

REPORT ON THE TIN-BEARING  
CAPABILITIES OF THE GLADSTONE  
DISTRICT.

Government Geologist's Office,  
Launceston, 11th May, 1901.

SIR,

I HAVE the honour to report that, in pursuance of your instructions, I have visited and examined the stanniferous ground at Gladstone. My visits extended from 28th January to 8th February, and again from 28th March to 13th April.

The primary object of my examination was to ascertain the capabilities, from a tin-mining point of view, of the country commanded by the Mt. Cameron Water Race. Mr. Rahbek, the hydraulic engineer recently appointed by the Government to report upon the cost of renewals and repairs of the water-race, having estimated the cost of restoration of the six syphons, and of a proposed reservoir on Old Chum Creek, as £22,000, or using perishable materials only, and without the reservoir, as £15,225; the question whether the tin deposits are such as to warrant the outlay has suddenly become of practical and pressing importance.

I may at once say that to form an estimate of the value of these deposits is no easy matter, and it cannot be even attempted without first systematically testing the ground by a series of trial bores.

The reason of the difficulty is that the bulk of the concentrations of tin ore is in gravels spread far and wide over the surface of the country. The configuration of the land was different in Tertiary times from what it is now, consequently, the rivers flowed in other channels, which were subsequently obliterated by being filled with marine wash, as this part of Tasmania sank slowly beneath the waves of the ocean. It has been shown by the diamond-drill bore at Belmont, near Longford, which went to a depth of 894 feet without bottoming in Tertiary

lacustrine strata, that the subsidence of the land was considerable. While the country remained at sea-level the wash was, doubtless, carried hither and thither and redistributed by the sea, in which process river gravels and beach shingle got mixed and scattered over a wide area. On its emergence, the rivers, diverted higher up towards the south by extensive outpourings of basalt, assumed channels different from their former ones, and the old watercourses, choked with the stanniferous waste of the Blue Tier, remained thenceforward hidden below the superincumbent later marine and estuarine deposits. Streams of basaltic lava extended further north than Gladstone, for basalt is seen on Foster's blocks and on the N.W. corner of A. Parker's lot, No. 142., between Gladstone and Cape Portland, at the Mussel Roe Marsh. The intervening part of the sheet has evidently been denuded.

In consequence of the commingling of the deposits which has thus been brought about, it is difficult, and often impossible, to separate purely marine drift from purely river wash. The marine or mixed terraces are only locally rich, hence it is, above all, desirable to discover the deep undisturbed river courses, which may be expected to contain the richest drift. Apart from the greisenised granite porphyry formations, the future of the district may be said to depend upon the old beach terraces, and still more upon the uncovering of the more ancient river courses, now lost to sight beneath the pretty uniform covering of drift left by the sea and its littoral lagoons before the land rose to its present level.

A depression of the land, 300 feet below its present level, would bring the highest terraces down to sea-level again, and, accordingly, it seems as if the buried leads of the ancient rivers in this part of the country would terminate by running out to sea below sea-level.

From Mount Cameron northwards the surface of the land is a gently undulating or nearly level plain of marine denudation, sloping gently towards the sea. This gentle slope of the surface may probably be taken as a guide to the slope of the bedrock. Deep leads may, therefore, be within practicable reach, but they are certain to be wet, as they will collect the drainage from the granite slopes.

From a geological point of view, it would be of interest if the Government were to arrange for ascertaining the yearly or quinquennial rate of elevation or subsidence of the coast-line by means of fixed permanent marks at sea-level, such as have been made under the direction of the Swedish Government in the Scandinavian Peninsula, where observations are made and recorded annually.

The rivers which now run through the field are the Ringarooma and the Great Mussel Roe. It is well known that in early Tertiary (palaeogene) times the Ringarooma flowed to the west of Mount Cameron. In like manner, it seems as if the palaeogene Mussel Roe also ran west of its present course, though its ancient line is now difficult to trace, owing to erosion, earth movements, and the deposition of later sediment. As a starting point, we may take the channel of drift on the east side of the river on the late Mussel Roe Proprietary's section 3467, six miles S.E. of Gladstone. There is here a north and south run of drift, which is separated from the river by a low ridge of granite, shelving away from the present stream eastwards beneath the lead. The granite, as seen in the tail-race, is thoroughly soft and disintegrated, almost like a body of wash, nevertheless recognisable as a rock-mass and intersected by quartz veins. It plunges beneath the drift at an angle of  $40^\circ$ , bearing upon its floor a bed of dark silt, charged with pieces of lignite and comminuted carbonaceous material, accompanied by pyrites. This silt is essentially a fine sand, composed of quartz, muscovite, and clay, the result of the disintegration of granite. It at first dips down in layers, parallel with the granite rim-rock, but soon flattens out horizontally, and fades away into the eastern part of the workings, where the sand still contains traces of the carbonaceous matter. The rapidity with which the silt assumes the horizontal form suggests that the gutter is not very deep. The full depth of the floor from surface cannot be seen now, as some of it is filled up with run ground, but I am told a depth of 40 or 50 feet was attained. The workings extend eastward across the drift channel for about 150 yards, and the drift still continues in that direction in horizontal layers. In one part of the face there is a reverse

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c. a. Ogilvie ✓

shallow dip of the beds to the west, but this is merely local, and probably only a case of false bedding, resulting from a deviation in the current. The drift is a coarse granitic sand, composed of even-sized grains of rounded to sub-angular quartz, with felspathic material in the interstices, and small flakes of mica. It has evidently been derived from stanniferous granite rock in the immediate neighbourhood, and is a purely river formation. The seams of tin-wash are a little coarser than the rest of the drift, and contain round and sub-angular stones of vein quartz. These seams are from 10 to 12 feet from surface and show fair tin, sometimes 1 lb. to the dish, for about a foot thick. The ore which I found at one place in one of these seams was clean and good-looking, without any iron, but I was told that there had been pyrites associated with some of the tin. The carbonaceous silt mentioned above is full of pyrites. The tin has not been got deeper than 12 feet, but no bottom has been reached in these workings. The Proprietary Company abandoned work last year. After that Mr. Ogilvie tried it, and won a little tin, but at present the claim is idle.

A few yards east from the face there is a shallow pit, 10 feet deep, in similar drift, and then a flat for 500 yards eastwards, bordered by a granite hill range, which bounds the old drift channel on that side.

This Proprietary run of ground is one of the best-defined channels to be seen in the district, and an effort ought to be made to trace the position of the gutter by means of boring. A bore or two in the face, and a line of bores eastwards across the plain between the face and the granite range just mentioned, would throw light on the old channel outline, and there is a good chance of tin ore being struck. The country to the south is all granitic, and the old stream flowing all its way over stanniferous rock, and receiving the waste of the country on each side, must have collected a fair quantity of ore. No attempt seems to have been made to get down to the bed-rock, but if there is tin anywhere in this neighbourhood, the lower part of this channel is the place to search for it. The silt proves that the conditions of sedimentation were tranquil, and I think it very likely that tin will be found to have settled in the deeper part of the lead. Of course

it will have to be elevated, as the lead bottom is below the level of the present river. The shallow work which has been carried on hitherto is absolutely useless as a criterion of the value of the deposit; nothing of any importance will ever be known about it, unless bores are put down as I have suggested above.

As far as can be judged from appearances, the old channel runs from the face north through Ogilvie's (or Carroll's) flat, still separated from the modern river by granite rock. North of the flat is a low E. and W. ridge covered with white quartz drift. If this ridge is granite, the lead bends round its eastern end, but its form suggests that it is made ground, and if so, it is the lead itself. On its northern brow a 5-foot hole has been excavated in granitic drift similar to that of the Proprietary. Further north, on the northern section, is another flat, with a shallow prospecting hole in similar drift. The next hill to the north of this is red granite, which continues northward. This blocks the lead on this side of the river (the eastern), and the old channel must then cross the modern stream in a north-westerly direction to Curtin's blocks (North Mussel Roe). Before it takes this turn the arrested flow very possibly gave rise to a deposition of tin, hence, the flat on the east side of the river is a likely place for prospecting.

On the western side numerous holes have been sunk in wash somewhat like that of the Proprietary, though often rather clayey and ferruginous. Some of these have shown a little tin. One of the holes, 15 feet, appeared to have bottomed on the granite, but in a northerly direction along the river a 30 feet borehole had not reached bedrock. No tin was shown in the northern bores.

The North Mussel Roe faces are two in number, the most southerly being the principal one. This is on granite bed-rock about 20 feet from grass, rather flat, but, on the whole, with a westerly dip. The wash is a granitic sand with a good deal of yellow clay. On the high reef the tin was pretty fair, but little, if any, was found in the deeper ground. The northern face is also in coarse granite sand on the solid granite, falling away to the west, though the uneven floor rises locally.

