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MOUNT LYELL COMPANY'S MINE.

REPORT ON NORTH-WEST COAST MINERAL DEPOSITS.

[Six Maps.]

Government Geologist's Office,
Launceston, 26th July, 1905.

SIR,

As instructed by you, I journeyed to the North-West Coast on the 10th January, and visited various mineral fields and occurrences of ore all along the coast, at the Forth, Penguin, Howth, Blythe, Stowport, Boat Harbour, and Rocky Cape. I returned to Launceston on the 10th February.

GEOLOGY.

This is far from being simple. The older rocks which are seen along the sea-shore are varied, sometimes metamorphosed beyond easy recognition, and disguised, too, by changes in colour and texture by the action of the atmosphere and sea-water. They comprise slate, quartzite, schist, conglomerate, sandstone, &c., penetrated in places by igneous rocks of granitoid, dioritic or gabbroid character, and often overlaid by basalt of Tertiary age.

The age of these ancient rocks is still unsettled, and is likely to remain so, as long as the stratigraphical succession is not elucidated by actual survey. Some of them may be Lower Silurian or Ordovician, others Cambrian, while crystalline and gneissoid schists, such as those in the Forth Valley and Inglis River, and quartzites, as at Rocky Cape and the Sisters, are probably Pre-Cambrian.

The oldest known fossiliferous strata in Tasmania are the friable yellow sandstone beds at Caroline Creek, between Railton and Latrobe, where Mr. Thos. Stephens, M.A., discovered trilobites, &c. (*Dikelocephalus*), characteristic of the Upper Cambrian; and a *Dikelocephalus* sandstone on the Tiger Range and elsewhere in the Florentine Valley, also discovered by the same acute observer, and referred by Mr. R. Etheridge, jun., to the Upper Cambrian. We have, therefore, in these Caroline Creek beds a definitely-known horizon, and a systematic survey would connect them stratigraphically with the strata on the coast, and enable a better idea to be formed of the age of the

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latter. Meantime, uncertainty exists as to which are Silurian, which Cambrian, and which Pre-Cambrian. The term Cambro-Silurian has been adopted in Tasmania as a temporary device, to avoid unjustifiable precision, but it is objectionable, as some of the strata designated by this name may be more ancient than the Cambrian.

Pre-Cambrian.—The Sisters' Hills and the Rocky Cape promontory are considered as probably belonging to this age. They consist of massively-bedded quartzite striking north-easterly and dipping north-westerly; at the Port the dip is north-easterly, and the strike north-westerly. West of the Port contorted quartz schists preserve the same dip and strike. The Rocky Cape hills run back from the sea for about seven miles to the main road, and continue southwards for another mile, when they sink rather abruptly to the level country. The quartzite of which they are composed is white and saccharoidal, not quite so dense in texture as that at Port Davey.

The schists and slate to the west are covered near Heller by deposits of recent sand and ferruginous drift. The country between Dallas and the Detention is occupied by cultivated basaltic soil. The junction of the quartzite with basalt along the main road between Detention and Boat Harbour appears to be at Mr. Moles' farm, half a mile east of Deep Creek.

At Boat Harbour the schists and quartzites may be considered as belonging to the same ancient series. The quartzite forming the promontory at the Penguin is also probably Pre-Cambrian, as well as other quartz schists which are visible along the coast-line. A gneissoid hornblende schist occurs in the valley of the Forth, a mile south of Hamilton, and must also be ranged among the Pre-Cambrian. This belt of rock strikes north-westerly, and from its direction would emerge on the coast in the neighbourhood of Clayton's Rivulet.

Cambro-Silurian.—These strata have been considered as filling an undetermined gap between the Pre-Cambrian and the Upper or Middle Silurian. They are supposed to include some of the slates which crop out between Burnie and Ulverstone, and are exposed in the gorges which score the basalt-covered plateau inland. Owing to synclines and anticlines, they alternate with the more ancient schists, and it is very difficult to unravel the succession. The term is susceptible of more than one interpretation. It might be used as denoting strata with organic remains characteristic of both the Silurian and Cambrian systems,

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as these are developed in the northern hemisphere; and as being equivalent to both these systems combined. Whether such an equivalence exists or not, cannot be affirmed, as no fossils have yet been found in these coastal beds. Or it might be taken as meaning a set of strata intermediate between Cambrian and Silurian, and filling the gap which is represented by the unconformity existing between the rocks of those systems in Europe. It is, however, employed here in neither sense, but simply as a cloak for ignorance. The data at our command are not sufficient to enable us to refer any of these rocks definitely, either to the Silurian or the Cambrian. Indeed, some of them may be Pre-Cambrian. It seems most likely that the work of future geologists will result in wresting many of these strata successively from their present provisional position, and adding them to the Pre-Cambrian division.

Eruptive Rocks.—Following the Silurian rocks in point of time are the igneous rocks of the coast (excepting basalt, which is much younger). These eruptive rocks are intimately associated with the occurrences of ore, so it is well to pay close attention to them. In time they occupy the interval between the Silurian and the Devonian. The conglomerates of the Dial Range are supposed to be Devonian, and (if we except provisionally the ill-understood breccia at the Neptune Mine) are not penetrated by the eruptives, or by any reefs proceeding from them; and they are singularly destitute of ores, excepting ores of iron. It is natural to suppose that the eruptive action took place before the conglomerate was laid down. The igneous rocks comprise gabbro, serpentine, basic diorite, syenite, granite, quartz-porphry. These rocks are not widely separated in geological age, and throughout the whole of the north-western district they are associated with ores either of copper or lead. I have in another report* suggested the existence of a genetic relationship between our basic and acid rocks (gabbro and serpentine on the one hand, and granite on the other), a progressively decreasing basicity of the rock magma finally resulting in the formation of granite and reefs of quartz as the end term of the series. The deposition of copper apparently lasted throughout this process, as the ore occurs in connection with both the acid and basic rocks.

There is an exposure of serpentine about 200 feet wide on the west side of the Forth, half a mile south of Hamilton. A mass of quartz or felspar porphyry occurs higher up the same river, at the waterworks building. On the

* On the mineral resources of Beaconsfield, 1903, p. 54.

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beach at the Blythe, opposite the railway station, is an intrusion of greenish gabbroid or dioritic rock into the quartzites, 100 feet in width, containing disseminated pyrite and copper pyrites. A somewhat similar rock crops out in the bay east of Cocee Creek and at Parsonage Point, West Burnie. At the Esplanade, west of Boat Harbour, a copper-bearing igneous rock of undetermined nature has intruded into the schist and quartzite for 150 feet in width. At J. Lee-Archer's copper mine a dyke of diorite, between 80 and 90 feet wide, in the Rocky Cape quartzite carries copper pyrites. At Hardstaff's mine, Dial Range, a copper-bearing quartz lode traverses granite; and at the Dial Creek group of mines pyrite and copper pyrites occur in the brecciated contact rock between granite porphyry and slate. The copper lode at Rutherford's mine, Stowport, is within a mile of the boundary of the granite running across the country east to Riana.

Devonian (?) Dial Range Conglomerate.—This formation comprises beds of cemented pebbles of quartz, quartzite, and jasperoid rock, lying horizontally or moderately inclined upon the ancient schists, and forming the bulk of the Dial Range. It apparently descends to the sea-beach east of the Penguin, for on examining the strata of the old Neptune Mine, I found an angular breccia lying horizontally on the older rocks. Near the summit of the range, the pebbles of the conglomerate are converted into hematite, and deposits of pure iron ore occur on Denney and Jones' sections. No mineral lodes have been discovered in the conglomerate, unless the uncertain case of the Neptune Mine is an instance.

Permo-Carboniferous.—The boulder clay or glacial till at Wynyard, with its embedded pebbles and blocks of rock, forms the base of the Permo-Carboniferous system. Granite blocks weighing several tons occur in this bed, which has been described by Messrs. Johnston, Stephens, Montgomery, Waller, and Kitson. Fossils derived from Middle and Upper Silurian strata are found in the pebbles of the conglomerate, and this indicates the existence of strata of that age in the back country. Such beds are known at the Heazlewood. This till is the basement on which the well-known fossiliferous Lower Eocene beds have been laid down. Permo-Carboniferous mudstones and sandstones occur along the coast east of Wynyard, and are known to the south at a distance of from 10 to 20 miles; where they enclose seams of excellent coal and kerosene shale (Preolenna). No mineral lodes need be sought in this formation.

Mesozoic Diabase.—This is known in Tasmania by its various field names of greenstone, bluestone, ironstone, or trap-rock, and is never absent from our coal fields. At Preolenna it crowns the high range between the Flowerdale and Jessie Rivers. No economic mineral has been discovered in it, but at its contact with the coal measure sandstones and shales in various parts of Tasmania, deposits of hematite and chalcidony have been formed.

Eocene.—This is represented at Sandy Cove Bluff, west of the mouth of the Inglis River, and consists of about 85 feet of limestone, charged with Eocene marine shells, resting on 3 or 4 feet of Eocene conglomerate. The lower part of this limestone for about 5 feet in thickness is characterised by its remains of *Crassatella*; over it for about 80 feet the rock carries *Turritella* and other shells, with leaves of dicotyledonous trees, and has yielded remains of a fossil marsupial. Seventy or 80 feet of Tertiary basalt overlies the whole. A catalogue of the shells has been recently published by Mr. Jno. Dennant and Mr. A. E. Kitson.* These beds are well known to Australian geologists, and visitors come to Wynyard from time to time for the purpose of seeing them.

Lower and Middle Tertiary.—Quartz gravel, or drift, in which a little gold occurs, is spread over the country at a height of 200 to 500 feet above sea-level, under a covering of basalt and basaltic soil, and protrudes from beneath the edges of this volcanic sheet, in the sides of the valleys which have been cut down by the creeks and rivers to and into the bed-rock. This drift is not really confined to the valleys, but caps the high land between them, where very often the basaltic cap has worn away and exposed the gravel and cement. The grit or gravel is often cemented with iron, derived from the overlying basalt, and concretionary iron ore (limonite) has formed in it, the whole bearing some resemblance to lode gossan, for which it is frequently mistaken. I had occasion several times in this journey to remove an impression that this sub-basaltic ferruginous cement or ironstone grit was the gossanous capping of lodes, e.g., at Mr. Taylor's, Primrose Park (Howth), Mr. Smith's (at the Blythe), Mr. Bramich's (at the Blythe), and on the hill between the Blythe and Howth. Lignite and brown coal occur in this formation, with impressions of leaves of European trees, similar to those found in beds of similar age in the basins of the Tamar and Derwent, at Mt. Bischoff, Burnie, Strahan, &c.

* (Rec. Geol. Surv., Vict., Vol. 1, Part 2, 1903.)

Heated solutions from the basalt have cemented the underlying drift into a hard quartz conglomerate at times, which is not always easily distinguishable from the older rocks in the neighbourhood. This may be seen on the hill on Mr. Bramich's section at the Blythe; and on the side of the hill on the western side of the Howth Valley, about 100 feet above sea-level, where cliffs about 25 feet in height expose a section of the conglomerate underneath a bed of coarse shingly wash. Caves are hollowed out in the softer portions of the formation at Howth. Gold has been found in these sub-basaltic gravels at different parts all along the coast, but so far no gutter has been located. The indications are those of a widespread sheet of gravel, rather than of beds of separate creeks or rivers. The fossil leaves and wood point to estuarine conditions. Still the uniformity of the deposit over such a wide area strongly suggests beach action. The coastal land at the time was evidently much lower than at present, and as it subsided, these drifts were laid down. At the same time, it is difficult to see how gutters could avoid being formed, running seaward; and if these can be found, there would be some hope of discovering payable wash.

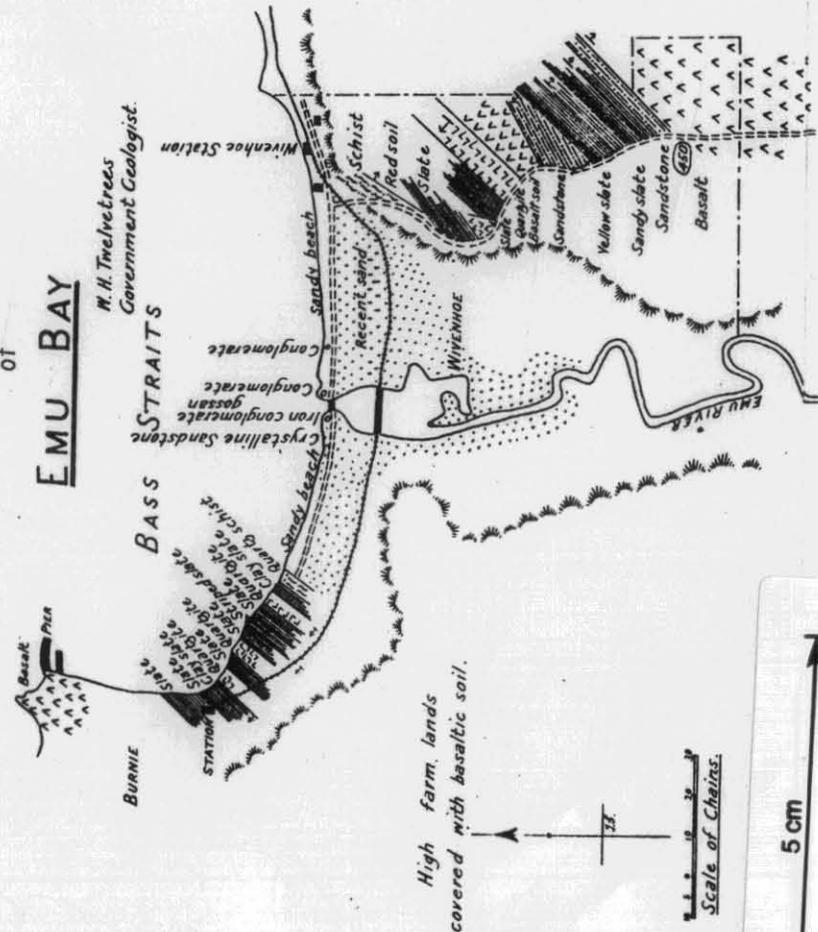
Creeks in the districts of Table Cape, Boat Harbour, and Rocky Cape contain zircons and sapphires. The source of these has not been discovered. They appear to have been proximately derived from the sub-basaltic drift, but their ultimate source is still a matter of conjecture.

