REPORT ON THE MINERAL RESOURCES OF THE DISTRICTS OF BEACONSFIELD AND SALISBURY.

[Four Maps.]

Government Geologist's Office,
Launceston, 13th March, 1903.

SIR,

I HAVE the honour to report having, in accordance with your instructions, visited Beaconsfield in June and October last, with reference more especially to the examination of iron ore deposits and of strata alleged to show indications of the existence of coal seams. An additional visit was paid last month, in order to examine the recently-reported discovery of auriferous conglomerate in the Tasmania Mine and elsewhere on the Cabbage Tree Hill. While on the field, I also inquired into the question of the probable extension of the Tasmania reef into the East Tasmania ground, with the view of ariving at some conclusion as to the depth probably required for bores by the latter company for locating the reef in their property. My report, therefore, will embrace several subjects, viz.:—

1. Deposits of iron ore.
2. Coal measures.
3. East Tasmania and other gold mines at Beaconsfield.
4. Auriferous conglomerate at Beaconsfield.
5. Gold mining at Salisbury, Blue Tier.

Before dealing with these subjects individually, I beg to offer a few remarks on the general geology of the district. The excellent reports written by Messrs. Gould, Thureau, and Montgomery, especially by the first and last (in 1866 and 1891), should be referred to by enquirers.

Asbestos Range.—A traverse from the Asbestos Ranges about 6 miles west of Beaconsfield to the River Tamar on the east shows that several great geological systems are represented in this area, and that the district, instead of possessing a monotonous uniformity of mineral characters, is one of special interest and variety. Beaconsfield has been so long familiar as a gold-producing centre, that the possibilities of the district in other directions are liable to be

overlooked. It is, perhaps, natural that the glamour of the dominant industry should divert attention from the other resources of the locality. The consequence is that outside the established auriferous zone very little serious prospecting has been done.

Thus, it happens that to the west of Beaconsfield, between Anderson's Creek and Port Sorell, the lofty Asbestos Ranges, which form a majestic linear series of mountain heights terminating to the north in promontories at Badger Head in Bass Strait, have been explored in a very cursory way. This almost uninhabited mountain region is cut up into deep ravines and valleys by innumerable ridges and spurs, and its proper exploration would be no mean task. A little copper ore has been found in it, but little or nothing is really known of the conditions under which any mineral is likely to be found in the range.

As far back as July, 1876, Mr. A. W. Loane found specimens of copper pyrites near Badger Head, and in October that year Mr. Adye Douglas, jun., with Messrs. W. Baker and Loane, found traces of copper ore in several places along the coast. A sample of chalcopyrite (copper pyrites) submitted by Mr. Loane in 1877 for assay showed the copper mineral in a gangue of quartz and carbonate of lime with traces of manganese, and yielded 21½ per cent. copper. In 1878 work was started in that neighbourhood on a few claims, the Pioneer or Tasmanian Copper Company, British Lion, &c. Loane and party had a lode reported to be three feet wide, which was covered by the sea at high-water. The ore was of the peacock variety, and one specimen, much water-worn, and weighing 22 lbs., attracted considerable attention. The Tasmanian Copper Company sank a shaft in slate country, with calcite and copper and iron pyrites, to a depth of 70 feet, and good lode-stuff was reported as brought up at the time. Barnard and Traill's claim was a mile north of this. But as no body of ore was met with, the prospecting work, begun with the usual haste and excitement, was not continued, and, deprived of financial support, died a natural death. At this period some further search for mineral was made in adjacent parts of the range, but such is the vastness of the latter that adequate prospecting of the whole would take a life-time.

In 1866 the late Mr. Chas. Gould made a rough traverse of it at Badger Head, and referred to it as consisting of micaceous schists, grits and clay, slates, and to its intricacies as rendering its detailed examination inland a matter of difficulty. I am informed that, so far, nothing besides

copper has been found, though veins and stones of quartz are met with. Two or three shafts have been sunk at the base of the east fall of the range, near its junction with the serpentine country west of Anderson's Creek. I visited one of these, and found that it had been sunk on an east and west reef of quartz, which I could not get down to inspect, but which I judged was a foot to 18 inches wide. The country-rock, from the few fragments outside the shaft, appears to be a hard blue slate. Gold has been reported from these reefs, but the information which I received was conflicting. There would, however, seem to be no reason why these veins should not be gold-bearing. Nevertheless, I am told that no free gold is obtainable in the creeks, and that is an unfavourable sign. Mr. Gould describes the strata as generally foliated and strongly contorted. I did not penetrate the mountain region far enough to recognise these highly metamorphosed beds. They have been more intensely metamorphosed than the Beaconsfield series of slates and sandstones, and *a priori* may be looked upon as likely depositories of ore. The fact that not much has been found in them hitherto is no valid reason for condemning them.