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The sand is composed of subangular quartz, felspar, and a little white mica, and contains a little coarse tin. There are more stones in this wash than in the Proprietary, and the gravel is ferruginous in places. The face is about 12 feet high.

The ground immediately to the west of this appears to be granite covered with a partly consolidated cement formation, which continues to the Edina Sugar Loaf and further north, back west (at the Amber bridge) and S. W. by the ordinary porphyritic biotite granite. This cement contains sporadic tin, but nothing payable. Mr. Jas. Ogilvie showed me some tin in it at the base of the Sugar Loaf, south of the Edina flat. Somewhere below this cement covering the old lead lies concealed between the Edina Sugar Loaf and the Great Mussel Roe River.

#### *Ground between Brown's Camp and Watts'.*

North of Brown's house at the No. 4 Syphon is the Edina Sugar Loaf; a sub-conical hill rising to 300 feet above the sea-level. The hill is composed of cemented quartz drift, and the country northwards between here and Watts' is of the same description, covered with partially consolidated cement.

I may here digress to say a word about this cement. It is composed of water-worn grains of quartz, sometimes either loosely aggregated or bound and stained by red iron oxide. It is occasionally excessively hard and sonorous under the hammer, the binding material being then a secondary infiltration of silica uniting the component grains. It then looks more like a solid rock, distinct from the alluvial quartz drift.

In Ogilvie's Edina workings immense blocks of hard siliceous cement, several tons in weight, lie in the wash, generally resting upon the granite bedrock. They usually occur as tabular masses which do not appear to have travelled, though some of the smaller pieces have been moved and rounded by water. The tabular form of the huge blocks in itself shows that they have not been carried to their present positions by running water, though the stream has played upon their surface. Some of them contain quartz pebbles of fair size, but none belonging to the shingle of the modern Ringarooma. I

imagine the blocks to be the result of the breaking up of cemented layers of drift *in situ*; and they are still *in situ*, or nearly so, as may be inferred from the fact that all along the Edina workings from the Sugar Loaf to the Ringarooma they may be seen lying nearly continuously at one horizon. They are seen at intervals all over the country: in Ogilvie's workings north of Ogilvie's bridge, and in the Scotia workings N.W. of Gladstone; in Moore's workings south of Watts', &c. Cement rock *in situ* is seen further north, outcropping on the button-grass plains N. of No. 1 reservoir. A ridge of cement also runs E. and W. to the north-west of Matthewson's Lagoon. Brown's Hill, further west of this, is a hill composed of the same cement.

It is not easy to decide whether it is of marine or fluvial origin. The widely separated localities where it occurs suggest that it was once more widely spread, and that the existing exposures are surviving remnants of a sheet of marine wash, unconnected with river deposits. The sugar-loaves and hill ridges are in favour of wider portions of it having disappeared by denudation. I saw some of it near Cape Portland, to the N.W. of Tregaron. In fact, I am inclined to think that the cementation of the wash may not have been co-extensive with the wash itself, but took place locally. All degrees of silicification may be observed, the drift being sometimes only loosely aggregated, the extreme being reached when the infiltrated silica has bound the component grains of quartz into a hard compact rock, liable to be mistaken for a quartzose modification of granite. Occasionally, I have found a little Kaolin coating the quartz grains. The upper surface of the blocks is worn frequently into hollows and potholes; and this, to my mind, is another evidence of water acting on an unbroken horizontal surface, and not on isolated boulders, which would have been worn into more rounded shapes: this has occurred in the case of detached fragments found in various workings.

Although pebbles are found here and there in this rock, I prefer the descriptive term "cement" to that of conglomerate, even on scientific grounds, for cementation implies definitely a subsequent binding action, which has taken place in the interstices of a loosely aggregated

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substance. We do not know at present how siliceous waters came to play upon this ancient wash, or whether the process is still going on. A possible explanation is that it was started in connection with the sheets of basalt lava which flowed over the country in middle Tertiary times. It is just possible that alkaline waters descending from the lava acted as a solvent on the quartz of the drift below, or that the descending water set free the silica in the basalt (basalt contains 40 to 50 per cent. silica), and carried it down to the wash. The silicification of tree trunks entangled in basaltic lava, and noticed in many parts of the world, is significant in this direction. This happens in the auriferous deep leads of California. Prof. Le Conte says\*: "The deep placers of California are gravel-drifts in ancient river-beds, covered up by lava-flows 100 to 200 feet thick. These placers are worked by running tunnels beneath the basaltic lava until the river gravel is reached. Now, the waters percolating these lava-flows, and reaching the subjacent gravels, are charged with alkali from the lava. These alkaline waters are also charged with silica from the same source. Hence the driftwood of these ancient rivers has all been silicified by these siliceous waters. The gravels are also in many places cemented by the same material."

But this process is not always dependent upon the existence of a lava sheet. Tertiary sand and hard siliceous cement at the base of the Urals in Russia present the same phenomenon. Lava is altogether absent, and yet precisely similar action has taken place: one and the same deposit being in part loose sand, and in part siliceous rock as hard as any of the Edina cement.

The low country between the No. 5 syphon and the Mussel Roe River to the east is swampy, and shows signs of cement or quartz drift, but though I broke through the scrub to the river, I could not see any granite. To the west of this are the Edina flats worked by C. A. Ogilvie, yielding about 1½ tons tin ore per month. This run of ground extends westwards across the Ringarooma and the old Moorina Road, and connects with the Enterprise, though the wash changes its character towards the latter claim, becoming more like

\* Elements of Geology. 1899. Page 258.

a river drift. The Edina workings show an abundance of slate, sandstone, quartz and quartzite shingle, alternating with pipe-clay and granular quartz drift, with the tabular blocks of cement described above. The channel is 40 feet higher than the present Ringarooma, and though it does resemble an old stream-bed debouching into the Mussel Roe basin, I cannot bring myself to believe that it ever had anything to do with the Mussel Roe lead, and for this reason: the shingle which surmounts the cement layer was naturally deposited subsequently to the latter. But the Mussel Roe deep lead received its deposits of tin prior to the depression of the land which admitted the sea and built up all this cement country. When the Edina waters deposited their shingle the Mussel Roe lead was already buried beneath the cement drift. On the other hand, it is difficult to connect the shingle with the Ringarooma, for that river never had an outlet to the east. Besides, whence could the modern Ringarooma, traversing granite country all the way from Derby (excepting only a small bar of slate at Derby itself), have derived the wealth of slate, sandstone, and quartzite pebbles which we find so profusely scattered through these terraces. Such stones must have come from the north, and the only agency which can have brought them from that quarter is the sea. Similar shingle occurs also in Moore's old workings to the north, and there, too, in connection with cement. We cannot suppose the Ringarooma to have twisted all about the country within comparatively recent times. These widely distributed areas of shingle can be more easily understood on the supposition that they are remnants of sea beaches. In this connection, I attach more importance to the abundance of sandstone, slate, and quartzite than to the shape of the stones. Even on a sea beach stones of slate assume a flattened form. A massive rock often forms flat stones. At Cape Portland the beach is loaded with flattened stones of the diabase (dolerite), which forms the promontory there. On the cement hill south-west of Watt's, and west of the Government race, are Moore's old workings, some 20 feet deep. The floor looks like soft semi-consolidated cement, which might very easily be mistaken for granite.

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Large smoothed tabular blocks of hard cement lie about the workings. In section the face exhibits, in its upper part, 8 feet of clayey ferruginous pan resting on 5 feet of granular quartz drift, passing downwards into 4 feet exposed of large slate and quartz shingle, with an abundance of micaceous sandstone pebbles. The hill both east and west of this is cement, and higher up on the eastern brow boulders of hard siliceous cement lie strewn on the surface, resembling pieces of bed-rock granite.

North-east of this is George Watt's face (Black Boy Syndicate), where about 18 tons of tin-ore have been won during the past year. This is being worked on a false clayey bottom charged with imperfect leaf impressions, timber, vegetable pitch, and pyrites. This brown pug, exposed for about 10 feet in thickness, is covered with about 20 feet of sand, seamed with layers of small white quartz pebbles. The upper part is yellow gravel and white stanniferous wash. Good tin was found on the false bottom of the creek. Drift sand has been found below the clay, but the ground has not been bottomed. In the creek workings, a little to the N.W. of this, both sandstone and granite were touched. Just north of the main face, and at the base of the hill, soft granite comes up near the surface under a foot or two of quartz drift. This is about a mile west of the Mussel Roe River, and, in a broad sense, is the eastern granite bank of that basin.