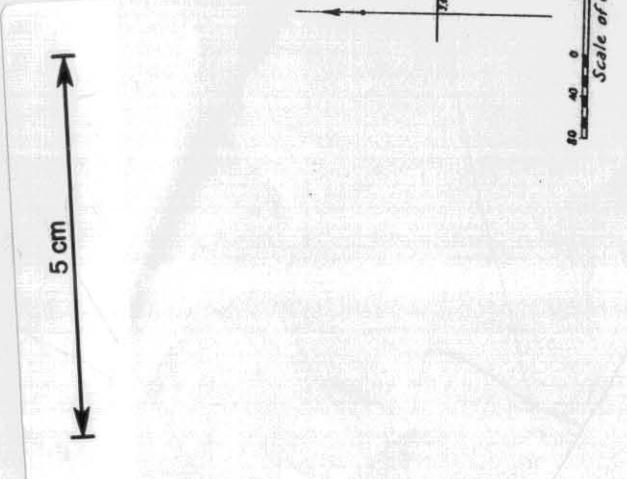
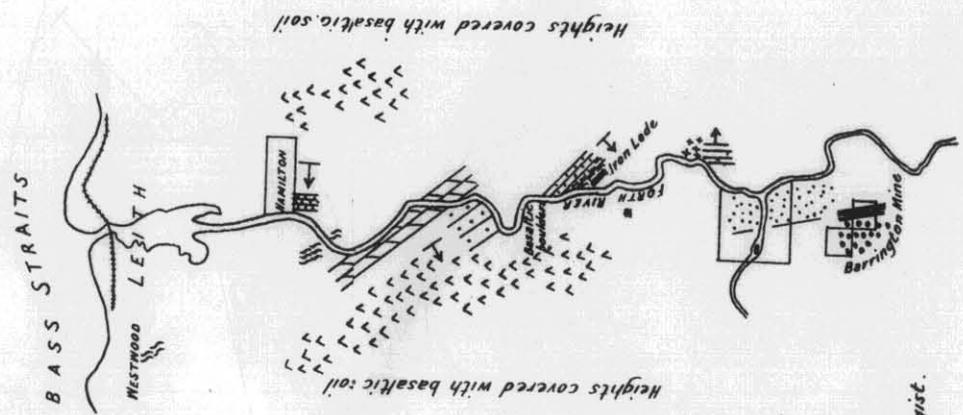
Tertiary Basalt.—This covers the whole country for many miles back from the coast, forming a rich red soil—the so-called chocolate soil—on a plateau 400 to 500 feet above sea-level, and occasionally, as at Penguin, Burnie, and elsewhere, descending to the sea-beach. The solid basalt is seen in road-cuttings everywhere, softening and decomposing into the fertile soil for which the North-West Coast is so famous. At Burnie, near the pier, it is prolonged into the sea in the form of a pavement of hexagonal columns, a structure due, as is well known, to the contraction of the cooling rock.

The Table Cape Bluff, which is a promontory rising to a height of 600 feet above sea-level, is composed of a rather coarsely crystalline basalt, of somewhat sodic constitution.

It forms a striking object in the landscape, and is visible for a great distance along the coast. The adjacent township is Wynyard, at the mouth of the Inglis, in a thriving condition, and destined to improve as settlement progresses in the back country.

Geological Sketch Map
of
EMU BAY





- REFERENCE.
- Serpentine
 - Basalt (Tertiary)
 - Hornblende Gneiss
 - Schist
 - Slide
 - Sandstone
 - Conglomerate
 - Quartzite
 - Felspar porphyry

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JOHN YU. GOVERNMENT PRINTER, TASMANIA.

Recent.—Beds of beach sand and pebbles at intervals along the sea-shore denote an elevation of the land in recent times. These are seen easily at the bridge over the Emu River and at the bridge over the Blythe, where (at the latter place) there must have been an elevation of from 40 to 50 feet. Recent sands extend inwards on the flat land at Emu Bay and Wynyard, and the gravels of this age also contain a little gold, but not payable.

To summarise the above remarks, and present the geological series in order of age, I append the following:—

Succession of the Geological Record.

RECENT AND LATE TERTIARY (NEOGENE).	Flat country along coast-line. Raised beach sands at Wivenhoe, Blythe, &c. Flats at Wynyard and on Calder-road.
MIDDLE TERTIARY.	Basalt sheet on high land at Forth, Ulverstone, Penguin, Blythe, Stowport, Burnie, Wynyard, Flowerdale, Boat Harbour, Detention. Promontories or bluffs of basalt at Table Cape and Circular Head.
LOWER TERTIARY.	Clays, sands, and gravels below basalt; exposed at Penguin (Pine-road), and on road near cemetery; at Howth, in creek on Mr. Taylor's farm; on hill west of Howth; on farms in Blythe district; below Burnie township (Wilson-street); Seabrook Creek, Mt. Hicks-road, Calder-road, Detention district, &c. Drift often cemented by deposition of iron, and becomes an ironstone cement and gossan, with bedded and concretionary brown iron ore. Sands frequently silicified and converted into quartzite and conglomerate (at the caves, Howth; Smith's and Bramich's mining sections, Blythe. Clays contain beds of brown coal and lignite, with leaf impressions (Howth, Blythe, Detention). Lower Eocene fossiliferous beds at Wynyard, Table Cape.

ROCKY CAPE DISTRICT.

The Rocky Cape hills form a high range, which is prolonged seawards as a bold promontory, building the eastern horn of a bay, of which the Circular Head peninsula is the western horn. The distance across this bay as the crow flies is 13 miles. The trigonometrical station is fixed on one of the summits of the range $2\frac{1}{2}$ miles from the extreme point and 2 miles north of the post road at the post office in the surveyed township of Dallas (locally known as Detention). The basalt country covers the area to the south of the main road, between it and Detention River. North of the road the quartzite hills begin.

The usual sub-basaltic gravel and ironstone grit or cement occurs on the farms in the district. I visited Mr. H. Boy's farm, which I am told is the oldest in the locality. The land is an ironstone conglomerate, composed of grit and clay and concretionary iron oxide. I was shown the site of a well which had been sunk for 40 feet, down to pipeclay, which is a well-known sub-basaltic formation all over the island wherever a basaltic area obtains. A creek (Coal Creek) which flows through the property west and into the Detention River has a bed of quartz-sand, brought down from the ironstone cement formation. Zircons and occasional sapphires are found in the creek, and it was here that the late Mr. Jas. Smith found a large sapphire, which, I am told, realised £15. I may here mention that a creek on the east side of the farm, east of the road, also contains zircons (locally, rubies); as also another creek running northerly through the farm. I was told, too, that zircons have been found in a creek near Dallas'.

It seems pretty certain that these gems are lying in the drift which underlies the basalt, but whence they were originally derived is unknown. It may be assumed that they have come either from some of the granite or syenite in the back country, or from ancient zircon-bearing schists. About eight years ago some carbonaceous material was discovered in Coal Creek, and some work has been done upon it, with a view of proving the deposit, which is about 5 chains from the western boundary of the farm. A shaft has been sunk 40 feet in drab clay, some of it a little carbonaceous. Higher up the creek, a pit was sunk 10 feet in the carbonaceous formation, and is not yet through. The deposit is a bed of impure brown coal and lignite, similar in character to the other deposits of this material at other places on the coast. Its thickness has not been proved, and its precise value is an unknown quantity, but

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it is improbable that its heating power exceeds that of wood. To make the material marketable, it would have to be pressed and moulded into briquettes (steam or air-dried), the cost of which per ton at the mine might be anything between 10s. and 13s. per ton. The calorific power being so low, the article would only be suitable for domestic purposes, and the likelihood of its displacing wood or coal at present is very small.

Mr. Boys obligingly showed me over his farm, and gave me an opportunity of examining the geological features of this area. To the north, between here and the sea, the ironstone drift becomes overlaid by more recent sand.

Rocky Cape itself forms a small peninsula, the port being on the east side of the narrow isthmus. About 150 feet above the jetty a natural cave exists in the quartzite cliff, on the floor of which are shells; but I did not notice any chipped stones or traces of the handiwork of aboriginals.

On the beach west of the Cape, associated with contorted quartz schists, is an outcrop of light-green actinolite-rock. It is a finer-grained and much less fresh rock than the diorite dyke at Mr. Lee-Archer's mine, but it belongs to the same type, and might carry the same minerals.

At the north-eastern point of Rocky Cape a wide dyke of greenish rock was noticed by Mr. Thos. Stephens, M.A., forming a well-defined intrusion between walls of quartzite. This is an augite-felspar rock, of dioritic affinities, and though no hornblende or actinolite is observable in it, it also must probably be classed with the Lee-Archer dyke and the other intrusions in the quartzites.

Lee-Archer Copper Mine.

This is situate on the beach $3\frac{1}{2}$ to 4 miles south-east of Rocky Cape port, in a broad dyke of eruptive rock which traverses the quartzite strata in a north and south direction, and runs out to sea. A steep gully leads down to it from the high land; the line of this ravine indicates the line of the dyke inland. The dyke rock may be best described as diorite.* The width of the dyke from wall to wall is 84 feet.

* Composed of hornblende and plagioclase felspar. The hornblende is frequently changed to actinolite and asbestos. A little epidote is present. Titanic and specular (micaceous) iron ore disseminated plentifully. No primary quartz.

Two shafts have been put down. The first was sunk in the dyke to a depth of about 30 feet, at 19 feet from the east wall. The stone broken is greenish-grey in colour, carrying disseminations of iron and magnetic iron pyrites, somewhat asbestiform in parts, and with a few blebs of bright copper pyrites. The joint planes of the rock show a facing of red hematite. I was informed that pieces of copper ore, as large as the tip of one's finger, had been found. Looking over the heap, however, I could not see that at this spot sufficient has been found as yet to drive upon.

Seventy-seven feet further north a small shaft, 5 feet by 4 feet, has been sunk to a depth of 40 feet, from the bottom of which a drive has been extended eastwards across the dyke for 25 feet. This was not accessible at the time of my visit. I was given some ore, stated to represent a seam met with in the drive, and this assayed 3.6 per cent. copper; as well as some stone from the last shot in the shaft, which assayed 2.3 per cent.; but though such results as these may be obtained here and there, workable ore has not been disclosed in these workings. Pieces of richer stone can also be got at surface, about low-water mark. The shaft has not been sunk lower than the level of low water, and the drive which has been commenced is too shallow to be of much use. The west wall of the dyke is formed by a reef of quartz 7 to 8 feet wide, and on the line of this the shaft was sunk. This quartz is laminated and white, and encloses in parts portions of the dyke converted into schist. This schistose rock appears to be the selvage of the dyke. Both quartz and schist contain iron and copper pyrites. The reef would seem to have been formed subsequent to the dyke, and the latter also is intersected by small veins of quartz. The copper ore appears to be mainly associated with the quartz, though the solid dyke rock is also impregnated here and there with this mineral. In the middle of the dyke is a band of carbonate of iron 3 to 4 feet thick, and it would be interesting to see what primary mineral exists below this in depth.

The dyke at present may be said to be entirely undeveloped, for the work done hitherto is too shallow to prove anything one way or the other. At the depths reached, nothing of any practical value has been discovered, for isolated pieces of pure copper ore scattered through a dyke like this are no more than mere indications of the existence of the metal. If it is desired to test the dyke in

depth, and ascertain what underlies these surface signs, the shaft on the west side should be sunk at least a further hundred feet, a crosscut extended from it at that depth across the dyke, and a drive put in on the course of the quartz reef. Of course, such work would be entirely speculative, as there are no surface exposures of secondary ores indicating any quantity of primary ore below. Mr. Lee-Archer has, however, laid out a certain amount of money in the work which has been done, and is, I understand, desirous of seeing the test carried to a conclusion.

At about 100 feet above the mine on the west side of the gully is a cave in the quartzite cliff. Its floor is strewn with shells of edible molluscs, and the cavity was no doubt used at one time by the aborigines. The cave at the port, already mentioned, is of the same type. It is difficult to account for these cavities in such an insoluble rock as quartzite, unless by reason of some faulting action causing the beds to slide along their lamination planes.

Another description of cave is situate to the east round the headland, also about 100 feet above the sea. This one is in sandstone, and is always full of drainage or spring water. I was told that dry seasons do not make much difference in the level of the water. It has a low roof at entrance, but inside is about 20 feet high. The sandstone is pure white, and soft. At the time only Permo-Carboniferous measures occurred to me, but I have since wondered whether the deposit is not of Tertiary age. This overlooks the Sisters' Bay, on the beach of which is some graphitic schist with disseminations of iron and copper pyrites.

Brakey's Show.

At Mr. Chas. Brakey's farm, 2 miles south-west from the above, either inside the northern boundary or on the Crown land outside (which, is not certain), is a mineralised outcrop of igneous rock. The rock is greenish, much decomposed, but some ill-preserved feldspars can just be identified in it, and it must be either dioritic or granitic. It is traversed by seams of iron oxide, carrying a little copper pyrites. A cutting has been put into the bank of the creek, but the strike of the formation has not been disclosed, nor can anything further be said about it at present. It is probably one of the igneous intrusions which run out seawards, but it is over a mile to the west of the line of the Lee-Archer dyke.

Detention Quartz Reef.

Past Dallas', and north of the road, is a reef on which some work has been done, but a thunderstorm prevented my visiting it when passing. Some quartz runs across the road, and I was told it was considered likely to be the continuation of the reef. The samples which I took from this did not contain gold, but I am informed that a little has been found in the reef. The country is one in which mineral may very well be found, but prospecting has been very imperfect. The strata belong to the most ancient in the island, and the numerous occurrences of eruptive rock in the district are favourable indications for the existence of mineral deposits. So far, nothing very decisive has been discovered here in the old quartzites and schists; but quartz veins are not uncommon, and traces of gold and silver in pyrites and small quantities of copper have been obtained. The quartzite is coarsely laminated, and is not characterised by the minute folding found in so many of the West Coast strata, and which doubtless greatly assisted the infiltrations of ore solutions and the replacement of the country-rock by ore. So far as the quartzite, by reason of its hardness, resisted the folding process, to that extent it would be less prepared for the access of mineral in solution, and the quartzite areas consequently would not be very encouraging for prospectors. But it must be borne in mind that prospecting here has been very superficial; and while there are close at hand the igneous rocks, the sources of all our metals, a discovery of payable ore may be made any day.