Gould's map shows these ranges as situate north-west of York Town, and extending for only a short distance, but they really form the whole of the mountainous land which extends to the south. A striking view of them is obtained from the Cabbage Tree Hill behind Beaconsfield, the lofty mountain line bounding the horizon five or six miles to the west. The name Asbestos Range is a misnomer, for, as far as I know, neither asbestos nor serpentine occurs in it. It has evidently been so named from its lying immediately to the west of the serpentine belt in which veins of chrysotile or serpentinous asbestos exist.

As the chain is separated from the Beaconsfield Silurian slates and sandstones by a patch of intrusive serpentine country about a mile in width, its stratigraphical relations with the gold-bearing eastern Silurians are not observable. Its lithological aspect (a not altogether trustworthy guide) would lead to the inference that it is older than the latter.

Serpentine.—An exposure of serpentine and serpentinised pyroxenite (a rock consisting of the rhombic pyroxene, enstatite, or bronzite) occupies the valley of Anderson's Creek for nearly four miles in a north and south direction, and about a mile in width. I have followed it southwards as far as the south end of Lot 730, Wm. Barnes, and to the north along the western boundary of the Township of

Leonardsburgh. It is in this rock that the asbestos occurs, which has been prospected from time to time, and was worked for a short period by the Australasian Asbestos Company in 1890. The shipments which were made to Melbourne consisted of asbestiform rock intended to be used in the manufacture of asbestic, an incombustible plaster, for which there is a good market in the United States and Canada. It became apparent, however, that a market for this article in Australia would have to be created, added to which the asbestic rock raised by the company evidently comprised too much stone and too little fibre. I pointed out in a previous report that the continuity of the seam which was being worked could not be relied upon, and the work which has been done since shows it to have deteriorated in quality. It is just as likely, however, to improve again with continued work, though it must be expected to prove irregular. It must not be forgotten that for this class of stuff only large deposits will pay to work. The fibre for this need not be long, and as both American and European markets for it are improving, it is probable that in time there will be an Australian demand for it also. Last year the British Fire Prevention Committee made successful tests of gypsine, which consists of compressed asbestos, sand, and hydraulic lime, and is made into fire-proof bricks. Every year the applications of the mineral are increasing, which must result in an increased demand for it.

The world's supply of asbestos comes mainly from Canada, small quantities only being contributed by Russia, the United States, Italy, and Cape Colony. Rothwell's Mineral Industry shows the Canadian output as—

	Metric tons.	*Value.* £
1897	27,617	89,073
1898	21,577	97,245
1899	22,938	96,659
1900	27,797	149,686
1901	34,554	237,287

In the Anderson's Creek area there are two varieties; the cottony long fibrous kind of a matted habit and with fibres disposed parallel to the jointings of the serpentine; and the short fibre occurring in ½-inch to 1 inch veins through the rock, with the fibres transverse to the direction of the vein. Both are the mineral chrysotile, the hydrous and fibrous silicate of magnesia. The anhydrous hornblende

asbestos is not found here. The matted cotton-stone is called locally "asbestic," and the narrow vein-fibre, "chrysotile." The recent prospectors devoted their attention to the narrow veins,, which, however, are for the most part only ½-inch in width, though now and then 1-inch veins are met with. If a width of one or two inches could be obtained, then the fibre would compare with that of the Quebec mines. The great drawback, however, is that these veins intersect the serpentine at far too great intervals. They will not pay to extract individually, and the interspaces of waste rock are too great for the deposits to be worked profitably by open-cut. To establish a profitable industry, either a zone of richly asbestiform rock must be found, or a part of the serpentine where the narrow chrysotile veins are numerous enough to form at least 1 per cent. or 2 per cent of the total rock-mass, which would have to be quarried as it stands.