Further east down the tail-race, near where it empties into the Mussel Roe, Tracey has a face on the south side of the tailings creek. This is on a tourmaline-granite bottom, which slopes down to the creek. This granite ridge is the immediate bank of the river, and the old lead must, necessarily, lie west of it. The presence of tourmaline-quartz rock indicates that tin-lodes may exist in the neighbourhood. This claim has returned about five tons of tin-ore.

Now, having traced the deep ground as far north as Watt's, one of two things may be conceived as possible—

- (1.) The lead may continue still further north, and either (a) recross the modern river and find an outlet to the sea on the East Coast; or, (b) after proceeding a mile or two north-

wards, bend round to the north-west, passing between the Mount Cameron Water-race deep-cutting and the Portland Mine.

- (2.) The alternative is to turn rather sharply a little north of west and continue on the Garfield-Tamar line. I think it has done this.

The crucial part of the problem lies here, because the adoption of one view will take us away to the east, altogether outside the sphere of action of the Mount Cameron Water-race; while the other view will confine us strictly to the country with which the race has more or less to do, though, perhaps, not commanding every part of it.

An inspection of the country lying south-west of the Portland Mine shows a continuation of Silurian slates and sandstones from the mine south-west to the deep-cutting, and, further south, to the 5-mile cutting across the eastern end of the Empress Dam Plain. Not far south of the Portland there is a narrow, treeless flat, on the watershed between the Great Mussel Roe and the Ringarooma, which might possibly be a channel through which a lead could pass. No wash, however, is discernible in the soil, and I doubt whether any exists. Still, to set the matter at rest and remove all doubts, a few prospecting pits should be sunk across it, and if no bottom is found, some bores would then be advisable. I anticipate, however, that the pits will be shallow, and bottom on hard ground (slate).

Instead of passing through this gap to the west, does the deep ground cross again over the Mussel Roe to the eastern bank? If it does, the crossing has to be looked for north of Watt's tail-race and south of Brown's Bridge. I heard that tin has been found to the east of the river, and a respected dweller in the district imparted to me his decided opinion that the lead, if there is one at all, does find its way to the sea in that direction. But the existence of alluvial ground on that side is not sufficient proof. A definite crossing-point must be found. At Brown's Bridge the river runs in granite. At Tracey's, on the tail-race, it does the same. A walk north from the tail-race shows that the hills skirting the west of the river are granite, overlaid with cemented drift and quartz and granitic sand. The white quartz

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sand is subangular, not so well rounded as the ancient wash. It is most likely that the modern Mussel Roe has cut its way down from here to its present channel. Tin-ore is present all through this drift. At one place dish prospects showed fine tin, with a little iron oxide, zircon grains, &c. Ruby and resin tin were proportionately plentiful. At this spot, opened out by Tracey, soft granite was found four or five feet from surface, and the wash was angular, showing flat pieces of felspar crystals, evidently from the adjacent bed-rock. Further north Watt has put down five bores for 25 feet, in sand with rotten timber, finding a little tin.

This is plainly a granite range running parallel with the western bank of the Great Mussel Roe, and forming a barrier to the passage of a lead across it. The tin found in the drift on the slope of the range has apparently been deposited by the modern river system, and, from appearances, I should think this ground is worth prospecting. There may be no great depth of wash, but a good extent of ground could be worked rather easily. The Mt. Cameron Water Race water could be brought on to it, and the fall to the Mussel Roe River gives grand facilities for tail-races. In any other part of the Island it would have been well prospected long ago, but Gladstone is afflicted with the disease of apathy.

The slates come down into this country, or, rather, at the back of it, from the 5-mile cutting, so that the only remaining course for the lead is through the run of ground between Watt's and the Tamar claim, *via* the Garfield. If it passes through the channel defined by the two exposures of granite at Watt's, it is rather narrow, in fact, narrower than might be expected. The only other direction for it to take from Watt's is nearly due west. There is hardly any other course for it, if it is to be brought into relation with the Garfield run. Bores in a north and south direction outside the west boundary of Watt's section will intersect the lead if it goes that way: and if these fail, bores in an east and west line north of Watt's eastward, down to the Mussel Roe, will intercept any northerly extension.

In the direction of the Garfield there is deep ground all along, and, strangely enough, it occupies the high hill country which slopes down northwards to the

Empress Plain. The Garfield workings yielded fairly good tin years ago, but the output had to bear pumping cost. Towards the west the face is 15 or 20 feet high, in loose sand, with alternating layers of quartz gravel. There is some slate in the eastern side of the Garfield workings, and Mr. Montgomery refers to Silurian bed-rock in a cutting at the back of the Eureka dam. This rock, therefore, would seem here to be the southern rim-rock of lead. North of this rim there is a continuous line of deep wash on the ridge. A good many small prospecting shafts have been sunk in ferruginous clayey and quartz sand, containing small white quartz pebbles. These are mostly on the northern brow of the hill, but are not more than 20 or 30 feet deep. Towards the east is a face some 18 feet, formerly worked by Chinese. It shows yellow and white sea-sand, with cakes and nodules of iron oxide. The pebbles are rounded white quartz; the sand is occasionally kaolinic, as if it had been derived from granite. Along the road also, on this ridge, towards the Tamar claim, is an old face cut about 12 feet through loose sand with horizontal layers of quartz pebbles. The drift has not been bottomed. The deep ground can be followed N.W. from the Garfield about three-quarters of a mile, as far as the Tamar, where the granite of the Empress Hill blocks it on the west.

The bed-rock at the N. end of the Tamar face is Silurian slate, which is, doubtless, underlaid by the western granite. Eastwards the drift is not bottomed, and nothing is known of what the ground is towards the north-east. There is a steep descent northwards and N.E. to the valley bottom occupied by Silurian slates, which rise again on the north side of the plain into a parallel ridge of hard country, hemming in any lead in that direction.

The Tamar wash is mostly a clayey, often iron-stained, and compacted sand, such as is often found in quiet marine backwaters. Plenty of grey sandstone pebbles occur in it. The bed-rock south and west is the dark mica granite of the Empress ridge, and pieces of granite are in the wash. In the north-eastern unbottomed part of the deposit pieces of drift-wood have collected in the loose sand-drift. I have had some of this sliced, and Mr. H. H. Scott, Curator of the Victoria Museum,

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Launceston, has furnished me with the following note on its microscopical examination:—

“With the exception of a faintly-indicated banding, and one well-marked area of perfectly evident structure, the specimen was so thinly ground as to leave little or no material to work upon. It was apparent that all ordinary methods of working would fail, and, therefore, the following method was adopted:—Wedge-shaped chips of various woods from many sources were examined, also shavings, polished woods, smoothly-planed woods, cut with and across the grain; also solid woody surfaces covered with Canada balsam and glass, and, as the woods included specimens from Australia, New Zealand, Tasmania, North and South America, Japan, Ceylon, and Northern Europe, the evidence was, at least, culled from a fairly-wide field. During this study over 80 distinct woods were examined. Coming back to the specimen with the evidence thus collected, it could be seen that the section had been cut at exactly right angles to the medullary rays, which, by compression and other external agencies, had been almost obliterated. A few broken scraps of the section removed from the main portion was a little thicker than the rest, and these aided largely in proving that the matter abraded during the grinding of the section had something to do with the filling up of the medullary rays in addition to the results of time. The wood would seem to have been that of some species of cedar, from which the whole of the true wood-cells have collapsed, and the hard bast has been compressed into solid straps.”

We know that coniferous trees were very common in the early or Middle Tertiary prior to the basaltic eruptions, and, thus, the timber preserved in the Tamar claim harmonises with a reference of the deposit to the palæogene division of the Tertiary. The deepest part of the old channel will lie towards the N.E., and in that direction a few bores would ascertain the actual depth of the lead. The necessary water for this claim cannot be drawn from the Mount Cameron Race, but can only be got by pumping it up from the Ringarooma River. But if the bottom of the gutter could be reached and tested, it would be a guide to the possible value of the lead, and, as the upper sands yielded a little tin, there is a likelihood that the confined gutter will be much better. The sands which we see in this claim are the upper capping of the old river-wash below, and show that tin-ore was being distributed here by the agency of water in those days. Two chains west of the Tamar a shaft has been

sunk by Mr. Galloway 20 to 30 feet in sand, with loose quartz pebbles. This drift is the old marine capping which extended to this height.