The Rocky Cape quartzites have not been traced definitely far south; not more than a mile south of the main road. They there enter the geologically unknown country which extends south across the Arthur River to the Heazlewood and Long Plain. The quartz schists of the latter resemble those west of Rocky Cape, and are on the same strike. The Rocky Cape quartzites bear in the direction of the Heazlewood. They are not seen there, but may have been obliterated by the intrusion of the Heazlewood igneous rocks. The Arthur River country is practically *terra incognita*. Prospectors have penetrated it from time to time, and reported discoveries of mineral; but there is a great area of 50 miles by 20, on which no authoritative reports exist, and which may in the future contribute largely to our mineral output. Tracks through it exist on paper, but some of these, disused for a long time, are no longer practicable.

JACOB'S BOAT HARBOUR.

The Rocky Cape series of quartzites and schists extend eastwards to here. At the Town Reserve, the land overlooking the sea is 300 feet above tide-level. The dark-red soil of the thriving farms of the district indicates the existence of the basaltic sheet; but the underlying ancient rocks are seen in the face of the sea-cliff.

King's Mine, at Esplanade.

The discovery of some copper in the rocks on the sea-beach a mile west of the promontory overlooking the harbour was made about six years ago. There is here an intrusive dyke intersecting the quartzite for about 150 feet in width. The rock is greenish in tint, actinolitic in character, much decomposed, carrying a little pyrites, specular iron, asbestos, and copper pyrites. Only two or three shots have been put into it so far. I was informed that the best exposures are to be seen at low tide, and was shown some clean copper pyrites, said to have been obtained from that part of the dyke. My samples of specimens assayed 2.2 per cent. copper. The dyke has a direction of N.E.-S.W., and the quartzite here runs north-westerly, with a north-easterly dip. Veins of quartz traverse the eruptive rock, principally on its eastern side. The best way of testing the formation is to go up the bank some 20 feet, and sink on the strike, say, 150 feet or upwards, and crosscut the dyke at that depth. A discouraging feature is the absence of secondary copper ores at surface; this contra-indicates the occurrence of much copper pyrites lower down. The dyke belongs to the Rocky Cape series of intrusions; these are identical in geological age, and if good ore can be established in one of them, there is a chance for the others.

King's Schist Show.

Half a mile further west, and a mile east of the Sisters' Cape, at the base of the cliff on the sea-front, quartz schist is exposed, with some veins of quartz 2 to 6 inches in width, containing a little copper pyrites and specular iron. These veins are lenticular, and conformable with the laminations of the schist. A few yards further west the quartz schist is accompanied by an argillaceous variety, studded with iron pyrites and specular iron ore, and stained with

the oxidation of iron. I could not detect any free gold in the samples taken, but if the discoverer wishes to test the formation, it is easy to drive into the hill, though there is not any great inducement. The eastern exposure is the better one of the two, but it is only a collection of small quartz lenses through 6 or 7 feet of country. As shown in the face of the hill, it is of no value, but a drive on its course would show whether any improvement is likely. These indications of mineral are poor things compared with those displayed by outcrops on the West Coast, but it would be unwise to positively reject them as unworthy of any attention, considering how little we know of the mineral contents of the ancient strata along this part of the coast.

Shekleton Zircon Deposits.

South of the town reserve at Jacob's Boat Harbour, and about $\frac{3}{4}$ mile from the sea, the land forms a saddle, from which a small creek flows northwards into Bass' Straits. A few zircons, or rubies, as they are called locally, have been found in the bed of the creek. From this saddle two or three zircon-bearing creeks flow south into the Shekleton Zircon Creek, which rises in the quartzite hills of the Sisters' and falls into the Flowerdale River further east. A couple of small zircon-bearing creeks also join the latter creek from the south. Mr. R. L. Skinner obtained a lease for zircon and corundum in March, 1889, which was transferred to the Shekleton Mining Syndicate, No Liability, in November, 1899.

The bed of the creeks consists of quartz and quartzite wash, evidently derived from the neighbouring hills and from the underlying bed-rock. Stones of basalt occur in it, and these have no doubt come from the overlying basaltic sheet on the farm lands. But the creek gravel is not basaltic in any way. It carries no inconsiderable quantity of small red and reddish zircons, with occasional sapphires. A good many of these gems preserve, roughly, their crystal form, but all are worn smooth, much smoother than the grains of quartz which accompany them. This, considering the superior hardness of zircon, points to an origin more distant than the Sisters' quartzite; and yet there is none of the granitic quartz which is usually found in the sub-basaltic gravels along this coast. Grains of black mineral resembling pleonaste are abundant in the sand, and there are also grains of a dark-brown mineral with conchoidal fracture and vitreous lustre, which, judg-

ing from Mr. W. H. Gaze's analysis, might be pyrochlore, or some mineral related to it. If this determination is correct, it complicates matters, and tends to make the origin still more obscure, as pyrochlore has only been recorded from elaeolite-syenite, which is a rock that has not yet been discovered in the north of the island. Mr. Gaze's published analysis is as follows:—*

Nitrate of uranium and chromium, a variety of pyrochlore:—

	Per cent.	to	Per cent.
Uranium	5.0	to	0.5
Chromium	10.5	to	12.5
Titanium	12.0	to	13.0
Niobium	4.5	to	2.5
Iron	25.5	to	27.7
Magnesium	2.2	to	0.5
Alumina	7.3	to	6.2
Lime	2.6	to	1.5
Silica	15.0	to	12.0
Didymium	7.5	to	0.5
Lanthanum	6.2	to	2.2
Thorium	1.0	to	traces
Yttrium	1.5	to	traces

In 1896 a ton or two of washed sand was exported to Melbourne, and some was sent to Europe, as it was thought that the zirconia and thoria might be utilised in the manufacture of the Welsbach gas mantles, which, as is well known, are made by saturating a cotton fabric in a solution of salts of some of the rare earths and metals, and then burning off the organic matter, so as to replace it by the metallic oxides. First, Welsbach used zirconia and lanthanum in equal proportions; then he found that by replacing zirconia by thoria he could increase the resisting power of the mantle. It seems, however, that the great improvement in modern mantles has been brought about by using small quantities of ceria with thoria; practically in the proportion of 1 per cent. ceria and 99 per cent. thoria. Curiously enough, pure thoria and pure ceria separately are valueless as light-producers, but the slightest addition of ceria makes all the difference.

The European trials of the Shekleton material did not disclose sufficient thoria contents for economic purposes, and work ceased on the claim. For some time after, however, search was made for specimens of corundum and zircon sufficiently large to sell as gem stones. Some were found large enough to cut, but the sapphires are generally

* *Mining Standard*, Oct. 8, 1896, p. 1373.

fractured. The wash is from a few inches to a foot in depth. Mr. King, jun., kindly piloted me along the creek in very bad weather. The bed of the stream is greatly choked by growing timber and fallen logs, so that examination is difficult. There is no doubt, however, that the zircons are abundant, and it is quite possible that, with some unforeseen turn of the market, the deposit may eventually prove valuable.

Reverting for a moment to the question of origin, the presence of zircons and sapphires in creeks at Detention, and also south of Wynyard in a creek falling into the Inglis, indicates a wide distribution. For the present, we seem unable to say more than that they occur in drift of early Tertiary age, generally in drift which has at some time been capped by overlying basalt. Their original source must have been some more ancient rock, which cannot yet be identified. Although at Boat Harbour I could not see much sub-basaltic grit or cement, such as is so prevalent elsewhere on the farms, it is very possible that a good deal has been denuded, together with the basalt, towards the Sisters', at some time or other.

TABLE CAPE DISTRICT.

Having visited the back country on a previous occasion to within a few miles of the Arthur River, I did not go up country again this time. The flat land round Wynyard carries gravel deposits of late Tertiary and Recent age. Though these contain a little gold, there is not much reason for believing that they will ever be found to pay for working. On the other hand, the gravels which are now or at any time have been sub-basaltic, and which are of early Tertiary age, are sensibly auriferous, and have been worked for gold all along this coast at Big Creek, Camp Creek, Seabrook Creek, &c. Heavy gold has been found in numerous branch creeks and gullies. It is extremely probable that auriferous leads exist beneath the basaltic sheet, and that gutters might be found by driving into some of the hill ridges below the basalt. Possibly, such gutters, where struck, would not prove payable, but exploratory work would disclose their direction and enable them to be traced and tapped further inland, where the gold might be expected to be heavier. A lot of unremunerative work has been done in the district, with the result, I believe, that the real leads have not been dis-

covered, and workers have only been operating on gravels which have been widely distributed by the action of the sea, and cannot therefore be expected to be rich. But below this distributed material, there are almost certainly hidden and buried gutters, in which, judging from analogy and from actual indications, gold will be found in more concentrated deposits.

While in the district I was told of tin being found up the Inglis River, and also at the Cam. The probability is that the occurrences are in the early Tertiary gravels, but as granite rock is only found at a great distance inland, it is not likely that stream-tin will be at all plentiful. Some granite is rumoured to exist somewhere west of the Inglis, and I am trying to verify this.

But the country behind Wynyard, as far back as the Arthur River, is, once the basalt is left, dominantly a coal measure area; and these measures also extend below the basaltic covering.

PREOLENNA COAL FIELD.

This is about 17 miles south from Wynyard, and comprises the country between the Jessie and Flowerdale Rivers. Seams have been opened on the Jessie Fall by the North-West Coal and Shale Company, disclosing kerosene shale and a high-class gas coal, superior to anything yet found in Tasmania. The seams are not thick, being from 20 inches to 3½ feet. They occur in sandstones, which rest on and are overlaid by the fossiliferous mudstones characteristic of the Permo-Carboniferous system in Tasmania. The seams belong therefore to the lower coal measures. Above these, in the western part of the field, are seams of poorer quality, which occupy high positions in the Preolenna system, and may belong to the Mesozoic series, but no evidence from fossil plants is yet available in support of this view or to the contrary. The Launceston Gas Company has tested the illuminating power of the gas from the Preolenna shale, and found it to be about double that from Greta coal. The superior bituminous coal yielded 12,030 cubic feet of gas per ton, which compares well with the best N.S.W. coal used here. The yield from the latter is about 11,000 cubic feet per ton, but generally works out in practice at 10,500 cubic feet. The following analyses of samples which I took from the various outcrops in 1903 may prove of interest. The assays were made in the

Government laboratories by Mr. W. F. Ward, Government Analyst:—

	Fixed Carbon.	Gases, &c.	Ash.	Moisture.	Coke.
Shale from tunnel	21.00	76.20	2.30	0.50	Rather tender
Shale from cliff outcrop	23.20	71.60	4.10	1.10	Fairly firm
IX-mile 18-inch seam ...	52.50	41.10	5.50	0.90	Ditto
Fault Creek, north fork	52.30	41.70	5.00	1.00	Tender
Fault Creek	45.70	43.40	9.70	1.20	Crumbly
Fenestella Creek, 20 in.	46.90	45.90	6.50	0.70	Ditto
Ditto, 3 ft. 5 in.....	44.40	50.30	4.90	0.40	Tender
Camp upper seam, 18 in.	44.40	48.30	6.60	0.70	Crumbly
Camp lower seam, 20 in.	46.90	44.20	7.10	1.80	Tender
Camp seam, N.E. Creek, south fork, 13 in.	45.70	42.00	10.70	1.60	Fairly firm

As the district develops, transport facilities will be brought within easier reach, and eventually these seams will form a valuable property. For the present, the only work which can be rationally undertaken is that of testing the seams in advance of the outcrops by two or three bores with a core drill. Freedom from faults would be ascertained in this way, and possibly some even better seams might be proved to exist below the known ones. The seams most likely extend to the north, and the country ought to be explored in that direction, so as to tap the coal nearer to the coast. A discovery has quite lately been reported between Camp and Seabrook Creeks, east of Preolenna, and nearer the sea. I anticipate that more seams will be disclosed in this district in the future, and I would urge continuous search. Unless Mesozoic measures are discovered, the seams are not likely to be thicker than those already known, judging from the analogy of the seams in the Mersey basin, which is of the same geological age, and in which the 10 and 12 feet seams of the Mesozoic measures do not appear to occur. The quality of the coal in the Wynyard district, however, is unsurpassed in Tasmania. The shale is identical with the so-called "cannel" coal of Barn Bluff. Both Mr. Thos. Stephens, M.A., and Mr. A. Montgomery, M.A., mention the occurrence of shale similar to that of Barn Bluff on the sea-beach at Wynyard, and in the Inglis River and in Seabrook Creek. I was able to verify this independently, and all this serves to strengthen the supposition that shale and coal seams still remain to be found much nearer the coast than Preolenna.

COOEE CREEK.

East of Cooe Creek, about a mile west of Burnie, is a broad bay, with sandy beach, through which protrudes an intrusive igneous rock, of dark-greenish hue and coarse gabbroid texture. Its constituent minerals are augite, hornblende or actinolite, and felspar, and it may be classed with the other dioritic dyke rocks which have been mentioned above as occurring along the coast. Disseminated through its substance are crystals of pyrite and a little copper pyrite here and there. An intrusion of a similar rock occurs at Parsonage Point, West Burnie, and the same rock may be seen at one or two other points between there and Cooe Creek. Although these rocks contain copper pyrites sporadically, there are no indications of ore-concentrations being present in payable quantities.

STOWPORT COPPER FIELD.

This field embraces the country between the Emu and Blythe Rivers, a plateau about 500 feet above sea-level, cut down into by Chasm Creek, which is a rivulet falling into the sea between Wivenhoe and Heybridge. The township of Wivenhoe is in the delta of the Emu River. The strip of land along the sea-shore for half a mile on each side of the mouth of the Emu consists of recent sands, covering most probably clays and gravels of Tertiary age. The latter occur in the township of Burnie, with characteristic fossil imprints of leaves.* On the east bank of the Emu mouth are boulders of hard quartz conglomerate. What formation these really belong to is somewhat uncertain, but I am inclined to refer them to the Tertiary system, and specifically to the highly siliceous conglomerates which are found below the basaltic sheet. The loose crystalline sandstone, which is scattered in tabular blocks over the beach at Burnie, appears to belong to the same series. Boulders of manganiferous iron ore at the mouth of the Emu River are also probably of Tertiary age. They form a confused mass of ferro-manganese gossan, running in a north-easterly direction, and prolonged to the eastern side of the river. They are embedded in the sand, but a close examination shows that the gossan is most probably a modification of the conglomerate just referred to. A hundred yards further west are embedded boulders of

* Some of these, obtained in sinking a well in Wilson-street, were sent to the Victoria Museum, Launceston, by Mr. R. S. Sanderson, several years ago.

highly crystalline and siliceous sandstone, which, according to the theory now suggested, is a part of the same series of strata. The manganese formation has been sunk on for gold, of which traces are said to have been found. My samples, assayed by Mr. W. F. Ward, Government Analyst, returned nil.