The large ratio of waste to the marketable product in most asbestos mines necessitates strict attention to economies in working, and these can be best effected when mining on a large scale. The rock has to be blasted, but this is always avoided as much as possible, so as to prevent needless destruction of the fibre. In the Canadian mines large travelling derricks and engines are employed for lifting the blocks of rock out of the quarries and conveying them to the dressing-mills. At Anderson's Creek most of the stone would come from the hill, and could be delivered to a mill by gravitation. In the mill the rock is broken up and the fibre freed from its matrix by screening and blowing. In the Danville Mills there is special machinery for treating the short-fibre material and converting it into asbestic.

The quality of the Anderson's Creek material is fairly good so far as the surface-veins go. Mr. W. F. Ward, the Government Analyst, tested it for the principal impurity, oxide of iron, which he found to be present in the proportion of 7·74 per cent. This is twice as much as is present in the best Canadian, and 2 per cent. more than other recorded Canadian analyses. The effect of this ingredient on the fibre is to diminish its infusibility and to make it rigid and brittle, besides affecting the colour, all of which points go towards determining its market value. Tests which I applied for its strength, elasticity, resistance to acids, and non-conductivity of heat were satisfactory. As regards contamination with iron, I do not attach much importance to tests of samples from near the surface within the range of oxidising waters.

The real crux of the matter lies in the quantity available. A little scratching of the surface has been done here and there over a wide area, but no deposit of any size has been discovered yet. Until it is found, no satisfactory industry can be established. Indications exist in numerous places, but small trials on these spots have not resulted in any discovery of importance. Still it may very well be that the material for a profitable industry exists in this area, and some day may be brought to light.

Some of the serpentine is adapted for ornamental use. It takes a good polish, and an enterprising lapidary could easily create a demand in the State for small articles. Large surfaces cannot be found free from cracks.

Formerly this serpentine mass was considered as probably very ancient, but the present evidence points to it being younger than the Silurian and older than the granite of our State.

On the eastern boundary of the serpentine, where the road leads down to Anderson's Creek, grey sandstones and calcareous grits strike N. 30° W., and dip north-east at an angle of 57°. This is close to the contact with the serpentine, but the actual contact is not observed. The plane of contact to the north on Dan's Hill, in the north-west corner of Section 148M, 40 acres, is occupied by a development of chalcedony, containing arsenical pyrites. Some holes have been dug in it, and prospects said to have been obtained. I could find no contact with the slates on the western side of the serpentine.

No gold has been found in the serpentine basin, but large deposits of brown hematite and magnetite ores contaminated with a small percentage of chromite (up to 6 per cent. in my samples) occur in it near its contact with an intrusion of granite rock. No deposits of massive chromite are known here. Mr. T. C. Just says in his notes on the iron ore deposits of the River Tamar district that the chromite is only found at some distance below the surface, and that it can only be detected by the aid of a hand-glass, running in fine threads through the ore. I have not been able to recognise it in any of the ore specimens which I collected. Fibrous or columnar magnetite occurs in veins in serpentine. Lumps of this variety may be found in the surface-soil.

Some chromic, iron, and manganese oxides were worked several years ago in the serpentine on the west side of Anderson's Creek. The Chromate, Asbestos, Paint, and Gold Mining Company worked previous to 1888, and the Native Paint and Oxide Proprietary in 1890-92. The latter

company shipped 500 tons of iron oxide (besides which 1000 tons were sent away from the old Tamar Hematite Iron Company's ground near Brandy Creek). Sale prices were from 27*s*. 6*d*. to 42*s*. 6*d*. per ton. The product was largely used for gas purifying. There seems to be a good deal of ochre surrounding the outcrops of iron ore, and possibly something might be done with it, though, for paints, manufactured reds are now superior in colour and quality to those produced direct from iron ores.

As far as I can learn, osmiridium and nickel ores have not been found in the Anderson's Creek valley.