We have now reached the end of a more or less continuous line of old drift from the Mussel Roe Proprietary northwards. This line can, with some confidence, be called the Mussel Roe Deep Lead, though the gutter has not been reached at any point along its course; but, in attempting to trace the line from the Tamar further towards the sea, the appearances leave room for a good deal of conjecture, for, with this claim, we are brought to a full stop. However, by a process of exclusion, we are led to assume a likely course for the old river. We have seen that hard slate country bars egress to the N. and E., hence, the only possible outlet remaining is in a N.W. direction. In that direction, across the Pig and Whistle Creek, deep ground exists from the old Lochaber workings right into the Aberfoyle country, and to try and turn the lead into any other direction is simply to refuse to recognise the facts presented to us. I admit that there is a difficulty in the way in the shape of an unbridged gap between the Tamar and the Lochaber, for there is no vestige of a lead in the slate valley below the Tamar, or crossing the Cape Portland road and the Pig and Whistle Creek, except, perhaps, at the Martha claim. Those who believe this difficulty to be insuperable are apt to lose faith in the very existence of a deep lead, and are driven to assume that the deep country north of the Ringarooma does not cover up any lead, but consists merely of terraces of wash forming the ancient beach when the sea laved the base of Mount Cameron. Consequently, they are shut up to a gloomy view of the future of the district, for, in sea-sand distributed over such a large area, the concentrations of ore would not be likely to be very payable, except in little gutters running down from the mount.

But I do not think the difficulty a fatal one. Once we have convinced ourselves that there was a Mussel Roe lead, it follows, necessarily, that it found its way to the sea in some way or another. A mere gap in its observed course does not remove that necessity, and can be understood by supposing the effacement of the lead by denudation and elevation of the land. In this

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connection it is advisable to prove the ground N. and E. from the Tamar claims by means of a few bores.

That great denudation has taken place just in this very valley is shown strikingly by the Empress workings  $\frac{3}{4}$ -mile to the west on the same granite range as the Tamar. This deposit is in a north and south gutter crossing the ridge, but denuded at each end, so that each extremity is open to and above the east and west valleys at each side of the ridge. In this way only a section of the former gutter is preserved. It may have emptied itself to the north into the old Mussel Roe lead, now denuded, or, on the other hand, it may be of later date. In any case, it affords an idea of the enormous amount of denudation which has taken place in comparatively recent times, and we may cease to wonder at the complete removal of all traces of the old lead in this valley.

The Empress claim has yielded excellent tin, coarse in character, up to nuggets weighing one ounce. The worked channel is upwards of three chains in width, but the unworked ground is much wider. The length extant is 15 or 16 chains. The bed-rock is coarse biotite granite merging into stanniferous quartz-mica rock. The drift consists of coarse granular quartz released from the granite. A feature is the abundance of large stones of reef quartz, some of them 2ft. in diameter. A few stones of black quartz are present. No tin has been noticed in the veins of quartz which intersect the granite. The gutter must originally have come across from the south.

The Bridge and Mary claims are north of Bell's Bridge. Both of them are on a slate bottom, and the drift, 15 to 20ft. deep, contains a good deal of flat shingle, but no granite stones. The Mary is S.E. from the Lochaber, but has nothing to do with that deposit, neither is it related to the Empress. It is not being worked now, but it has been above the average for tin, though nothing like the Empress in that respect. I noticed several water-worn pieces of cement in the workings. The Bridge claim belongs to the same class as the Mary. A Chinaman there is getting 1dwt. gold to every hundredweight of tin.

On the east side of the Pig and Whistle Creek, opposite the Lochaber, is the old Martha face, with some 30ft. of small gravel and sub-angular stones of reef quartz resting on a slate bottom, dipping away north and north-west. Small gravel and loose sea-sand alternate. The drift is essentially the same as that in the Tamar and Lochaber, and is in the line connecting the two. It is, however, a good deal lower than the Tamar.

Crossing the Pig and Whistle about  $\frac{3}{4}$ -mile north of Bell's Bridge we come to the Lochaber claim north of the Ringarooma. The workings are about 40ft. deep in quartz drift, resting on soft, pale-coloured slate, with sometimes a bed of pipeclay. The gutter here is deep, coming in from the S.E., and going out unbottomed N.W. The strike of the bed-rock slate is N. 10° W., and dip E. The slate contains quartz leaders. The drift consists of layers of sand and small rounded stones of quartz, and contains water-worn stones of cement. Some timber has been found in the gutter. There is a noticeable absence of shingle. The claim has yielded fair tin, and the lessees tried hard to make it pay. About half a ton per month was produced formerly, and a little gold was saved; but a drawback is that there is not a good get-away for the tailings. It has lately been started again. I have not much hesitation in co-relating the Lochaber with the Tamar drip; and if this is correct, then the deposit is the marine filling in of the old lead. Deep country exists W. and N.W. from here for two or three miles. It has been tested imperfectly in a desultory way by shallow prospecting-holes and bores, which have not reached bottom. All round the intake of No. 6 syphon the country is overlaid with gravel said to be 12 or 15 feet deep, carrying a little tin. The large broad plain traversed by the northern extension of the Mt. Cameron Water Race is covered with wash, but it would be a mistake to bore promiscuously all over this wide area. The bed rock probably slopes very gently towards the sea, for if it did not, the present shore-line would be nearer. This being the case, there is a chance of the lead having been destroyed, and its material distributed in the terraces all over the plain. It is this element of uncertainty which

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forbids anything like a confident forecast of the future of this district.

The deepest shaft which has been sunk in the ground is the 56-feet one, between the Scotia and the water-race, in a sub-angular quartz drift, which, from the nature of the quartz, I should judge was derived from Mt. Cameron. The drift, however, in its upper part, is a ferruginous quartz pebble. About 700 yards S.W. is a line of shallow holes sunk in the top drift in a north-westerly direction from the Scotia, but without finding any good wash. Such, indeed, need not be expected in the superficial drift. I recommend a line of bores right across this ground in a N.E. direction as far as the bog at Stinking Creek. If the ground is found deepening steadily to the N. we shall know that the lead has been levelled to the sea, and that the deep ground rests upon the sea bottom sloping to the N. There is a further chance that the lead widened out as it approached the sea, and merged into deposits on the ocean floor, forming a wide flat delta, devoid of any defined channel. Whether a defined gutter or not passes this way can only be decided by the bores suggested, which will cross its presumed direction at right angles. The northern bank of the Ringarooma is slate, and its ridge of slate possibly forms the southern rim-rock of the lead.

Cutting across the slate country here is the Scotia lead. I call it a lead, though it is hardly possible, as yet, to say positively whether it is a lead or a terrace. From the irregular form of the old workings, it might be considered the latter, but having in view the fact that they are bounded on each side by hard slate country, I am inclined to think that the run of drift occupies the bed of an old creek descending from a high ground south of the river. The sapphires, topaz, and smoky quartz, so abundant in the drift, support this view, for these minerals are eminently characteristic of Mt. Cameron, and are not features of the Mussel Roe lead. The numerous water-worn boulders of reef quartz lying on the slate bottom, and the subangular quartz stones in the wash, have undoubtedly been derived from the Mt. Cameron side of the Ringarooma. Such stones may be seen in abundance in the terraces on the northern side of the mount, and the denudations of large reefs like

that of the Royal Standard would furnish large quantities of quartz. Here, too, water-worn stones of cement occur, also large tabular pieces with depressions worn into their upper surfaces. One large piece looked as if it were almost *in situ*, but I could not see any adjacent mass from which it had been detached.

The claim has been known for many years, and in the old times a fair quantity of tin was extracted, but the production then fell off, and has only been revived lately by Mr. Jas. Galloway, who, by dint of perseverance, has brought the output up to about 5 tons per month. As far as he has stripped to date, the ground, including his previous clean-up, ought not to yield far short of 30 tons ore. There is not much tin in the upper part of the drift. Payable ground began about 10 feet below surface along a horizontal seam of yellow iron gravel, and good tin-wash has been found on the slate bedrock, nice coarse black and amber tin being plentifully disseminated. Rich, shotty tin crystals are studded in the soft clay slate. The drift is quartz, with pebbles of quartz and sandstone. Near the bottom little patches of clayey deposit occur where the current had slowed, and slow sedimentation took place. At the south end of the claim the alluvial is stated to have yielded sometimes as much as 1oz. of gold to the ton of tin, but the yield falls off going north.

The bedrock runs up to surface southward, and has been touched by Mr. Galloway's bores ahead of the face northwards, at a depth of 60 feet. It is safe to assume that the northern extension of the workings will lead into deeper ground. It will be gratifying if the bore-holes now being made show tin in the deep ground. If, however, they do not, the lessee need not despair, for the ore in these deposits is inclined to be patchy. At the same time I think the chances are in favour of the drift getting less rich as it extends north. No gutter has been reached yet, as the workings are still going down on the slope of what may be the western rim-rock if it is not the mere configuration of an uneven bottom.