Towards the west end of Emu Bay the underlying Cambro-Silurian slates and quartzites crop out on the beach, striking north-easterly and dipping north-westerly. At the breakwater these are covered with basalt, which here has a pronounced columnar structure, and runs out seawards. At the eastern end of the bay the road to Stowport winds up the hill to a height of 450 feet before reaching the chocolate basaltic soil of the farm lands. The road shows the hill to consist of a succession of mica schist, quartzites, slate, and sandstone, with a north-easterly strike. There is an anticline in this hill, the western strata having a north-westerly dip, the easterly a south-easterly dip. The lower part of the road, about 500 yards from the Wivenhoe railway station, exposes dark micaceous and quartzose schists, which, for about 80 feet, are strongly seamed with quartz. An excavation has been made in a ferruginous bank by the road-side, where the soil is red, and has the appearance of covering a lode. This is opposite the sawmill.

These ancient rocks, when the brow of the hill is reached, near Mr. Norton's house, are covered with a capping of decomposing basalt and soil derived from it for a distance of 4 to 5 miles, when they again appear as the Rutherford mining property is approached. A mile south of the Rutherford Mine, the edge of the granite is reached, which stretches across the country east to Riana.

The Emu River has cut down first through the basalt, then through the underlying gravels and clays with their seams of lignite and brown coal, and into the underlying Cambro-Silurian slate and schist. The various creeks on the basaltic plateau frequently show the older rocks coming out from below the edge of the volcanic sheet.

Mr. W. Rutherford showed me an exposure of the sub-basaltic clays on his 92-acre lot east of the Emu River, 250 feet above sea-level, on a small creek which flows into Glance Creek. Mr. Rutherford has sunk a small hole 7 feet through brown coal or carbonaceous clay into underlying sand or gravel composed of small beach stones. This black outcrop has been noticed for a distance of 45 or 50

feet. At other points, pipe-clay or a drab sandy clay has been met with under a foot or two of the brown coal.

The overlying basalt along the east side of the Emu Valley forms a capping of from 50 to 100 feet in thickness. The farms on this land yield splendid crops of potatoes and oats. Wheat is grown here and there, but does not thrive like oats; and either the soil or the position is not the best for fruit. I was informed that a fair yield for potatoes is 5 to 6 tons per acre, and a good yield, from 8 to 10 tons. For oats the yield ranges from 50 to 60 bushels up to 80 bushels per acre. This rich agricultural land, lying side by side with a mineral zone in the same area, forms an ideal district for both industries.

At about 6 or 7 miles from the coast, the slate strata are more or less strongly impregnated with iron and copper pyrites for a width of a couple of miles from east to west, at intervals. The strata here have a north-easterly strike. In the western part of the field, at the Norton-Tattersall property, they dip to the south-east; in the eastern part, at the Rutherford Mine, the dip is in the same direction. Between the two properties mentioned, on the banks of Chasm Creek, on Mr. Edward Gee's land (formerly J. Griffith, 107 acres), the slate is impregnated with iron pyrites, but, judging from samples shown to me, there is nothing at present to warrant any expenditure on discoveries made, though this does not discourage search for something better, which possibly may be found.

Norton-Tattersall P.A.

On Mr. J. Laxton's 50 acres east of the Emu River a zone or belt of slate and sandstone, heavily charged with iron pyrites, runs N. 25° E., dipping south-easterly, and some work has been done on this, with the view of proving it, and if satisfactory, of developing the formation. A tunnel has been driven into the hill for 90 feet. After driving 56 feet through slate, the mineralised slate and sandstone strata were driven into a distance of 34 feet. These are veined with quartz, and heavily charged with iron pyrites. Here and there a little copper has been observed, but the samples which I took in the tunnel yielded, according to the Government Analyst, negative results for gold, silver, or copper.

The strike of the formation would take it into Crown land, as well as into Mr. J. Laxton's 147 acres further north, and copper ore may occur somewhere along its

course, but the absence of this mineral in the tunnel discourages further work at this spot.

In the creek, between here and the farm, there are two occurrences of graphitic slate. At the lower place it has been exposed by a cut in the side of the bank, showing graphitic slate and quartz intermixed. Higher up, within 50 feet of the brow of the hill, 4 or 5 feet of graphitic material is seen in the bed of the stream. Being softened from exposure to water, the occurrence was difficult to examine. The Government Analyst's assay disclosed poor results for graphite (carbon). Two years ago half a ton was got out, and it is reported to have realised £3 per ton. The present exposure of this slate is insufficient for any estimate of the extent of graphitisation, but a great improvement will have to take place for anything profitable to ensue. The history of graphite mining elsewhere in the world is replete with examples of unprofitable and abandoned mines, with deposits of only 10 per cent. to 20 per cent. carbon contents. If it is wished to test this occurrence, and to ascertain the average quality of the bulk, the creek should be diverted and the seam excavated sufficiently for the purpose.

Rutherford Copper Mine.

The Rutherford Copper Mining Company's mine is on Section 4496-93M, 60 acres, and purchased land 120 acres, F. C. Groom; with continuation of the lode south into T. S. Rutherford's purchased 320 acres. It has now been discovered about five years. A tunnel was first driven into the hill some 150 feet, intersecting a small copper lode near the entrance. This was then sunk upon, and drives opened on its course at 16 feet and 32 feet. The lode proved to be of varying width, 1 foot, 1½ foot to 2 or even 3 feet. The ruling width is 1 foot or 18 inches. When I was there, foul air prevented me from entering these workings, which up to recently had been worked on tribute, 70 tons of ore having been raised, with recoverable metallic contents worth £4 9s. 2d. net per ton after making smelters' percentage deductions. In addition to about 7 per cent. copper, the ore carries 3½ ozs. silver per ton.

A site has been chosen for a main shaft, and this has been sunk 99 feet. At 95 feet a crosscut was being started for the lode, and it was estimated that this would be cut in 50 or 60 feet.

The ore at the 16-foot and 32-foot levels is in the oxidised zone, and consists of copper pyrites and black oxide of copper in a silicified slate gangue. The lode strikes N. 40° E., and dips north-westerly. About 5 chains west is a belt of ironstone 4 chains in width. This is good hematite ore, containing 53 to 58 per cent. iron, 2 per cent. to 5 per cent. silica, and 0.5 per cent. phosphorus. South-east of the mine is a long belt of iron ore passing through Section 960M, 48 acres, G. F. Jewkes, and a good distance through T. S. Rutherford's 320 acres, where the outcrop forms a hill several chains in length and about 10 chains in width. The iron lode is bordered on the west by quartzite (locally known as porphyry), and metamorphic slate forms the country intervening between the latter and the copper lode. I followed the iron formation to within about half a mile of the granite country which comes in on the south of the 320 acres. The close proximity of granite suggests strongly a causal relationship between it and the iron lode. The copper ore deposit, too, may be regarded as having a similar origin. Finding good copper ore here with a strong iron lode as a near companion, the indication is that elsewhere along the same strike where there is a good development of iron ore, copper ore will be found in its vicinity.

The iron lode continues north into the 120 acres, F. C. Groom, but becomes concealed by basalt, which covers also 318 acres, A. J. Morris, and most of the 186 acres, W. H. Atkinson, still further north. The iron re-appears in the northern part of the 186 acres, and then continues as the well-known lode leased by the Blythe Iron Mines, Limited.

The Rutherford property has not been provided with adequate funds for its proper development, but the good ore already met with in the shallow drives is warranty enough for exploring the lode at increased depth. The width of pay ore is not yet sufficient to correspond with all requirements, but it is clear that remunerative ore exists, and its extent cannot be proved without further work. The mine is still in its prospecting stage, and perseverance in a vigorous programme of exploration is necessary for any results to ensue. The lode is likely to contract and expand along its course, and if it is not as wide as expected when intersected from the shaft, that should not discourage further work, but it should be followed, with a view of reaching points where it will be found to widen, as these will certainly occur.

North Commonwealth Mine.

This is on Section 876M, 80 acres, in the name of T. J. Dorgan, on the west bank of the Blythe River, 3 miles north of the Rutherford. I approached it by a track from the 250-acre farm of Mr. J. Morris. Inside the east boundary-line of this farm, the basaltic soil is replaced by the older rocks, which here consist of grey metamorphic sandstone, intersected by veins of quartz. A descent is here made gradually into the timbered valley of the Blythe. The first work on the property was started last July, by putting a short cut into the hill east of a small creek, where a foot of soft broken slate is showing. A few yards further north, about 35 feet were driven through clay slate with bands of pug, and at the end of the cross-cut is a vein of quartz 2 feet to 18 inches wide, narrowing as it goes north, and also underfoot. The pug and quartz carry iron pyrites, but no copper so far. A good deal of iron is coming away with the water from the quartz vein. A few inches of quartz follow the north side of the drive, with pug and pockets of iron pyrites. The country is disturbed on this side of the drive, and as the latter is only 15 feet from the surface, it is too shallow for an opinion to be formed of the ground. There is evidently a silicified band of country, and it would be promising enough if any mineral could be seen other than iron pyrites. The cross-cut is in an awkward place, below the level of the creek, and the hill spur falls going north. The better way would be to go further down the creek, and crosscut from there, though with increased length.

Further north, on the eastern boundary-line of the section, the hill spur which falls north-easterly to the River Blythe has been trenched across, but the trenches are not quite deep enough. Ferruginous quartz gossan occurs in pieces here and there, but no sign of copper is to be seen.

At 10 feet above the Blythe, below these trenches, the low north tunnel, a crosscut across quartzites, has been driven north-westerly for about 80 feet. At 36 feet in the tunnel a level has been driven off the tunnel, along a junction of sandstone with graphitic slate, where there is a band of silicified country. The distance driven was about 30 feet, but the lode-matter was soon left on one side, and the drive continued in graphitic slate slightly impregnated with iron pyrites. Further in the tunnel past this drive is a little quartz in soft black slate, and then hard, blocky grey quartzite continues to the end. The indications scarcely justify continuing the tunnel,

besides which it is too near the north end of the hill spur to gain much depth. To prove the ground, it would be better to go further up the river, where the hill is higher, and then put a prospecting tunnel into the hill. About here are a few copper carbonate stains, and also a little copper pyrites.

A little south of the tunnel is a bold outcrop of grey quartzite traversed by numerous veins of quartz. It bears across the Blythe River to the north-east, running up the steep high bank on the other side, but seems to be quite barren of mineral.

Although this property is known as the North Commonwealth, and is, in fact, north of the Commonwealth, it is not on the same run of country as the latter. The Commonwealth belt runs to the east of it.

Commonwealth Mine.

This is on Section 874M, 80 acres, in the name of C. J. Leighton. The River Blythe runs through the section, but the mine is on the east side of the river.

About 30 feet above the Blythe a tunnel has been driven for 280 feet, 15° south of east, to intersect a lode outcropping higher up the hill. The outcrop line is bearing N.W.-S.E., so that if that direction is to be taken as a constant one, the tunnel has not taken the shortest course to cut it, and, in fact, would have to be driven 300 feet more before reaching the point of intersection. But this north-west direction is so different from that of all the other lodes in this copper-bearing belt, that the owners looked upon the course observed at the outcrop as abnormal at that particular point, and drove the tunnel east, believing that the lode would come round again to its natural strike. When the tunnel had been driven beyond where it was anticipated that the lode would be cut, a shaft was sunk on the outcrop to a depth of 30 feet. The lode in the shaft is split by a horse, and from the bottom a drive has been put in for over 20 feet south-westerly without picking it up again. The lode material is indurated slate and quartzose rock traversed by parallel veins of quartz, crossed in all directions by veinlets of the same mineral. There are signs of disturbance of the strata here, which is unfortunate just when the position of the lode is required to be located.

At the entrance to the tunnel a pyritic seam has been cut, and at 20 feet in a soft formation was passed through for a distance of 25 feet, and further in one or two seams

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-of gossan and iron pyrites were intersected. The tunnel shows the same succession of strata as on the surface, striking north-easterly and dipping south-easterly. At about 200 feet in the slate becomes hard and dark, with large heads, and carrying pyrites on the joint planes. A little distance behind the end the slate arches over and forms a flat roof. A disturbed zone is apparently being entered, which makes it difficult to assure one's self of what is ahead. The present end is close upon 300 feet south of the shaft, and it would take 300 feet to continue the tunnel in its present direction in order to reach the lode, assuming the latter to maintain the same bearing as at the shaft. This distance could be reduced to about 170 or 180 feet by turning the adit in a north-easterly direction. There is some doubt, however, whether the lode has not recovered its normal bearing, and been intersected already by the tunnel. If this is so, its position in the tunnel ought to be about where the soft formation was cut not far from the entrance. Unfortunately, there does not seem to be any metal there. On the whole, it would seem advisable to explore from the shaft, and having located the lode, to follow it. I understand some nice copper ore was found at the outcrop.

At 100 feet up the hill, south-east of the shaft, is an outcrop of yellow gossan bearing north-easterly. This has been trenched upon, but though a nice-looking quartz-iron gossan, did not yield anything beyond iron in the Government laboratories.

On the western part of the section, a long spur of cemented rock comes down, which, for a couple of chains in width, has a gossanous appearance, and has been locally taken for lode gossan. It is, however, a cement of quartz and sandstone fragments, and evidently belongs to the sub-basaltic drift formation.

BLYTHE COPPER FIELD.