Granite.—In the serpentine area there is a zone or linear ridge of dark granite rock for about a mile in length and 300 yards in width intruding through the serpentine and rising above the level of Anderson's Creek to a height of 200 feet. The top of this ridge has weathered into a succession of dome-shaped elevations quite characteristic of the rock. Some of these hills on the east side of Anderson's Creek are known as the Settlers. The most northerly outcrop of this dark basaltic-looking rock is about 32 chains south of the old tramway bridge over Anderson's Creek. Thirty chains south-east, on Section 1774, a steep face of it may be observed, where the creek has cut through the hill about 50 yards east of the little wooden bridge. Here the granite separates the serpentine of the asbestos claim on the east from the serpentine of the iron ore mine on Mt. Vulcan on the west. A low saddle or depression separates the granite ridge from Mt. Vulcan. The ridge continues in a southerly direction or S.S.W., rising into two rounded summits, the second about 40 feet lower than the first, and then plunges down steeply into the serpentine flat at the south end of the range 10 or 12 chains west of Anderson's Creek and 15 chains north of northern boundary of Lot 748, 500 acres.. This rock was evidently observed by Mr. Gould, though he does not appear to have recognised its nature, for he marks it on his chart as "Rock altered by contact with serpentine." It also attracted the attention of Mr. T. C. Just, who thought it was a basalt, for he reported that, "at the Settlers there are several very curious mounds of basaltic rock." The dark colour of the rock would readily lead one to suppose that it belonged to the basic division. It is, however, really an acidic rock, consisting of magnesian mica in great preponderance, and quartz and orthoclase felspar in about equal proportions, the whole forming a medium-grained admixture, with a structure resembling that of aplites. Mr. G. W. Card, A.R.S.M.,

Mineralogist to the Geological Survey of New South Wales, determined for me two doubtful-looking crystals of tourmaline in one of the slides, and kindly gave me his determination of the rock, as follows:—

Miner's name.....	Granite.
Ordinary mineralogist's name	Biotite granite.
More precise name for the petrographer	Aplitic tourmaline-bearing biotite granite.

The presence of tourmaline is a feature of interest, as confirming the general reference of the rock and opening up possibilities of tin ore discoveries. No tin ore has, however, been seen in the district, and the most that can be said is that this kind of rock is favourable to its occurrence; a little white mica is also present in it.

The ore with which it stands in some sort of causal connection is the brown hematite and magnetite, which occurs in the serpentine. This ore, though apparently actually within the serpentine, is close to the contact of the latter with the granite. The ore lies as it were up against the granite rock, and having regard to the fact that in other parts of the State magnetite and hematite deposits are often found at or near granite contacts, and that the Anderson's Creek ores are along the linear direction of the granite exposures, it is reasonable to infer that the ore is related in some way to the intrusion of the granite.

In this linear belt there are also several exposures of white granite. It is a binary variety, consisting almost exclusively of quartz and felspar, the crystals of which are frequently intergrown with each other, so as to produce the structure called "graphic," from its appearance in transverse section. The most northerly occurrence which I have noted is a mile north-west of the tramway bridge. Another exposure is on the western side-line of Section 1773-93M, 30 chains west of the tramway bridge (known also by the name of Nichols' Bridge). Five chains further south, outside the south-west angle of the section, it is seen again. On the north side of Anderson's Creek, a couple of chains east of the bridge, there is an exposure of the same rock, about 50 feet wide. About 250 yards south-west of the bridge is an outcrop of stones of the same rock. A small pit has been sunk on this outcrop. A few yards further south similar stones are exposed round the base of a tree. An identical outcrop

appears under a tree two miles further south, on Lot 730, W. Barnes, 640 acres, two chains south of Gale's Gate on the north boundary, and five or six chains east of Anderson's Creek. The enclosing rock there, too, is serpentine. On the slope of the hill east of this are more stones of white granite.

The existence of granite in the serpentine is thus well established, and that it occurs in connection with the iron ore deposits at Leonardsburgh in the north and at Barnes' Iron Hill in the south, is significant. It is almost needless to remark, too, that the proof of the granite in our State being of subsequent age to the serpentine is strengthened by the Anderson Creek occurrences.

West of Lot 730 some chlorite and vesuvianite rock is visible at surface in the serpentine area. There would appear to be a concealed granite contact here, and limestone is apparently not far away.