The old Scotia workings a little further N.W. are said to have still unexhausted tin-wash. Mr. Galloway got five tons of tin out of these, and the wash has not been bottomed at 35 feet. To the north, the pits which have been put down in the drift have disclosed poor ground on

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the whole; but they are not deep, the water generally coming in and causing suspension of sinking. Just N. of the Scotia race a shaft was sunk 20 feet in (it is alleged) payable wash. Three chains further N.W. a shaft was put down 16 years ago in wash to 30 feet without bottom. The wash looks favourable. A little tin is said to have been met with in seams. This wash carries stones of cement, which, moreover, is scattered all along the ridge. Some distance north of the present Scotia face a shaft 45 feet deep was sunk in nice-looking quartz wash, not bottomed. Seams of tin said to have been found.

Besides the Scotia shafts just mentioned, I was shown three others: one sunk in the old workings in clayey and sandy ground, with shingle, &c.; another, further north, in nice-looking wash, not bottomed on account of water; and another, higher up, about 20 feet deep in tin-bearing drift.

Mr. Galloway has commenced an improved race to the river, less circuitous than the old one; but the great drawback to this tract of country is that the Mount Cameron Water-race has not been brought across from the Sugar Loaf through Gladstone. In that case, instead of arriving at the Scotia by a detour of 15 miles, it would come in six miles, and give that claim 50-head more water. It would, further, command the terrace on the 2nd Sugar Loaf and the Fly-by-Night ground. Coming in at the top of the township it would command the Gladstone gravels, and the lessees of the Mount Cameron terraces, which still carry good tin, would almost certainly pump another hundred feet to get the water on to their claims. The manager of the water-race estimates that the renewals of syphons Nos. 5 and 6 will cost £5000. If that outlay is avoided, and the race diverted as aforesaid, the cost would be very little more than that amount. If it is decided to keep up the supply of water for the mines I am in favour of this diversion. Below No. 5 syphon there is no fluming to decay, and the race could be used afterwards, if necessary. If the Mussel Roe lead is tapped near Watt's, small tubes could be used in place of the No. 5 syphon.

West of the Scotia are the old workings of the Doone, on an uneven slate bottom, rising to surface N.W. The

deposit is a granular quartz drift, with irregular layers of medium-sized quartz, slate, and sandstone pebbles. Micaceous quartz, porphyry, stones from the granite area, are mingled with pebbles of quartzite and metamorphic slate. There are occasional water-worn stones of cement. From the nature of the drift, I regard the deposit as a marine terrace. At one time good tin came from the Doone, scarcely so good, perhaps, as the Scotia mineral, but the next best along these terraces; and a good area of ground was worked eight years ago, when the syndicate carried on active operations. Work was abandoned about three years back.

Near the Doone is the Newhaven, on the north bank of the Ringarooma. It has less sand and more shingle, and no cement stones. It is difficult to say whether it is an old terrace or connected with the modern Ringarooma River.

A mile further N.W., on the same side of the river, is the Black Duck claim, in about 20 feet of pebbly river-drift of quartz, sandstone, and slate. The bottom is slate and sandstone, and, I should say, the deposit is related to the modern river system. This bank of the Ringarooma is slate and sandstone all the way up to Gladstone. Work on this claim has been stopped for two years. Men made wages here before, and would most likely do better now with the higher price of tin.

Half a mile still further north, on the north bank of a northerly loop of the Ringarooma, is the Canary claim, where the drift has been worked on a soft, decomposed, granite bottom, rising towards the river and shelving towards the sea. This is close to the contacts of the slate and granite, and is either the south rim of the basin of the Mussel Roe lead or the sea-floor of a granite terrace, for we see no more granite to the north of it. A little fine tin associated with iron came from this claim, but work was unremunerative.

Half a mile further west are M'Gregor's workings in the Aberfoyle country. This claim is the only one which has not bottomed, but it is only 20 feet deep, and on the tailings area, perhaps, another 20 feet. This depth is only what might be expected, for it is north of the granite outcrop. The drift is clayey sand with quartz pebbles, both large and small, jasper and quartzite, and

concretionary iron in cemented layers. Pebbles of cement are seen, as well as some flat shingle. It is probably a mixed river and beach deposit. A few bores should be put across the face to reach the bottom, and test nature of the channel, if there be one. Work has been pursued irregularly by Chinese labour, till recently, but the three men used to get only about 2 cwt. of tin a week, which is somewhat below the standard, as a bag of tin per man per week is considered a fair average at Gladstone.

South of M'Gregor's is the old Aberfoyle Company's claim, which has a bed of small gravelly wash from 3 to 15 feet in places, resting on granite bottom, and carrying fairly good tin in places, not rich, but paying Chinese to work. Water from Browns' Hill commands the claims. I should place this ground in the class of beach terraces, and the tin, consequently, is liable to be concentrated in patches, irregularly. This class of deposit is often very disappointing, for though, in the aggregate, the quantity of ore may be considerable, payable patches are discontinuous and met with only accidentally.

Being so near the slopes of Mt. Cameron, it might be thought that streams would run down from the Mount into this country, forming gutters lined with tin drift. But the presence of fine sand, and the absence of stones characteristic of the Mount (granite and black quartz) seems to be against this supposition. The quartz grains composing the sand of the drift on these flats are well worn and of even size, implying long and continuous battering and tossing, such as would take place on the sea-shore. On the other hand, the large stones and black quartz crystals prevalent in the Scotia claim, rather point to that deposit having taken place in a confined channel, such as the bed of a stream descending from Mount Cameron.

You Hen's claim is further south, abutting on the north bank of the Ringarooma. A deposit of 3 feet quartz sand, passing down into river pebble wash with stones of cement and quartz, rests upon the granite in which the Ringarooma has carved its bed here. Very little tin is being produced by these workings, only 1½ cwt. a month. The water difficulty impedes work in the Aberfoyle. If a higher pressure were obtainable,

some of these claims might pay for working. Terrace ground is widely spread, and I do not think it is likely to furnish very brilliant returns. The deeper ground may be expected to lie a little further to the north-east, but whether it will pay to work at this distance down the lead, is, to say the least, problematical. Other things being equal, the *lead* will be richer in its higher reaches, and poorer as it approaches the sea, except where tributaries empty into it. The *terraces* will be richer the nearer they are to Mt. Cameron, and poor and patchy as they advance on the Great Northern Plain.

I have now carried conjecture and probabilities respecting the deep lead of the Great Mussel Roe as far as is warranted by appearances. The lower part of its course is not altogether free from doubt, as the land has suffered movement and denudation, in consequence of which bits of the land have been eaten away, leaving isolated fragments, which, unless we grasp the true position of the case, may be mistaken for mere pot-holes in the old sea-floor. More reliable information can only be obtained by means of boring.

The same uncertainty which attends the existence of the lead also exists with respect to its value from a tin-miner's point of view. There, too, the boring results may possibly give some encouragement. The only claim along its course which is paying at present is Watts', returning about  $1\frac{1}{2}$  ton per month; but it must be borne in mind that no claim has bottomed to the gutter; and until the gutter is found, no satisfactory test can be said to have been applied. Under these circumstances, it is impossible for me to predict what the lead will or will not produce. In its favour we have the fact that at intervals along its assumed course tin ore is present in the upper gravels, and, accordingly, an increased richness is probable in its lower beds. On the other hand, the distance of this part of the lead from the Tier is against continuous runs of ore. The ore concentrations are likely to be in patches, and have been governed by factors now unknown to us, such as gradient of river bed, obstructions to current, &c.

Apart from the deep lead, the alluvial terraces of Gladstone deserve consideration, for, in their time, they

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have contributed a good deal to the tin output of the district. Many of them are by no means exhausted yet, and, with a more reliable water supply, could be put upon the producing list.

South of the Lochaber the northern bank of the Ringarooma is covered with wash of a shingly nature 8 to 10ft. deep in places. A little ore is disseminated throughout, perhaps just payable at the present price of tin. On the southern side of the river at Gladstone Point, wash has been sunk in for 40 feet. On that side, and east of Bell's Bridge, are Morrissey's old workings in about 18 feet of drift, consisting of 12 feet of shingle covered by 6 feet of clay. The bedrock is Silurian slate, and a quartz reef 2ft. wide and vertical traverses it in a direction N.  $55^{\circ}$  E. Angular and water-worn boulders of reef quartz occur, and there are some rounded stones of quartzose granite. The tin has been irregular here.