The Blythe and Stowport copper deposits are in one and the same geological area, though geographically separated by the Blythe River. The Blythe River, running north to the sea, has intersected the wide basaltic plateau, and carved its channel deep down into the underlying slate and quartzite strata which enclose the ore deposits. Consequently, these strata are exposed for about half a mile on each side of the river. The same process has taken place on the Emu River and Upper Chasm Creek. The

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Stowport strata, having a north-easterly strike, are prolonged across the Blythe River into the Blythe field proper, and the same lode lines, both of iron and copper ores, are continued also. The Rutherford-Copper King line of lode can certainly be traced at intervals along a distance of 5 miles, and probably 7 miles, if McKenna's Heybridge mine on the sea-coast belongs to it, as, judging from its position, is most likely the case. The line passes beneath the basaltic farm lands in G. Rooke's 52 acres and A. Littlejohn's 50 acres, continuing doubtless under the 100 acres of A. Littlejohn, not far from Mr. G. Radford's house, and a mile further north-east ought to be visible in the slate and quartzite of the hills overlooking the sea. So far, however, it has not been picked up there, and this may be due to more than one reason. In the first place, these hills were at one time largely covered with basalt, and the bed-rock is still in many places concealed by the remains of sub-basaltic drift and cement, the latter of which is, as usual, often mistaken for lode gossan. Secondly, the copper deposits do not always happen to rise to the present surface of the slate strata. The persistency of the lode line for such a distance speaks strongly for it being found payable at more than one point in its course. The Blythe iron lode, too, shows a visible length of $3\frac{1}{2}$ miles, its southern exposure being in the 320 acres, T. S. Rutherford, and its most northerly point being on the east side line of the 100 acres, O. Allen, forming the boundary between it and the 238 acres, C. and J. Robinson (60 acres, C. Sice). I have not seen it further north than this. It disappears here beneath the basalt, and does not emerge from it near the coast.

A great deal has been said about the possibility of the outcrop of the iron lode covering copper deposits. Of course, this question does not in the slightest degree affect the future of the Blythe Iron Mine as an iron ore property, because the huge outcrop on which it is proposed to work has been proved to be hematite down to river level. The small proportion of limonite and the absence of lode minerals contra-indicate a copper lode lower down. A very large number of analyses have been made, without disclosing the presence of copper sulphides or of any precious metal. As far as we know the occurrence, it is a large hematite lode. The latest facts learned appear to indicate a genetic association with the granite, which is near the southerly exposure of the hematite on Rutherford's.

At the same time, though the iron in this lode may not be associated with copper, there would appear to have been a deposition of copper along parallel lines, and wherever the iron development is strong, the parallel copper deposit is also pronounced, *e.g.*, at Rutherford's and the Copper King. Copper prospecting on the Blythe Iron Mines property has so far been unsuccessful, but the results are not final. At the northern end of the iron lode on Sice's 100 acres about half a chain of iron ore is exposed, with the characteristic red siliceous contact rock a chain in width on the eastern side of it. This contact rock here is sparsely impregnated with specular iron, iron pyrites, and copper pyrites, which strengthens the supposition that the deposition of both metals formed part of one physical process.

Prospectors on the Blythe Iron Mines Company's property have unsuccessfully sought copper ore on the west side of the iron outcrop, and the company has also done some abortive work in the same direction. A nice-looking outcrop of iron gossan, carrying pyrite and copper pyrites is exposed for a width of 3 feet in descending the hill on Section 1009, 73 acres. The edge of it is visible in a cut put north into the hillside, and it looks as if it might extend several feet further east. About 25 feet below, the company's prospectors have driven a tunnel below the outcrop, but failed to find anything beyond bunches of gossan with a little copper ore. It would have been better to have started the drive a little lower down. There has not been enough work done to prove the formation. A short T-drive has been put in at the end of the tunnel, but the course of the lode should be followed further into the hill. Lower down, near the level of the river, what seems to be the same line of lode has been tapped by a tunnel, but without any result. Speaking generally, the prospecting for copper on this section has been too limited to test the ground adequately.

Copper King Mine.

This property, owned by Mr. L. J. Clark, is charted as 915-m, 63 acres, north of and adjoining the Blythe River Iron Mines 40-acre section. A turn off the main road from Heybridge is made at Mr. Sice's house, which is on the basaltic agricultural plateau, 650 feet above sea-level. On the way, the northern extension of the Blythe iron lode is crossed on Sice's 100-acre lot. South-west of this is a valley which has eaten away the large outcrop between here and the Blythe Company's 40-acre section. The

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basalt covering extends a little way down into this valley along its eastern edge.

On the west side of the track going down to the Copper King, and on the boundary between the 63 acres and O. Allen's 100 acres, is an outcrop of quartz carrying pyrites. The country-rock is a yellow sandy schist, or laminated sandstone, striking north-easterly and dipping south-easterly, and the quartz follows this strike. A few veinlets of quartz traverse the rock at right angles to the strike. A sample of the outcrop quartz was assayed by Mr. W. F. Ward, Government Analyst, but contained neither silver nor gold. A few yards below this, boulders of gossan occur, which have evidently rolled down the hill from some point higher up.

The copper lode (Clark's lode, as it is called) runs through the section in a north-easterly direction, with an underlay to the south-east. In strike it is conformable with the country strata, but in dip it certainly, in places, transgresses these.

The first drive which I saw was a cut into the hill on the course of the lode, but the approach had fallen in, and the face in the end was exposed to daylight. The drive has been carried for a width of 6 feet, 3 feet 9 inches of which are in soft lode slate heavily charged with iron pyrites, copper pyrites, and black oxide of copper, the remainder consisting of much harder lode stuff, with nice bands of rich copper pyrites. Some of this hard lode stuff which I sampled, and which was assayed by the Government Analyst, returned 15 per cent. metallic copper.

Ten feet below this, a crosscut tunnel (No. 2) has been driven 31 feet across the lode formation. This is the only place in the mine where the full width of the lode has been proved. Outside the tunnel mouth was a pile of over 12 tons second-class ore, estimated to average 7 per cent. copper, and which was taken from the crosscut in driving across the formation. Its gangue is quartz and carbonate of iron. Some seams of copper ore occur at the immediate entrance to the tunnel, and just inside a short drive has been put in (north) for 12 feet on an 18-inch seam of ore, which, however, has diminished in the face to a few inches in width. Some nice-looking red and black oxides of copper show in this seam. The main tunnel passed through alternate bands of hard rock and black copper ore. For 11 feet the lode matter intersected was poor, but afterwards about 10 feet of gossanous material came in and yielded the ore which is piled outside. The adit has been

driven right through the lode channel to the graphitic slate country on the east wall. In the roof at the end of the tunnel a little gibbsite (aluminium hydrate) occurs. A drive south has followed the gossanous band for 12 feet, exposing some good oxidised ore in a siliceous gangue, the latter forming heads and blocks of stone. In the drive north the wall has broken away, probably through surface disturbance, as the workings are very shallow. At about 12 feet, a crosscut was driven east in gossan, but this is now built up. Good copper ore continues a few feet to the break. Past the crosscut, the drive seems to be on the west side of the lode, and is in a serpentine direction, turning east, however, and recovering the gossan. The latter continues, but lies mostly outside the east wall of the drive, which is practically between the slate and the gossan. Near the end, the gossan is stronger. Towards the end of the drive the lode is carried along the east wall, showing some copper stains and oxidised ore. A crosscut east is necessary here to tap the richer part of the lode. Unfortunately, it is only about 20 feet below the surface, and if the drive were extended, it would soon come out into the creek which lies ahead. As the hill spur runs out here, backs cannot be obtained. This drive is over 100 feet long. Some fair-sized pieces of native copper have been obtained from the gossan, which is often plentifully seamed with veins of quartz. The siliceous gangue is generally strongly charged with iron pyrites. On the whole, the best plan would be to continue the crosscut east in the drive north, and get to the other wall of the lode.

Upper Tunnel (No. 1).—This is a narrow crosscut tunnel driven west for 100 feet into the hill, cutting the lode at that distance. The lode has been driven upon south for 75 feet, and two crosscuts put into it from the drive at 52 feet and 12 feet respectively behind the end of the drive. The lode has been carried the width of the drive, but extends outside the west wall for at least 23 feet, as the south crosscut near the end is in the lode formation for that distance and not through yet. The formation as disclosed in this crosscut consists of hard, massive quartzose rock with veins of copper-bearing matter at intervals. A good deal of quartz enters into the composition of the formation, and a little good ore occurs here and there. The north crosscut also shows hard and barren stone throughout its length of 12 feet, but just behind the face is a vein of oxidised ore (with some gibbsite). The

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best ore in the drive is in the present end. Three-fourths of the face consists of graphitic slate, carrying copper and iron pyrites. A pile of about 10 tons of good ore was stacked outside the tunnel entrance ready for market, consisting of erubescite, copper pyrites, and oxide in a gangue of metamorphic slate, with veins and patches of quartz and disseminations of iron pyrites. Grab samples which I took from this heap, assayed by the Government Analyst, returned 10.5 per cent. metallic copper. However, shipments of ore since my visit have been made, returning for 20 tons an assay value of 15 per cent., and for 23 tons a value of 24.7 per cent. copper, according to returns furnished by Mr. Clark.

Northern Workings.—About a couple of hundred feet from the face in the drive from the No. 2 tunnel, the lode has been cut again in a short crosscut east from the branch creek. A 9-inch seam of copper oxide and pyrites has been cut through. A crosscut tunnel has been driven to intersect the lode, and at about 30 feet in, this passed through the same graphitic slate as seen outside, but no ore. A drive west passes through what would seem to be the lode formation, but nothing like the fine lode in the cut outside.

The line of lode is a persistent one, and of considerable width, nearly half a chain. The formation must not be looked upon as payable all through this width. The foot-wall portion seems to be that in which payable ore is most largely developed, though at the same time there are bands of ore elsewhere in the formation which will make frequent crosscutting necessary. The ore deposition partakes of the irregularity which characterises most lodes, but the large quantities of oxidised ore indicates the probability of a strong pyritic lode at greater depth. The mine cannot be done justice to with the present inadequate outlay on development work. According to the returns, the following are the parcels of ore already sent out:—

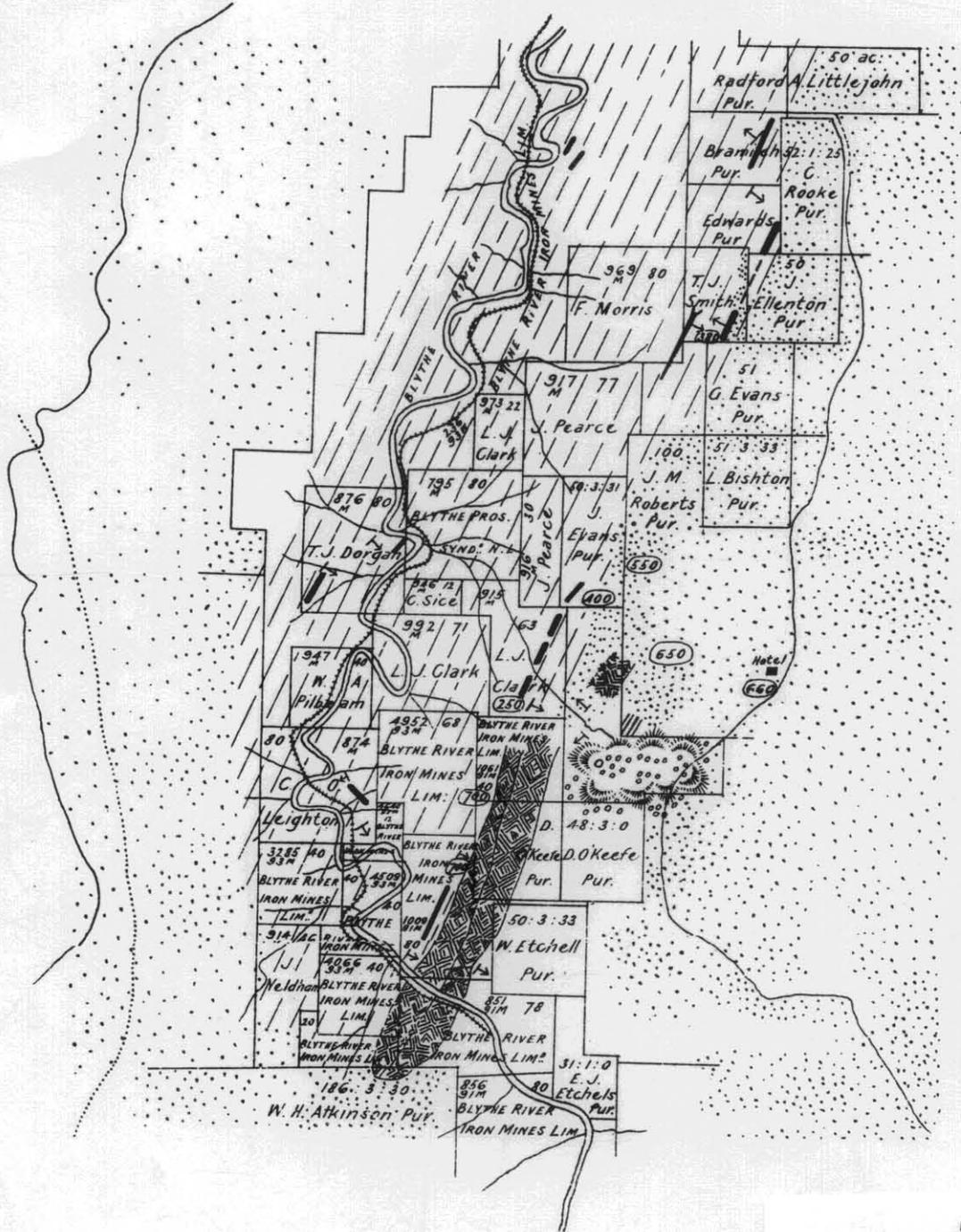
10 tons, assay value	13.7 per cent. copper.
12 tons, "	11.7 "
20 tons, "	13.2 "
20 tons, "	15.0 "
23 tons, "	24.7 "

This represents the result of work on a very limited scale, and with not the best methods. As such, it is encouraging, and points to a line of ore deposition here which invites vigorous work with ample capital for proper

Geological Sketch Map of BLYTHE MINERAL FIELD

Scale of Chains
0 10 20 30 40 50

W. H. Twelvetrees
Government Geologist



REFERENCE

- Basalt
- Slate and Quartzite
- Iron lode
- Copper lodes
- Dial conglomerate
- Heights above sea level (aneroid)
- Dip of strata

development. The success of this mine will produce a marked effect on the field, which otherwise is in rather a languishing condition at present.

Evans' Mine.

The north-east angle of Mr. Clark's 63 acres is close to the south-west angle of Mr. J. Evans' (now W. Evans') 50 acres, near which some mining work is being carried on upon the northern continuation of the Copper King lode line.

