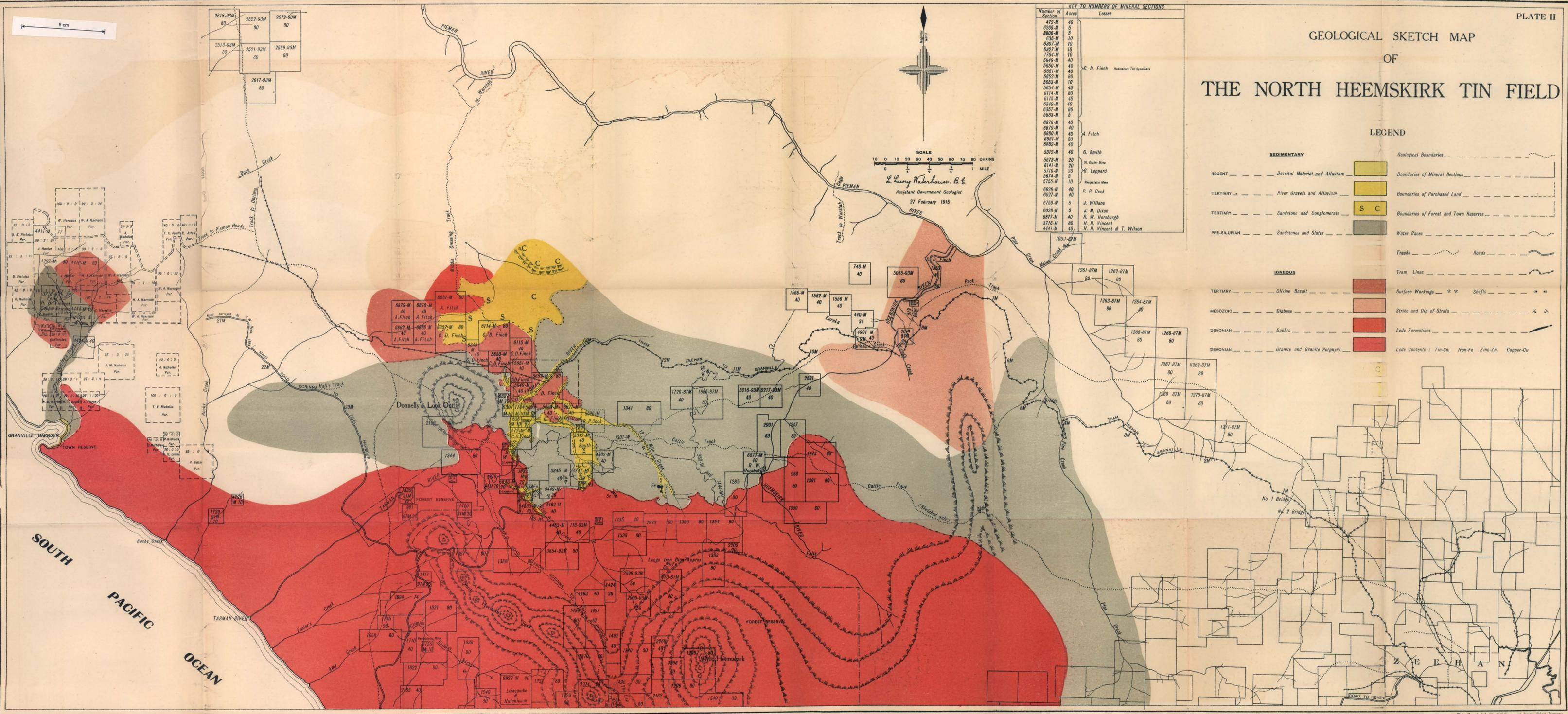


Plate prepared by Mrs. Hall Government Printer, Hobart Tasmania