A little further south is the gravel terrace called the Syndicate's Claim, which has returned a fair quantity of tin. It is composed of 6 to 10 feet of quartz drift, with pebbles of quartz and sandstone on the Silurian bed-rock. This terrace, too, has stones of reef quartz and some jasper pebbles. There is no really deep ground here. The ground becomes clayey towards the N.E. and falls off towards the valley of Coarse Gold Creek. These deposits do not seem to have been laid down in any definite channel, but rather to be the result of sluicing by the sea waves. Gladstone itself is on a similar terrace. A shaft behind Galloway's Hotel is sunk about 80 feet in wash, which has shown some good tin. Further N.W. towards the river is a large face, exposing about 20 feet of granular quartz drift bottomed on slate. When the Esk Company stopped pumping from the Ringarooma, this face stopped, too; but it is not worked out yet. At the bottom of the drift is a remarkable rubble of angular blocks of slate and sandstone. Pebbles of quartzite and jasper occur, but most of the large stones are only a little water-worn. Reef quartz boulders are present. Nearly all this material has come from adjacent rock.

Higher up, nearer the mountain, are the North Mt. Cameron terraces, which would yield good returns of

tin if they could be supplied with water. These terraces are characterised by coarse tin, abundance of smoky quartz crystals, and large stones of reef quartz, all derived from the mountain. It is generally believed that tin ore exists in small quantities in the granite itself, and this is possible enough in the neighbourhood of tin-bearing veins. I have not seen such an occurrence, but I noticed fine crystals of tin in quartz veins traversing the granite at the Star Mine. The works there are in simple granite detritus, no pebbles, but angular fragments of white quartz from veins in granite. The granite is a coarse red variety, containing dark mica with accessory white mica. The quartz veins contain tin ore and mica, and are from 2 inches to 4 inches thick. The claim is strewn with lumps of tin-bearing greisen (quartz-mica rock) detached from higher up the mountain. There is no sign of alluvial drift in the little creek or ravine, and the ore must be patchy.

East of the Star is the Enterprise, which formerly returned good quantities of tin. It is still worked by Chinamen in the winter, when there is water. It is a wide body of drift, at the N.W. end, purely granitic in character, with quartz pebbles. Further east a few sandstone pebbles creep in, but all small, and mostly rounded, and then the deposit becomes clayey. A descending section would present 4 feet of clay, 3 feet of granular quartz drift, 6 inches layer of quartz pebbles, 3 feet large angular stones of quartz, resting on the granite bed-rock. There is no large shingle, and the drift appears to have come mainly from the mount. Going east, the run of ground leads to Ogilvie's workings, south of second Sugar Loaf. Here cement comes in, and pebbles of quartzite and slate are abundant. In this face the decomposed granite bed-rock rises to within 3 or 4 feet of the surface, and sinks in the bottom of the claim to 25 or 30 feet. The outlet creek from the claim goes east into Jewel's Flats, and the ground seems to be connected with Mr. Ogilvie's Edina workings. There is a continuous run from the Enterprise, although the nature of the drift varies so much from that nearest the mountain. It cuts the modern river system at right angles, and I am inclined to think it is late marine terrace ground. This claim is now

abandoned and nearly worked out, but has yielded a good average for tin. The sand is very granitic; in the drift are ovoid, flattened and cylindrical pebbles of quartz, quartzite, slate and jasper, and frequently large worn and subangular stones of reef quartz. Water-worn and tabular blocks and stones of hard Edina cement are frequent, containing quartz pebbles. Gold, one ounce to the ton of tin, has been obtained from here. Round the eastern side of the Sugar Loaf are some shallow tin terraces.

An old claim, known as Brown's Face, is situate north of Ogilvie's Bridge. The deposit is coarse river-shingle, resting on the bed-rock of coarse porphyritic granite. The shingle is composed of quartz, quartzite, and sandstone. False bedding is prevalent, and the sand is apt to cake and be carbonaceous. This is, evidently, a river shingle-bed, the stream having redistributed marine material.

*Lode-mining.*—Tin-mining in the bedrock has not been carried on to any great extent. The greisen or quartz-porphry rock on Harden's ravine and the Fly-by-Night Creek, forms a stanniferous zone between the unaltered granite and the Silurian slate. It has been cut into and worked a little, and some rich tin extracted. It merits attention, and, possibly, might be found to offer a payable proposition. The occurrence resembles the contact formation on Roy's Hill, in the St. Paul's valley.

The Royal Standard and Tasman quartz reefs behind the township were opened upon for gold, but appear to be closely associated with a tin-bearing granite source. In the fine-looking massive reef of the Royal Standard I found tin crystals, and a good deal of white or lithia mica. The reef is in slate country, bears N.W., and attains a width of 20 feet. Several shafts have been sunk on it, the deepest one being over 100 feet in depth. No great depth can be attained without sinking, as the ground falls away very gently to the N. and W. This reef is not far from the surface contact of granite with slate, only about half a mile, but, from the angle at which I observed the granite sloping below the slate in a deep cutting on the Mount Cameron Company's ground, the granite may be calculated as lying not less than 2000 feet

below the surface at the township, unless, of course, there is some variation in its underground dip, which would affect the calculation.

Three-quarters of a mile north of the main race, crossing on the road to Cape Portland, a white barren quartz reef, in soft yellow slate, has been exposed in a prospecting hole.

N.E. of Gladstone, and west of the Mussel Roe River, is the old Blue Bell Mine, in slate country, where a shaft 200 feet deep has been sunk to exploit a white hungry-looking quartz reef. The mine had one crushing.

At the deep-cutting N.E. of Gladstone, I visited M'Donald's Gold Mine, which was started about three or four years ago. The shaft is abandoned. The lode is an east and west one. There was never any crushing, but a couple of tons of stone were washed, and are reported to have returned 6 dwts. gold.

The old Portland Mine has a 200-foot shaft in connection with an east and west lode, varying from 6 inches to 14 inches in width, but the stone pinched both east and west. The ore is a mixture of argentiferous galena and arsenical pyrites, in a quartz gangue, carrying gold. A lot was sent to New South Wales for treatment, and some of the stone is reported to have gone 6 ozs. gold per ton.

It is apparent that the slate country is traversed by numerous reefs, and some of these may be expected to contain gold in payable quantities. The precious metal in this field is apt to be alloyed with silver.

*Gem-stones, &c.*

Mount Cameron has long been known as the source of crystals of topaz, apparently released from coarse pegmatitic veins in the granite. Mr. Wintle was the possessor of a fine crystal from the Mount. This was eventually, sold in London to Bryce Wright for £60. There is also a very large one, eight inches long, in Mr. W. F. Petterd's collection. They are usually found rounded and waterworn in the stanniferous drift, where they suffer numerous fractures. The tint is generally slightly bluish and pale-green; but colourless stones are also met with. When properly cut they exhibit a fine lustre. In lustre, after the diamond, come the colourless

zircon, the white sapphire, the colourless topaz. But to bring out the full beauty and brilliancy of the stone it is essential that it be cut properly, that is, that the facets and angles be cut in accordance with the optical constants of the mineral. When Mount Cameron stones have been sent to England for cutting, it has been found that ready-cut stones can be bought there for the price of cutting the Tasmanian ones. There seems to be no market in Tasmania for these stones, except among the Chinese miners, who collect them and send them to China. In hardness (8) topaz is next to the ruby (8.8), sapphire (9), and diamond (10). Though so hard, in nature it is not a very stable mineral, but readily turns to kaolinite and mica minerals when in veins.\* This instability is illustrated by the ease with which coloured topazes change colour when heated, or even when kept exposed to sunlight. This is, probably, a chemical change. At Mount Cameron only crystals of the rhombic prism and its sections occur, never the partially crystallised and radiating form of topaz called pyenite, which is found at Mount Bischoff.

The Mt. Cameron drift also contains sapphires, also certainly released from the granite, but more frequently, I think, from the Blue Tier than from Mt. Cameron. I saw some small stones of various shades of blue, but none of the genuine "royal" blue, which is the colour of the blue cornflower. Most of them were of a darker, more intense blue, which is apt to show rather black when cut, and has lost favour in the eyes of connoisseurs. One or two parti-coloured gems were shown to me: these colour patches are also often detrimental in the set gem. The hardness of the blue sapphire exceeds that of the ruby, being generally 9. There is, consequently, nothing surprising in the occurrence of these small stones at such a distance from the Tier. They are always well worn—more so than if they had been derived from the neighbouring mountain, though some of them may possibly have come from there also.

The brown and black crystals of smoky quartz, so abundant in the terrace ground, have, most of them, come from veins in the granite of Mt. Cameron. We

\* Lindgren, *Metasomatic Process in Fissure Veins*, p. 37.

have in some of these the morion tint of the Scottish cairngorm. The colouring matter is mostly diffused carbon. Where a tendency to violet is present it is probably due to titanitic acid. Large water-worn prisms, 8 and 10 inches long, are common, sometimes slightly yellowish, or even colourless. Quartz crystals are collected by the Chinese workmen, who send them home to China to be used in making spectacles or crystal spheres.