Mr. Robt. Short started the work towards the end of last year about 80 feet from the south-west corner of the property, and on the strike of Clark's lode, as far as could be judged from the position. A rather shallow tunnel crosscut has been driven across the slate strata for a chain in a south-easterly direction. A lode formation has been cut at about 30 feet in, consisting first of a few inches of white clay in the roof carrying a little copper pyrites and stained somewhat with green carbonate of copper, but widening to 18 inches in the sole of the tunnel. This gives place to 3 feet of lode slate interspersed with quartz, and on the wall of the lode are a few inches of sugary quartz. In the approach to tunnel there is discoloured material for 4 feet with vein quartz and iron pyrites. The lode was cut in the tunnel at a depth of only 20 feet from the surface, and as 10 feet of the overlying material is soil, there is practically no cover. The drive is under a small creek, and consequently wet. Additional 30 feet could be obtained by going down the creek below the tunnel and bringing in another adit. The present adit has been almost useless, as it does not permit of any reliable opinion being formed of the lode. The samples of lode stuff taken did not yield anything appreciable when assayed in the Government laboratories. The kaolin which borders the lode and the slickensiding which is seen in the slate show that some movement has taken place along the line of mineralisation. The Copper King is about 18 chains south of this. Though there is nothing of importance at the shallow depth at which the lode has been tested, it is possible that if the latter could be reached at an adequate depth better results would ensue; but to do this it would be necessary to go a good way down the hill, when the length of crosscut would be extreme. The point to remember in this proposition is that it is the nearest to the Copper King of all the works along this line.

Up the creek at the camp is some gossanous and concretionary iron ore (limonite) of the kind usually found associated with the basaltic drift of the tableland. Being so near to the occurrence of iron ore at the Blythe, the casual observer might easily take the two as related occurrences. A better acquaintance with the district dispels this idea. The hard white quartz conglomerate found round the camp and lying unconformably on the older rocks is the drift sand which was hardened and cemented after having been covered at one time with basaltic lava. The same formation may be seen at the caves at Howth.

Smith's Mine.

A mile north-east of the preceding, Mr. Smith has been carrying on prospecting operations on a 40-acre section east of and adjoining F. Morris' 80 acres, 969-m. The section embraces the continuation of the Copper King metal-bearing strata, exposed along the western edge of the basaltic farm lands. A small creek rises in the north-western corner of G. Evans' 51 acres purchased land, and flows north-easterly into the section on which Mr. Smith is mining. The basalt land is on both sides of the creek, in the bed of which are the blue clay slates, in which several holes have been sunk. This is at about 380 feet above sea-level. The strata preserve their usual bearing of north-east, but are dipping here north-westerly. The section shown by a cut across the lode formation is 1 foot of quartz on the footwall, succeeded by soft puggy slate in patches, graphitic slate containing lumps of dense iron pyrites, and dark slate with curved laminae, measuring with the quartz 4 feet in width. Seven feet of hard micaceous rock underlies the footwall quartz, and outside this is slate again with veins of quartz and pyrites. The puggy slate in the lode is also veined with quartz. A little copper pyrites is present, associated with carbonate of iron and quartz.

Thirty feet north of this, a cut failed to pick up the lode. A little lower down the creek two cuts have been put in in opposite directions. The western one, which goes into the bank below the basalt, has only passed through slates. The east cut is an excavation of about 9 feet in indurated micaceous slate with thick veins of quartz in it, and very dense iron pyrites along the planes of parting. There is no copper here, but quartz a few yards to the south-west carries a few specks of copper pyrites.

The great development of iron pyrites is a feature of this formation, but there is very little copper. The samples which I took were assayed by the Government Analyst, with negative results. The lode can be prospected by sinking or by crosscutting further up the creek, but before undertaking the latter, it must be ascertained whether the lode does not cross the creek, as there is some possibility of it doing. The question is, whether there is any likelihood of copper ore coming in in depth. At present the quartz exposed has only a few specks of copper pyrites in it, and the absence of staining and oxidation is not a favourable indication. There is undoubtedly plenty of evidence of lode action, and though there is not much to encourage one, the possibility of copper deposition at a greater depth or somewhere else along the course of the lode always exists.

A good deal of ironstone cement exists on the hill to the west of this creek, and about 2 chains in width of this gossan-like cement overlies a tunnel which has been driven south-westerly into quartzite along a quartzose and quartz lode carrying abundant iron pyrites, but no copper. The underlay of the strata here is to the east, and the lode is perhaps more directly on the strike of the Copper King than the eastern workings in the creek are. The ferruginous cement on the surface is locally believed to be lode gossan. This is a mistake. It has nothing to do with any lode which may chance to be below it, but is the cemented sub-basaltic drift so frequent all over the district. Just west of it the basalt covering still survives in a small patch.

Edwards' Mine.

This is on a 40-acre section immediately north of the preceding, and west of the purchased lot, 52 acres, in the name of G. Rooke. The strata and lode formations are the prolongations of those on the section to the south. Messrs. Edwards started operations down on the bank of the creek on the eastern boundary of the section about a year ago. A tunnel has been driven east across slates veined with quartz for a distance of nearly 40 feet. At the entrance is a seam of soft slate mixed with quartz, then the tunnel passes through hard quartzose country, and again into slate. A little ore has been got in driving (copper pyrites). An excavation in slate south of the tunnel has given a little native copper, and but for this indication, the drive would not have been put in here, but

higher up the creek, where some copper pyrites has been found. Up the hill is a broad band of gossan-like iron ore, which, however, contains no valuable metal, and is probably of the same origin as the other occurrences of concretionary ore in the district. Mr. Edwards' mine appears, by position, to be on the continuation of Mr. Smith's eastern show. Though the line of mineralisation right through from Rutherford's is a long one, it does not follow that one and the same lode continues through without interruption. It is more likely that the lode shoots tail out and separate ones start, not exactly on the same line, but on parallel lines, the whole, however, forming a mineralised belt which is continuous all through these mining sections.

Behind Mr. Edwards' farm and below the basalt, a belt of hard grey conglomerate is exposed in the bank descending to a creek. The rock contains iron pyrites sprinkled through it rather plentifully, and a little copper pyrites is said to have been found. The rock is very siliceous, and contains numerous white quartz pebbles and some jasperised stones. There is not enough of it exposed to show the relations of this bed, and it is too isolated an occurrence to justify any definite statement about it as an ore-bearing stratum, but search should be made for a lode along either side of it, as it is not likely that a rock of this hardness will be fissured very much.

Farther south, where the road passes through O. Allen's 100 acres, boulders of the Dial Range conglomerate are seen by the wayside, and a small hill to the west is composed of this rock. This is the only patch of these conglomerates which I have seen in the district. I was told, however, that they extend further south on the east side of the Blythe iron outcrop.

Bramich's Mine.

This is on the 40-acre section north of Edwards' mine, and west of and adjoining G. Rooke's 52 acres, purchased land. A turn off from the main road leads through scrub down to a small creek about 100 feet above sea-level, where work was started a year ago to pick up the line of the Copper King lode. A small drive has been put in for about 18 feet, across dark slate and seams of pug with splashes of copper associated with carbonate of iron and a little quartz. The last 4 feet are in smooth slate, locally called schist. The drive was intended to intersect some

copper-bearing slate seen in the creek about 30 feet further north. Further down the creek another cut shows a band of black slate with veins of quartz carrying iron and copper pyrites; a few more cuts have been put in still lower down the stream. One of these is in hard quartzose rock traversed by veins of quartz and carbonate of iron, carrying splashes of clean copper pyrites here and there. The right course has been pursued in crosscutting into the belt at intervals along the creek, in preference to sinking at one spot.

No body of ore has been discovered, but a good deal of mineral is scattered through the rock in these workings, and it may well be that there is more ore in the neighbourhood. It is intended to go about 50 yards further down, and crosscut through the formations for 100 or 150 feet. This seems feasible, and should be a useful test.

Up the hill to the west a belt of the white Tertiary quartz conglomerate is met with, and still higher is a large spread of gossanous material covering Tertiary drifts and lignite with impressions of twigs and leaves of European trees. The lignite is highly sulphurous, with decomposing secondary pyrite.

A tunnel has been driven into the side of the hill below the gossan at 80 or 100 feet above the creek, exposing 2 inches of pipeclay resting on 7 feet of brown clay and lignite, the whole lying on the upturned edges of schistose bed-rock. The dip of this formation is away from the present creek, showing that the latter has carved out its channel subsequently. The gossan has been mistaken for a lode capping.

North of this section is one held by Mr. Radford, taken up presumably for position. West and south-west between here and the Blythe River the ancient slates and quartzites are exposed, and several discoveries of mineral have been made, which at present are not receiving much attention, pending developments on the field.

Heybridge Mine.

After leaving Bramich and Radford's claims, the Copper King line of lode passes below the basaltic farm lands, and the next trace of any lode action visible is met with at the Heybridge Mine, between the road and the railway, about 15 chains inside the east boundary of Heybridge township.

Along the sea-beach slate and quartzite strata are exposed, striking north-easterly and dipping north-west-erly. No eruptive rock is shown. These are impreg-nated with iron pyrites and a little copper pyrites. The pyrite is distributed abundantly on joint faces, as well as scattered through the solid rock. South of the railway an open cut has been driven across the slate, &c., but the deepest level reached by this is not below sea-level. A seam of pug traverses the beds from west to east, varying from 3 or 4 inches to a foot or 15 inches in width, and carrying some copper pyrites. From its direction this cannot well be the main ore channel, unless it is bent out of its course. The lode minerals, quartz and carbonate of iron, are present in the formation, and there is no doubt that a lode channel exists. This is, however, the wrong place to work on it. It must be sought in the hill, and reached under sufficient cover to ensure it being beyond the reach of surface agencies.

About 250 feet above sea-level, on the hill behind this outcrop, the indurated slate carries between its lines of transverse jointing some carbonate of iron with a little iron and copper pyrites. This line, however, would run out to the beach at the point east of the Heybridge Mine. On this hill the strata dip to the south-east.

On this range, east of the Blythe River, are some super-ficial workings in the Tertiary gossanous cement so often referred to in this report. The first place is on the brow of the hill, where the gossan forms a thin crust overlying the quartzite bed-rock. On careful scrutiny it will be seen to contain small waterworn pebbles. A little way back a trench has been cut down a few feet through the gossan and into underlying pipeclay. Further along, towards the sea, the gossan has been cut again, and shown to be merely a shell.

Just outside the township boundary and 100 feet up the hill facing the sea is a cemented iron ore formation which belongs to the basaltic series of gossans and breccias. The deposit has certainly no connection with the Blythe iron outcrop or any other lode. These beds have been a fruitful source of misunderstanding.

On the hillside overlooking Heybridge Creek and Howth railway station the sub-basaltic gravels and conglomerates are well exposed. They form here small cliffs about 25 feet in height, in which caves have been excavated by natural agencies. The summit of the hill at one time was capped with basalt; at present the superficial covering is either

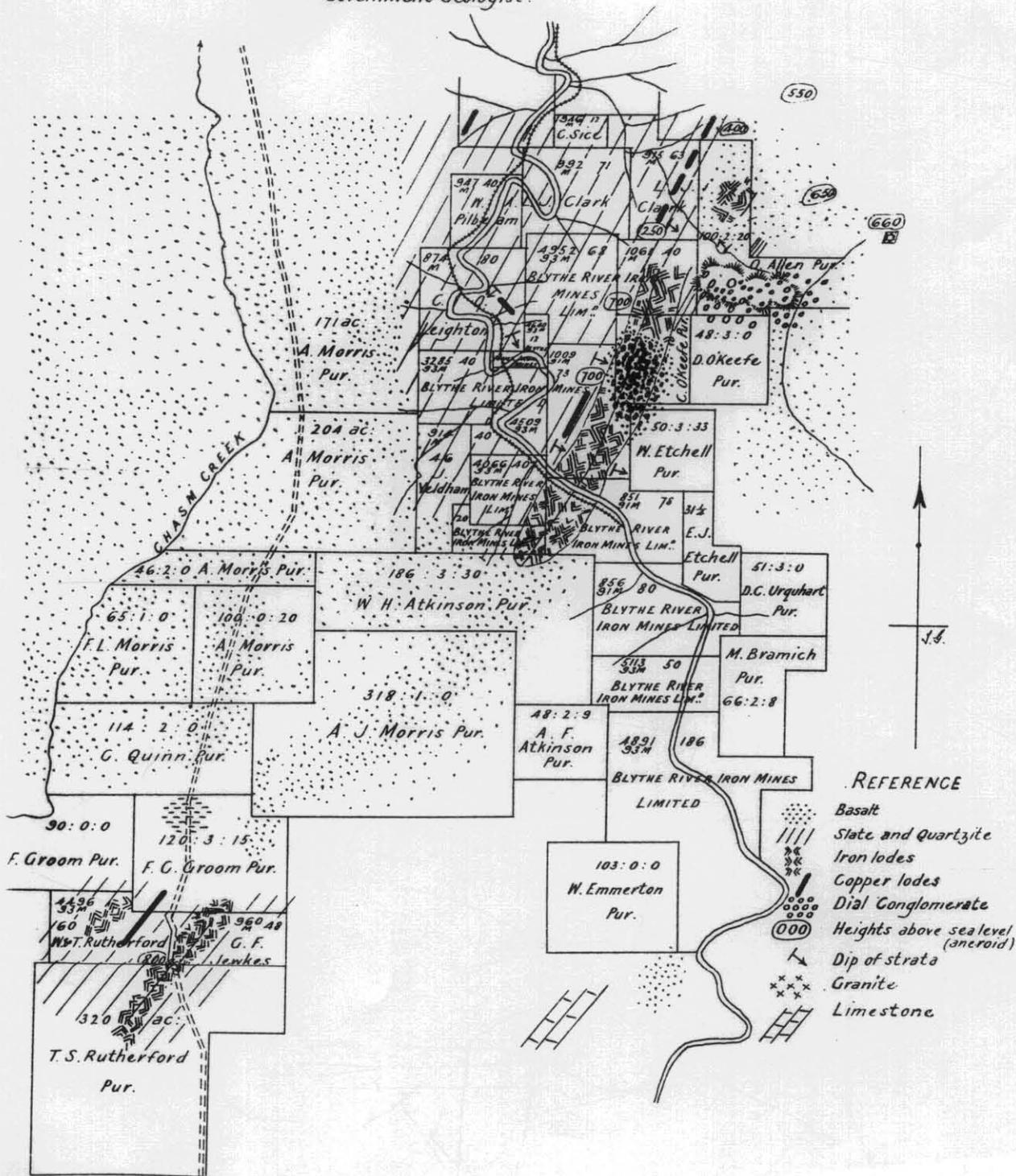
Geological Sketch Map of BLYTHE MINERAL FIELD

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20 15 10 5 0 10 20 30 40

Scale of Chains
W.H. Twelvrees
Government Geologist.