I was told of the recent discovery of an "obsidian button" in a creek on the south slope of Mt. Cameron. It is uncertain as yet whether these pieces of lava emanated from terrestrial volcanoes or are to be considered as fragments of acid meteorites falling to the earth from stellar space.

#### *Granite.*

The granite of Mt. Cameron and the Gladstone district is part of the granite mass which occupies the country as far south as George's River. It is usually composed of quartz, dark mica (biotite), orthoclase, and oligoclase feldspars, but where it is tin-bearing, white mica is developed in it. It is generally coarse in texture, and contains large crystals of feldspar, which decays readily under atmospheric influences. Still, there is a good deal of a more even-grained variety, which would lend itself to structural and monumental purposes. For the latter purpose, once the rock were polished the surface would resist disintegration more successfully than in its natural state. Imported granite comes from Victoria and Scotland: the latter country yields a superior stone to ours. The foreign rock can be imported ready polished at a less cost than Mt. Cameron stone could be delivered and polished in Launceston. In Britain, the polishing work is done by machinery, and incidental labour is cheaper there than here. Mr. Dunn, of Launceston, assures me that there is not the outlet here for granite which would warrant the importation of plant, and even then the imported stone would compete successfully with the Tasmanian. Under any circumstances the dressing and cutting of granite is not easy, and it is unlikely that

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the near future will see any demand for locally-hewn stone, but there is no doubt that eventually some of our granites will be utilised.

#### CONCLUSION AND RECOMMENDATIONS.

Viewed as a whole, the district surrounding Gladstone is endowed with three classes of potential resources: (1) auriferous reefs; (2) stanniferous lodes or formations; (3) alluvial tin-bearing terraces and leads.

1. Quartz reefs have been opened upon at the Portland, Blue Bell, Royal Standard, Royal Tasman, and a few other points with no great success. But these failures are not sufficient to deter renewed search for better reefs. Those which I have seen certainly have unpromising-looking stone. The Portland reef forms an exception to this statement, and I understand that mine is likely to be started again. But the country all round has numerous reefs in slate-rock, and it is unreasonable to suppose that every reef is certain to be barren. There are likely to be scores of reefs, also, which are concealed by the wide-spread alluvial. The alluvial tin workings which bottom on the slate country nearly always return gold with their tin, and this can only have been derived from denuded reefs traversing the slate. The suspicions of salting in the case of some of the reefs worked has rested upon Gladstone like a cloud, and effectually crushed gold-mining there for a long time past; but I believe its time will come again. There is no warrant for concluding beforehand that the reefs now visible are all which exist there, or that the Silurian slates are less likely to carry gold-bearing quartz than elsewhere. On the contrary, the prevalence of gold in the tin drifts points strongly to sources of the precious metal still undiscovered.
2. There is a belt of stanniferous rock forming the margin of the granite along its contact with the slates from near the Empress to the old Mt. Cameron Company's ground, west of the Fly-by-Night. This rock (known

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locally as quartz-porphry) is essentially greisenised granite, and is a home of tin ore. The small veins of tin in it are individually insignificant, and not worth working by themselves, but selected parts of the formation itself may be remunerative, and a constant supply of water could be furnished to the ground by re-arranging the course of the Government race. The testing of the formation on any considerable scale would, of course, have a certain element of risk, but not greater than usual mining risks. The problem requires carefully looking into by investors.

Mt. Cameron itself has not revealed yet any substantial tin lodes, though undoubtedly it is traversed by veins of tin-bearing quartz, as seen at the Star. I should think it probable that it has not been prospected all over thoroughly, for there is a good deal of Mt. Cameron tin to account for in the high terraces on the slopes of the mountain. The veins are responsible for much of this; disseminated tin, too, may have been released from the granite itself; but these sources hardly seem adequate for the quantities formed. Against this idea of undiscovered tin lodes existing on the mountain is a noticeable absence of tourmaline courses, such as are prevalent at Ben Lomond and Mt. Heemskirk. On the other hand, as tourmaline quartz rock occurs at Tracey's on the Mussel Roe, that neighbourhood might well be prospected for tin lodes.

The alluvial terraces and leads are the mainstay of Gladstone, though from the very nature of the case, alluvial tin-mining, here as elsewhere, must eventually decrease in importance as the deposits become worked out. The deposits in this district are far from being exhausted. The question resolves itself into one of economical mining. The payable parts of the stanniferous drift require locating; and the supply of water is a *sine qua non*. This, in a nutshell, describes the conditions of remunerative mining at Gladstone.

The local output of tin has fluctuated in sympathy with the price of metal, and with the seasonal stores of water. Many claims can only be worked in winter, and are absolutely idle during the

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tion are groundless. Now, given a nearly stationary

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# GEOLOGICAL SKETCH MAP OF GLADSTONE DISTRICT

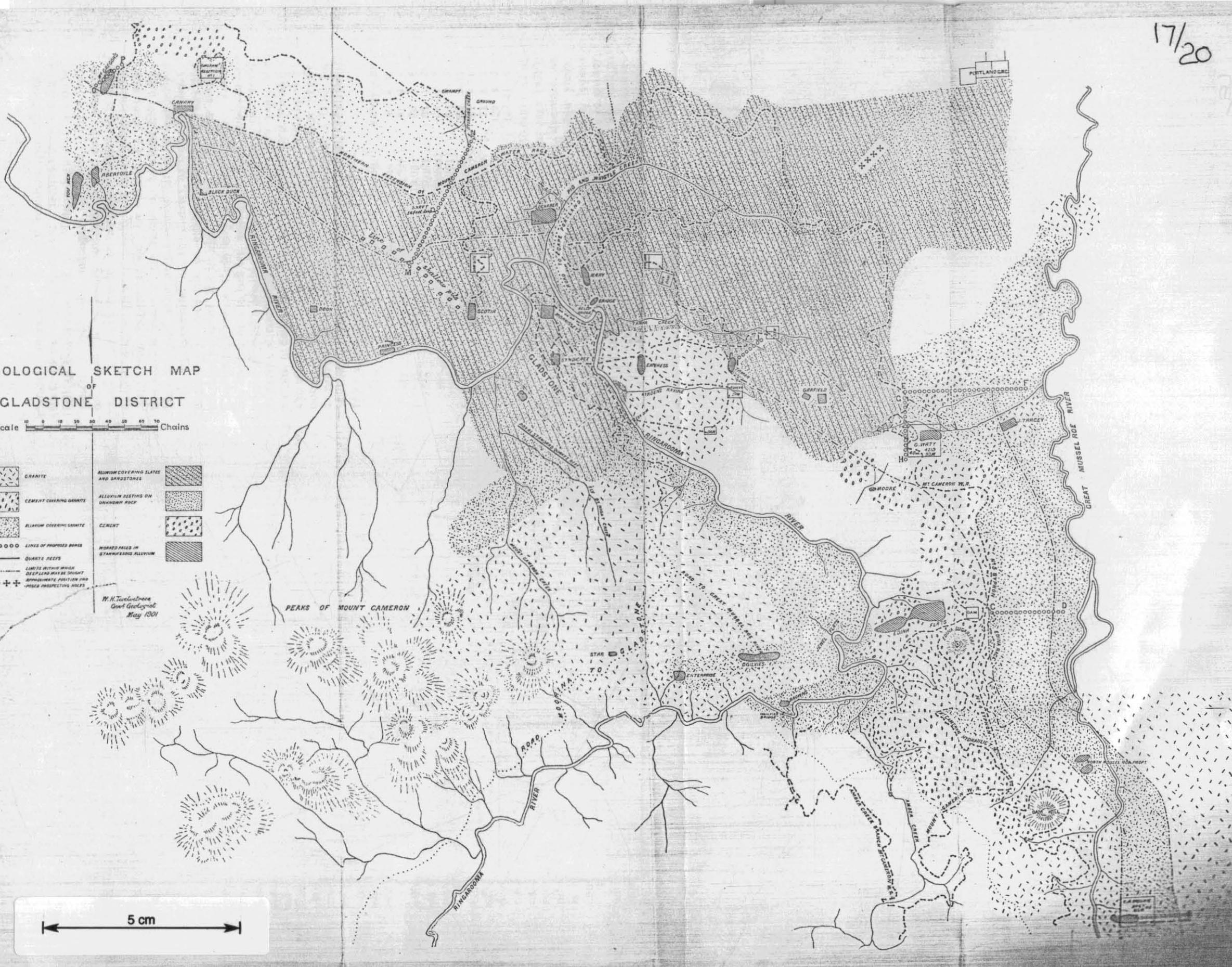
Scale 0 10 20 30 40 50 60 70 Chains

-  GRANITE
-  ALUMINUM COVERING SLATES AND SANDSTONES
-  CEMENT COVERING GRANITE
-  ALUMINUM RESTING ON UNWASHED ROCK
-  ALUMINUM COVERING GRANITE
-  CEMENT
-  LINES OF PROPOSED BANKS
-  QUARTZ REEFS
-  WASHED FALES IN STANHOPEAN ALUMINUM
-  LIMITS WITHIN WHICH DEEP LEAD MAY BE SIGHTED
-  APPROXIMATE POSITION AND POSSESSOR'S PROSPECTING LIMITS

M. H. Todd  
Geol. Geologist  
May 1901

PEAKS OF MOUNT CAMERON

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in winter, and are absolutely rare during the

summer drought. I may mention parenthetically, that there is no means of ascertaining the rainfall at Gladstone. If the Meteorological Department would supply the manager of the Government race with the necessary instruments for daily observations, a record would be available where it is more needed, and of greater use than at many other stations. Also certain claims can only be worked at a profit when the market price of tin keeps up to about £80 a ton. Hence, a not unimportant consideration in connection with putting capital into the district, or incurring heavy expense for renewals of existing races, is what the market price of tin is likely to be in the near future. The outlook seems satisfactory in this respect. Looking back upon the last ten years, the first quinquennial period showed a production of tin throughout the world in excess of consumption. During those five years the output exceeded the demand by 20,000 tons, while for the last five years' period the demand has outstripped the output by 15,000 tons. To exhibit the position clearly, I reproduce the following tabular statement from the *Australian Mining Standard* of 14th March, as extracted from a review by the *Financial Times*:—

Year.	Production. Consumption.		Stocks.	Average price.	
	Tons.	Tons.		£	s.
1891.....	59,463	57,095	18,709	91	3 0
1892.....	64,569	60,842	19,065	93	6 8
1893.....	67,701	67,066	20,082	85	1 2
1894.....	73,634	66,817	29,220	68	14 2
1895.....	74,981	68,522	35,704	63	7 1
1896.....	74,867	71,949	40,101	59	9 11
1897.....	69,924	71,284	34,937	61	8 0
1898.....	69,262	80,436	23,353	71	4 1
1899.....	70,707	74,216	20,681	122	8 7
1900.....	77,925	79,869	20,377	133	11 6

The Straits were responsible for nearly 50,000 tons of the 1900 output (an increase of 2000 tons over 1899), and Cornwall for 4000 tons, a 50 per cent. decrease, as against that county's production for the last few years. The output of the Straits is, in many quarters, looked upon as a dark horse, but from what I am able to gather from published reports and private advices, I am lead to believe that fears of any immediate leap in the production are groundless. Now, given a nearly stationary

output, or, at any rate, only moderate fluctuations, no new sources of supply in sight, and a steadily increasing consumption of the metal, I do not see how we can do otherwise than look forward to the future of the tin market with confidence. It has taken three or four years for the world to wake up to the state of the case, for though the consumption began to increase in 1896, the market price did not become appreciably affected till 1899. Of course, last year's quotations were too unsteady to last, but an ordinary business view of the situation is sufficient to tell us that present prices are likely to be fully maintained.

The annual output of tin ore in the Gladstone district from claims supplied by the Mt. Cameron Water Race, according to statistics furnished by Mr. M. J. Griffin, the manager of the race, is about 80 tons. The last six months 53 men were employed on 15 claims, though shortage of water at the end of the dry season has reduced the number of workers to 25. The last six months' production of tin has been 38 tons; with an average year's water supply, the annual output might be raised to 100 tons. This industry supports a population of about 150 souls. The water-race has so far paid its way and returned £6262 3s. 6d. surplus revenue into the Public Debts Sinking Fund. Its annual revenue is about £1500, and annual costs about half that sum. The output of the principal claims drawing water from the race is as follows:—

Scotia claim .....	About	5	tons per month	
Edina claim .....	"	1½	ton	" "
Watts' claim .....	"	1½	"	" "
Tracey and Daws.....	Nearly	1	"	" "
Moore's claim .....	About	¼	"	" "
He Sung's claim .....	"	1½	cwt	" "
M'Gregor's claim.....	"	½	ton	" "
Lochaber—restarted..	"	¼	"	" " formerly
Bridge claim.....	Nearly	¼	"	" "

The above figures are per working month, but shortage of water interrupts work.

It seems to me that it would be a fatal blow to the whole field to pass death sentence on these claims, as would be done if their water supply were allowed to cease. The result would be the immediate and almost entire abandonment of the Gladstone district and the

stoppage of all revenue from mining leases therein. And resuscitation at any future time would be a matter of enormous difficulty.

In order to acquire additional and necessary information respecting the Mussel Roe deep lead, and the possibilities of the field generally, before committing the Government to a serious outlay for the renewals of the race, I would recommend a series of bores being put down in the drift at the places marked on the chart which accompanies this Report. Something more will then be known about the direction and nature of the ancient channels in which it is believed accumulations of tin ore may have been collected. These places are as follows:—

1. Five or six bores at the Great Mussel Roe Proprietary, on Section 3467-93M. These bores would be about two chains apart, if necessary. Their object is to cross and define the channel of the Great Mussel Roe lead from west to east, eastwards of the present unbottomed workings of the Proprietary. In this case, as in all others, before boring is started, care will have to be taken that the land is in the possession of the Crown. Marked A—B on the annexed chart.
2. Nine or ten bores, four chains apart, on Crown land, between the No. 5 Syphon at the Edina dam, and the Great Mussel Roe River. The object of these is to cross the Mussel Roe deep lead and also prove the ground east of the Edina run of tin-bearing wash, which has been worked more or less continuously from the Enterprise on the west, to the Edina Sugarloaf on the east, a distance of nearly two miles. Marked C—D on the chart.
3. Four or five bores, four or five chains apart in a north and south line a few chains west of Section 4219-91M (Watt), south into 3566, and north into 2143, to intercept possible channel of lead in this direction. Marked G—H on chart. If the channel is not found here, then bores to be started at the north end of the line and at right angles to it in an east line to the Mussel Roe River. The bores would be twelve

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in number, about five chains apart on Crown land. This would settle once for all whether the lead goes out to the north. Marked E—F on chart.

4. Four or five bores, about two chains apart, northward and eastward from the deep ground in the Tamar workings on Section 2011-91M, proceeding towards the Empress dam. This ground has not been bottomed, and, as the lead ahead of it is surmised to have been denuded, it is important to settle the point. Marked I—J on the chart.
5. Twenty-two bores, five chains apart, from the north-west angle of Section 1857-87M to the south-east corner of 172-87W, Stinking Springs, and further north-east, if found necessary. This line will cross north of the Scotia claim, and is designed to prove the lower portion of a heavy bed of stanniferous drift. The line passes at right angles across the presumed direction of the Mussel Roe lead, and the bores will prove, firstly, whether there is any such channel at all, or only a sloping sea-bottom, and secondly, whether the bottom part of the drift is encouraging for tin. Marked M—N on the chart.
6. Three bores in the floor of the M'Gregor workings, Section 2089, in the Aberfoyle country, to find the bottom, and prove whether the deposit is in a confined channel; or consists simply of marine terrace ground. Marked O—P on chart.

The above work comprises 50 or 60 bores, and these, with a few shallow pits south of the Portland Mine, referred to previously, marked K—L on chart, would certainly throw light on much that is now obscure. The work would take about four months, and would cost about £200, in addition to the cost of delivery of the boring apparatus on the field. If the rods could be borrowed or hired, the total cost of the undertaking ought not to exceed £250. Three men would be required, and rods to go down to 200 feet if necessary, though I think the bottom will be reached generally at a much less depth.

In fact I doubt whether the extreme depth will exceed 100 feet. Still, it is well to be prepared. Needless to say, exact registers of the borings must be kept. The ground is loose or partially consolidated quartz drift, here and there only hardened to a kind of cement.

With the additional information obtained by this means, the inferences indulged in in my Report may be fortified, and useful and necessary hints secured for future work: or, on the other hand, eventual loss may be saved by doing away with baseless hopes. In any case I think it would be unwise to abandon the field without a final test.

I have to tender my thanks to Mr. M. J. Griffin, Manager of the Government race, Mr. James Galloway, Messrs J. and C. Ogilvie and others in the district, for information and help received.

The chart herewith shows the bed-rock which underlies the superficial covering of drift. This drift, while deep wherever terraces and leads have survived, is shallow on the higher ground, where the granite or slate bed-rock becomes visible.

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

W. H. TWELVETREES,  
*Government Geologist.*

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