REFERENCE

- Basalt
- Slate and Quartzite
- Iron lodes
- Copper lodes
- Dial Conglomerate
- Heights above sea level (aneoid)
- Dip of strata
- Granite
- Limestone

sub-basaltic gravel or quartz conglomerate, or gossanous material, and in the Howth cliffs below this, heavy shingle wash is seen resting on hard white quartz conglomerate, all of Tertiary age and lying on ancient quartzite. The conversion of these loose sediments into hard siliceous conglomerates is instructive. It is difficult at first to realise that they are not rocks of far higher antiquity.

Manganese at Mouth of Blythe River.

On the beach east of the mouth of the River Blythe there is a blow of manganese gossan, which lies about in lumps over a wide area, though the main outcrop occurs as a reef-like mass of boulders. If it were a reef, it would enter the hill behind McKenna's hotel; but it is improbable that the occurrence is anything other than a deposit. Manganese, removed from older rocks in minute quantities is precipitated as a hydrated peroxide from solutions derived from decaying organic matter. It is found on the beach at the mouths of several streams on the North-West Coast, but mostly impure, or when pure, in insufficient quantities to be of economic value. It is devoid of gold or silver values.

Blythe River Iron Mines.

The huge outcrop of hematite on this property is still unworked. I visited it again this time, to see if a renewed examination would suggest any additional conclusions to those expressed in my report of 30th January, 1901. I do not see any reason for modifying my then stated opinion of the value of this deposit of iron ore, based upon its outcrop and the results of the exploratory tunnels. The mineral discoveries in the district during the last few years have, however, made it highly probable that the ore-body is the result of lode formation, and indeed, directly associated with the granite to the south. Although it has copper lodes as neighbours, there is reason to believe that it is an independent primary mass, and not derived from the oxidation of iron or copper pyrites.

Alluvial at Upper Blythe.

Two miles higher up the Blythe than the iron outcrop, Adams' Creek, rising at Riana, falls into the Blythe River, cutting through a deposit of Tertiary gravel. On the south side of the creek, on Mr. D. Wescombe's property, it is associated with the usual sub-basaltic pipeclay. On

the north side, Mr. Peter Price has put a cut into a terrace of sand and felspathic clay, about 40 feet above the flat ground; and a little higher up the road the wash is exposed in the drain, where it is also very kaolinic in nature, evidently derived from granite not far off. In fact, the granite country comes in a mile further up the Blythe, extending in one direction west to the south of Rutherford's and in the other south-east to the southern boundary of Riana township. This wash, being so near the granite, might be expected to be charged with gold or tin. Some of it shows a colour or two of gold, but nothing at all encouraging. However, it is not impossible that in places better results could be obtained. This is an ancient body of wash, which was deposited before the outflow of the basalt which caps the surrounding hills, and has been cut into and much of it carried away by the modern Adams' Creek. The height of the creek here is about 200 feet above sea-level.

The river flats on the bank of the Blythe are formed of modern shingle and wash. West of the Blythe, on Mr. Edward Addison's 314 acres, I was informed that beds of limestone exist. These would be useful in the event of any local iron ore smelting being started.

Alluvial Ground at Primrose Park, Howth.

On this estate, situate up the Nine-mile Road from Howth railway station, and on the divide between Heybridge Rivulet and Sulphur Creek, the creek east of Mr. Taylor's homestead exposes a bed of clay charged with carbonaceous matter and imprints of Palæogene leaves. This deposit has been sunk into 6 feet without bottoming. On the east side of the creek the bank has been cut into, and shows about 4 feet of conglomerate or cemented wash below 10 feet of pipeclay and grey clay.

A quarter of a mile to the south of this, Mr. Cameron put in a couple of cuts in the bank on the east side of the creek in yellow and red clay, carrying two flat seams of iron and manganese oxides.

These workings are in the sub-basaltic formation, in which no lode can be expected to exist. The lumps and boulders of siliceous chalcedonised rock occurring in the farm soil belong to the same formation, together with boulders of brown and micaceous iron ores ploughed up or occasionally rooted up by falling trees. The height of the basaltic tableland here is 350 feet above the sea. Descending from the house to the road, the bed-rock of white sandstone and

soft schist is exposed, showing a strike of N. 70° E., with a dip to the north-west.

The sub-basaltic drift is distributed so generally over the coastal tableland from Rocky Cape to Ulverstone, that the discovery of leads or gutters in it is no easy task. Its exposure in existing creeks is merely accidental, and no indication of a channel at any of the particular points where it is found. Its general deposition is more likely to have been due to estuarine or even marine action than to rivers, though earlier gutters may possibly be still concealed in it here and there. It is these gutters which will probably yield payable gold, and not the general drift layer, which has filled up the old channels and been uniformly distributed over the country.

In concluding my remarks on this part of the coast, I repeat my impression that the Stowport-Blythe field gives fair ground for hope that in the future it will become an established seat of copper mining. The mineral-bearing series of strata are there, and there are plain evidences of lode action, and modest shipments of quite nice copper ore have been made. The two premier mines have shown lodes which offer every encouragement for deeper mining. In spite of this, a drowsy air pervades the field, and every one seems to be waiting for something to turn up. What is wanting to revive the springs of action is capital. The undertakings are very imperfectly financed, and will really be a hindrance to the progress of the field rather than a benefit, unless adequate funds are provided for working in a proper manner. The splendid farm lands in the neighbourhood will be of great advantage to the mines when the latter are established; but in the prospecting stage they are rather the contrary, for the district is inhabited by farmers, whose chief attention is rightly directed to agriculture, and not by miners and prospectors who would overrun the country and doggedly tear every outcrop and indication to pieces in their search for mineral. To the agricultural community this is new work, and besides, they cannot afford the time. There can be no doubt, however, that fresh discoveries are to be made in country so promising as this is. Meantime, the development of those which have already been made is greatly to be desired.

Eventually, too, the iron and steel industry, which is destined to derive part of its raw material from the Blythe deposits, and to be an important factor in the future commercial prosperity of the State, will draw increased attention to this part of the North-West Coast.

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PENGUIN AND DIAL RANGE.

Tasmanian Iron Company's Mines.

The deposits of red hematite are still worked by Mr. J. C. Ellis, though severe Australian competition has been encountered, in consequence of which the output is temporarily reduced to about 150 tons per week. The grade of ore shipped has been maintained at 67 to 68 per cent. without difficulty. The known deposits extend for $1\frac{1}{4}$ mile along the creek in the form of boulders and nodules of hematite from creek-level up to the edge of the basaltic tableland, and constitute a mass of iron ore of great purity. The ore, as mined, is shipped to New South Wales for flux in smelting furnaces. The nodules strongly suggest the transmutation of pebbly beds of sediment to iron oxide, and the question is whether these beds belong to the Dial Range conglomerate series or to some other similar strata of later age. I am disposed to think it quite possible that they may belong to the gravel and conglomerate wash series underlying the basalt; and hence, may extend below the farm lands for a great way horizontally, though probably nowhere deeper than 200 or 300 feet below the surface.

Along this coast we have at least four different sources of iron ore, and it is necessary to recognise these sources before it is possible to properly appreciate the occurrences. First, there is the outcrop at the Blythe, which may be regarded as a primary derivation from the granite. Second, the Iron Cliff outcrop, which is a hydrated ferric oxide derived from the decomposition of iron pyrites in all probability, and forming the cap of a lode containing metallic sulphides. Third, the iron conglomerate near the top of the Dial Range, where the pebbles of the Devonian conglomerate have been converted to more or less pure hematite. Fourth, the nodular iron deposits of the Penguin Creek, assumed to belong to the sub-basaltic beds of gravel and conglomerate.

Thus, it is of no use to connect these deposits with one another, as is sometimes done, for they are distinct in origin. When the iron industry is started, some of these Penguin deposits will be available, and will contribute in no mean degree to the total output.

Dial Mine.

The old tunnel on Section 3190, driven north, has been abandoned, as well as the one driven south on Section 3188, and a new low adit has been started on Section 3189,

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about 20 feet below the south tunnel and at right angles to it, being driven 130 feet S. 70° W. The rock through which the drive passes is, or has been, a crush breccia of a granitic or quartz porphyry nature, which has been developed at the contact of the granite with the slate. At the entrance it has been reduced to a light-coloured clay, and it continues soft for about 100 feet in the tunnel. It then becomes harder, carrying grey and dark patches of pyritic rock and white clay. In the end seams of iron pyrites pass down the face. This clay is not argentiferous, and the pyrites does not contain any precious metal. The idea is to drive right across this breccia formation to its contact with the slate on the west. It is at the contact that the best chance offers of finding lode minerals of value, but the unfortunate feature in these drives is that they are not very deep. However, if anything like a lode is met with, it can be followed into the hill. From the appearances in the various drives, it is not probable that anything of importance will be found far from either margin of the broken country. This shattered zone of rock is 500 or 600 feet in width. There is, however, always the likelihood of a strong deposit of copper being found in depth, and this property will never be satisfactorily tested without deep sinking. Some fair assay returns for copper were obtained from ore from the old shaft on the north section in 1898-1900, which would warrant the belief that payable shoots exist in the pyritic formation. The iron pyrites is especially abundant. It is crystalline, and good cabinet specimens can be obtained. Its precious metal contents are variable, being from traces up to 1 dwt. 15 grs. gold per ton; silver, nil. The same variability exists with respect to the copper pyrites, in which usually traces only of gold are found, and from 15 dwts. to 3 ozs. silver per ton. This ore is often faced with a film of black oxide of copper. The general looseness of the formation makes it possible that a good deal of metal has been removed in solution, and will be found in concentrated form at a greater depth.

Revell's Workings.

On Section 2880-93M, and on the east side of the Dial Creek. The country is part of the same brecciated contact belt as exists at the Dial and Keddie's mines; but the precise width of the formation here is not known. Granite is known to the east, and slate exists to the west, and this significant band of broken, mineralised rock lies between.

Mr. Revell has driven a cut into the hill in a south-easterly direction for 20 feet into the decomposed rock, which carries here iron gossan veins. Where any fresh rock is seen, it is of a quartzose, hornstone-like, and sometimes even of a granitic appearance, and extremely hard. The granite is evidently not far off. There is none of the friable formation which prevails at the Dial Mine, and driving, once the work advances under cover, will probably be slow. Backs of 100 to 200 feet can be obtained by extending the drive into the hill. The lode lies flat—about 45°—and is a good deal stained with blue and green carbonate of copper. The country-rock contains large included fragments, and is blocky, with large heads. Some of the gossan has been copper-bearing, and it would be worth while proving the formation, by driving into the hill. If anything encouraging were met with, the lode could be further tested by sinking near the Dial Creek.

A little further up the creek is a development of hornstone with iron and copper pyrites on the joint faces. The rock is excessively hard, and not favourable for much ore deposition.

A chain further up the stream another cut has been put in; also in hornstone breccia, showing nice-looking gossan and copper stains. This contact-line has been traced still further south, but its boundaries are undetermined, and until they are ascertained, work will necessarily be uncertain, and, in a measure, at random.

Contact lodes such as these are often rich, but always irregular and expensive to work. The lode action which is disclosed on these contact properties at the Dial has been extensive, and the poverty of so much mineral suggests leaching and re-deposition of the valuable constituents at a lower level. This consideration points to the necessity for deeper exploration than has been as yet contemplated. Shallow working cannot be expected to throw much light on the deposits.

Rogers and McKenna's Mine.

This was formerly known as Hardstaff's mine, and is situate south-west of the 104 acres purchased by W. Russell, west of the Leven, 3 miles south of the Dial Creek.

The lode outcrop on the side of the hill, one of the slopes at the base of Mt. Duncan, bears north-easterly and dips north-westerly, at an angle of 45° or 50°. It is in granite rock, and occupies a fissure from 18 to 21 inches wide.

The lode action has altered the granite on each side for about 4 feet, producing a quartz wall-rock, which borders the lode proper. The lode itself consists of quartz and carbonate of iron, carrying iron and arsenical iron and copper pyrites and glance.

About 50 feet below the outcrop line, a crosscut adit has been driven north-westerly into the hill for 200 feet in granite, and at 108 feet in a small lode of carbonate of iron, copper, and iron pyrites, only a few inches wide, was intersected and followed south for 20 feet. The lode passed out of the drive, and the face now shows only barren country. The main adit was then deflected north, to follow a rock face which was believed to be the lode wall, but as nothing was found, its course was brought back to a north-westerly bearing, and driving was continued in the hope of the lode still being ahead. After taking measurements, the conclusion was forced upon me that the lode cut in the adit must represent the one which crops out at surface, and which has suffered a temporary pinch. The owners have now continued sinking the outcrop winze, and intend to drive south from it. At about 30 feet down I am informed that the lode has widened out to 2 feet 6 inches, and carries veins of rich ore. Some samples sent up from the mine and taken from across the lode in the winze were assayed by Mr. J. D. Millen, A.S.T.C., with the following results:—

No. 1.—Copper	19.48 per cent.
Silver	12 ozs. 15 dwts. 1 gr. per ton
Gold	Nil
No. 2.—Copper	6.49 per cent.
Silver	17 ozs. 19 dwts. 8 grs. per ton
Gold	Trace

Samples of the iron pyrites from the outcrop returned 1 dwt. gold per ton in the Government laboratories, and I believe some of the copper pyrites went higher than this. Ore of the above quality, say, averaging '13 per cent. copper, would return the owners about £4 per ton, less the cost of transport to the sea-coast. What is wanted, of course, is that the lode should widen a little and carry a continuous and good shoot of ore. From the outcrop it is difficult to say how the lode will behave in depth. The question can only be settled by actual work.

The country south and east of this mine is unalienated mineral land, and 3 miles south are the copper deposits on Walloa Creek in metamorphic slate strata striking north-easterly and dipping south-easterly. The whole district

bordering the Dial Range on its east side has been imperfectly prospected, and the discoveries which have been made have been imperfectly developed.

PENGUIN COAST-LINE.

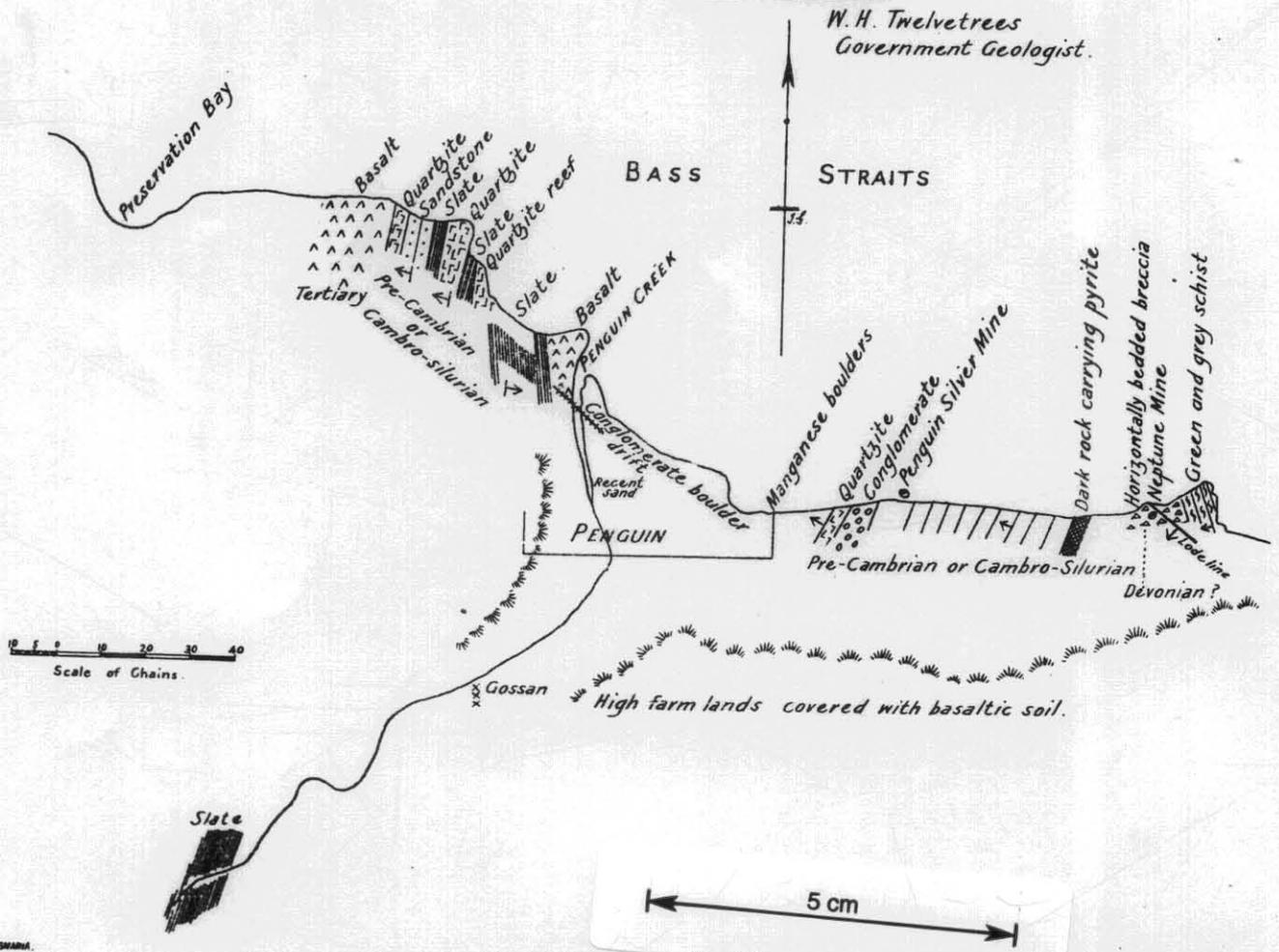
The old Penguin and Neptune mines are still in their abandoned state, and I doubt whether any renewal of work would be judicious, unless at a reasonable depth. The country-rock is meshed with veinlets in a way which debars profitable work at the depths at which mining has been carried on here, and the only chance is by getting down below this fractured zone and proving the lode channel in depth. The constant percolation of water has probably assisted in taking the richer elements of the lode to a lower level, besides which, the lode channel will most likely be better defined lower down. The variations in assay returns point very strongly to leaching having taken place. Shafts sunk 300 or 400 feet would give access to the formation at a depth which would disclose its real nature. These beach mines attract the attention of every one travelling along the coast, and one hears fabulous tales of their silver values. When one examines the outcrops and all that there is to see above ground (for the underground works are flooded), the impression left is not encouraging. But the case is not so bad as it seems at the first glance, for drives only 50 and 70 feet below the surface do not prove anything. They might just as well have not been driven for all the results to be expected. From the work done, however (especially by Mr. Ellis, at the Neptune Mine), we see that the ore yields about $\frac{1}{2}$ oz. silver per unit of lead, which is a low silver ratio. Mr. Montgomery's samples returned nearly 3 ozs. silver per unit of lead from the Penguin Silver Mine, but the ore was unusual, for it contained 2.5 per cent. nickel and 0.8 per cent. cobalt. We have really nothing but shallow burrowings and impoverished outcrops to base any calculations upon, so that I do not see that there is as yet any reason for despair.

Parson's Outcrop.

Mr. Parsons has an outcrop of nice-looking gossan south of M. Clarke's 33 acres on the Penguin Creek. It consists of ferro-manganese and limonite, but the samples which I have tried do not contain any precious metal. This discovery seems to be on the strike of an ironstone reef running out to sea west of Penguin Point. It is apparently

Geological sketch Map of Coast Line at PENGUIN

W. H. Twelvetrees
Government Geologist.



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a replaced quartzite. At some points in its course it is not at all unlikely to be auriferous.

From the preceding, it will be seen that there are potentialities in the Penguin and Dial Range district, possibly convertible in the future into actualities. Sooner or later the iron deposits will be more valuable than they are at present, and any successful work, either on the beach lodes or in the ranges, will give a powerful stimulus to the district. The district lies at present in the backwater of the stream of exploratory and industrial mining, but there is really nothing in the surface indications or in the shallow work results to forbid, but on the contrary, a good deal to warrant, the expectation that more thorough exploration and deeper work will reveal payable copper and silver deposits at more than one point in this rather wide area.

FORTH.

Basaltic agricultural land caps the hills on either side of the Forth Valley. The volcanic sheet, however, forms only a thin covering of the ancient rocks, which have been cut down into by the stream and are exposed on both sides of the picturesque river gorge. The country has not been surveyed geologically, and hence the stratigraphic relations of these rocks are not known, but from their lithologic characters and aspect there is reason to believe that they belong to our most ancient series, viz., Pre-Cambrian.

I spent a day at Hamilton-on-Forth in 1903, and another day on this journey, and in this space of time could only cursorily note the geological features of the country, which, however, are replete with the interest which necessarily attaches to the ancient foundation rocks of the island.

Opposite the township, and on the west bank of the river, is a crag of white quartzite, forming a belt flanked on the west by mica quartz schist, which runs north and south and dips westerly. About $\frac{3}{4}$ mile south of the township is an intrusion of serpentine rock about 200 feet wide, which seems to follow the general strike of the country, a little west of north, as it re-appears on Mr. Smith's estate of Westwood, near the coast. Half a mile further south a beautiful garnetiferous hornblende schist is seen in Mr. Field's garden along the road, and $\frac{1}{4}$ mile further a reef 6 feet wide of flesh-coloured vitreous quartz occurs at the water's edge in the same band of schist, which is here very ferruginous and specked with iron and copper

pyrites. At the Devonport waterworks intake on the Forth is a dyke of felspar porphyry* of reddish-brown colour, about 3 chains wide. Immediately south of the waterworks building slate comes in with a N.-S. strike.

Cooper-Smith's Iron Formation.

This is on Mr. Cooper-Smith's farm, a mile north of the waterworks. Near the farm-house is an outcrop of ferruginous quartzite, forming an iron ore deposit exposed for about 25 feet in length by 10 or 12 feet in height, and another outcrop, rather impure, occurs on the low flat to the west. East of the quartzite, the strata consist of soft, wavy schists, with laminæ and eyes of quartz, changing in parts into graphitic schists. On this bed-rock floor of schist and quartzite rests a body of wash with large rounded stones. Colours of gold are obtainable in this wash and the river bed. The high flat field to the east is all wash. Basalt caps the hills on either side of the river, and careful examination would no doubt make it possible to distinguish between the older drift, which was once protected by the basalt covering and the modern shingle of the River Forth. The older wash might very well contain a payable run of gold. The lower flat bordering the river is probably modern.

The iron ore is too impure for economic purposes, and is so irregular in its segregation that sufficient quantities could not be relied upon with any degree of confidence.

About 300 yards south of the house is a gossan formation in the bank of the river, which is said to pass over to the western bank. It looks very much like a lode. The rock in which it occurs is not visible, but micaceous schist or quartzite exists between it and the other iron ore. The outcrop is not opened up sufficiently to see exactly what it is.

Barrington Copper Mine.

This is situate about 3 miles south of the angle made by the junction of the River Wilmot with the Forth, and is reached by a foot and bridle track through the bush from the bridge at the junction. South of the bridge, the rock is an ancient metamorphic sandstone or greywacke of a massive habit, somewhat simulating an eruptive rock. It extends for some distance. The mine was started

* Felsite-porphyry (Rosenbusch) = a variety of quartz porphyry, in which the porphyritic crystals are felspar, not quartz.

twenty-five years ago by a local company, consisting of Barrington, Don, and Forth people, and registered February 15, 1881.

A tunnel has been driven into the hill at creek-level for nearly 400 feet in a north-westerly direction on the course of slate strata (dipping south-westerly). The end has passed under an outcrop of gossanous slate occurring a couple of hundred feet higher up the hill, and on which a shaft has been sunk for 30 feet. The end of the tunnel is upwards of a chain north of this gossan, but no lode has been intersected. Three crosscuts have been driven from the tunnel at intervals in a south-westerly direction. These crosscuts have touched a parallel belt of hard pebbly sandstone or breccia, which is also seen outside the tunnel entrance to the west. The first one intersected a flat vein, 1 foot to 1½ foot wide, carrying a little copper pyrites associated with baryta and siderite, as well as vughy quartz. This was followed for some distance by a drive parallel to the tunnel. A crosscut 50 feet ahead of the end of this drive failed to pick up anything; and a crosscut was driven from the tunnel north-easterly to see whether the mineral continued in that direction. Nothing, however, was met with, beyond a little baryta and specks of pyrites. I am told that 9 cwts. of copper pyritic ore was obtained.

Higher up the hill beyond the gossan outcrop is another occurrence of gossan, on which a shaft has also been sunk, but has passed through it. A small cut to the west has also traversed it. It has a nice appearance, but is apparently superficial and irregular. It is in slate country, and near the conglomerate or breccia contact. My samples, assayed by the Government Analyst, yielded neither gold nor silver.

The occurrence of mineral here cannot be well understood without a knowledge of the geology of the country west of the breccia formation, as the latter may possibly be a shattered contact zone bordering an intrusion of some eruptive rock. In that direction there is a rock stained green with chrome, but it is too badly preserved for identification; still further west I was told there is gabbro, and then slate succeeds again.

About 300 feet above the creek is a boss or crag of pebbly quartzite, with segregations of quartz. And at the crown of the hill, Mr. Leslie Smith has sunk 9 feet into a favourable-looking gossan, which, however, has probably

been derived from the country-rock, into which it seems to merge. Samples assayed in the Government laboratories gave negative results for gold and silver.

Some sort of lode action has evidently taken place at this mine, and produced the lode minerals, baryta, siderite, and copper pyrites. The latter may be seen scattered in the breccia, but so far all the prospecting has not revealed anything in the shape of a solid lode. The prevalence of pyrite in the country-rock may account to some extent for the abundant gossan. My examination of the outcrops and work done resulted in an impression far from inspiring, but as said above, there is an unknown factor which may yet lead to some discovery in the breccia belt.

CONCLUSION.

From the above, it will be seen that the North-West Coast is a mineral area, in which certain belts of country occur possessing indications pointing to the existence of deposits of economic value. Mines showing payable concentrations of iron and copper have already been opened at Stowport, Blythe, and Penguin. And there are other places where mineral has been uncovered, but not yet in sufficiently remunerative quantities. With so many indications, surprise is sometimes expressed that not more discoveries are made. But the districts have not had their fair share of prospecting, and when money has been expended, it has often been laid out improperly and uselessly. Work, too, has been intermittent, and often separated by long intervals of time. The districts are also largely agricultural, and do not possess prospectors of the right stamp. The geological conditions for ore deposits are present, and I do not doubt that mines will gradually spring up, but lodes will not be found indiscriminately distributed all over the coast. I have endeavoured in this report to suggest the zones in which search should be made. These ancient rocks are often extremely hard and tight, and not favourable for ore precipitation, except along certain lines of weakness. These lines require to be sought, followed, and examined intelligently and well. Unfortunately, such work takes time, and in nine cases out of ten, is unremunerative from a bread and butter point of view. In the tenth case it is successful, and the reward is not to the discoverer alone, but is shared by the inhabitants of the district as well as by the State at large. It is this sort of work that is wanted on the North-West

Coast. A cursory trip into the bush will not do. Intelligence, perseverance, and financial support are the requisites.

The great granite contact area at the base of the Dial Range is one which is well worth exploration. The reason why such zones of country are specially favourable for mineral deposition is because after the heat generated by the intrusion of the eruptive mass has subsided, the consequent shrinkage tends to leave an open space more or less between the intrusive rock and the rock upon which it impinges. This space is seized upon by the metal-bearing solutions and vapours, which also penetrate the adjoining strata, so that ore deposits are produced not only at the actual contact, but also some distance away. Subsequent earth movements often follow these lines, which have become lines of weakness, and this faulting prepares the channel anew for the further introduction of metal-bearing solutions. The intelligent miner therefore looks upon these contact zones with favour; and it is because the above-described indications are so pronounced at the Dial that a hopeful opinion of the future of the district may be entertained.

The ores of the copper mining field of Stowport and the Blythe are not exactly contact deposits, though the lode action is connected with the proximity of the granitic mass. It is the nearness of the eruptive rock, with all its mineralising signs, which inspires those who are mining here with the confidence arising from the knowledge that they are working in the sort of country which is relied upon elsewhere as favourable.

So many residents along the coast extended to me hospitality and assistance, that I cannot mention them all by name, but I beg here to thank them cordially for their kindness.

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

W. H. TWELVETREES,
Government Geologist.

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