Silurian (or Ordovician).—The slates, sandstones, and conglomerates of the Beaconsfield series appear in near contact with the eastern edge of the serpentine, where they dip to the north-east at angles ranging between 47° and 57°. Between here and the Cabbage Tree Hill they are generally concealed beneath a light covering of quartz-drift, which lies upon the whole of the surface of the country between this and the West Arm, and survives south also as far as the Ilfracombe Saw Mill. Where exposed, the strata are light-coloured sandstones and quartzites. At the contact with the serpentine, conglomerate is interbedded with the sandstones. The conglomerate of the Cabbage Tree Hill can be traced north of the North Tasmania Mine, and probably extends below the drift still further. The mine-workings in the Cabbage Tree Hill at Beaconsfield and the section in the Blyth's Creek Gorge which cuts through the hill have shown the succession of the Silurian strata near Beaconsfield rather plainly. Setting aside the various faults in the hill, the general succession in ascending order (west to east) may be stated thus:—

1. Lowest. Light-coloured sandstones and quartzites between the Serpentine and the Cabbage Tree Hill.
2. Dark-blue and black slates in south crosscut of the Wonder Mine.
3. Dark sandstones, grits, and conglomerates on the top of the Cabbage Tree Hill and in the Gorge.
4. Grey and whitish limestone in Tasmania and Wonder mines.
5. White sandstone.

6. Dark sandstones and conglomerates on east side of hill.
7. Light-coloured sandstones.
8. Bluish limestone. East end of Tasmania Mine, East Tasmania bore, Dally's United, Blyth's Creek, &c.
9. Dark-grey and green slates. East Tasmania Mine.
10. Grey sandstone.
11. Slates and sandstones concealed below alluvial, and further east below the Permo-Carboniferous beds.

There are minor variations of material in each series, but the above appears to be the broad arrangement of strata. I understand that Mr. C. F. Heathcote, F.G.S., A.M.I.C.E., &c., the General Manager of the Tasmania Mine, is making a geological survey of the Cabbage Tree Hill.

The various bands of grit and conglomerate are well exposed in the Gorge at the south end of the Cabbage Tree Hill, and their relation to the lighter-coloured sandstones which lie upon them eastwards is clearly seen. The Gorge beds strike several degrees more northerly than those at Beaconsfield, and it has been suggested that this is due to faulting. It is, however, quite possible that the difference is due merely to the natural sinuosities of the beds. The same strata continue south of the Gorge, with an average strike of S. 20° E., dipping 40° to 50° north-east, and form the Blue Tier Range which stretches southwards to Salisbury, where the Salisbury and Duchess of York companies are carrying on gold-mining operations. The beds there consist of light-coloured sandstones, dark slates, and conglomerates. The light-coloured rocks are on the eastern side of the range, and give place to the dark ones going west. It is certain that the Tier beds are the southern prolongations of those on the Cabbage Tree Hill.

A thick bed of limestone succeeds the sandstones at the eastern base of the Cabbage Tree Hill. This limestone was cut in the bottom drive of the Ophir Mine, at 460 feet from surface and 330 feet east of the shaft. In Quigley's Well, opposite the Scotch Church in Weld-street, there is limestone at a depth of 14 feet, and the same rock occurs on the English Church allotment at the corner of Weld and Crowther streets.

This limestone has been penetrated 70 feet in the east end of the 700-feet level in the Tasmania Mine, and 374 feet further east was pierced by the East Tasmania bore at 458 feet from surface, and bored into 520 feet 4 inches. Mr.

J. G. Payne tells me that at Dally's United shaft, 500 feet south-east of the East Tasmania bore, limestone was touched in the bottom of the well at 220 feet. The drive south-east for 500 feet was in limestone. A burst of water stopped work there, filling the drive and shaft in less than 40 minutes, and poured out of the shaft at the collar for over three years.

This blue limestone is seen again in Dally's Quarry, Middle Arm Creek (Blyth's), and it would appear to be next to certain that all these occurrences are one and the same set of beds. The thickness of the band where met with in the East Tasmania bore and Tasmania Mine, at right angles to its dip, is 340 feet. A belt of limestone has been driven into by the north crosscut of the Wonder Mine at the 800-feet level. From the angle at which the strata are dipping in that crosscut, this limestone would seem to be bound to crop out at surface about 100 feet north of the shaft. This appears to be the same limestone as that driven into west in the Tasmania Mine at the 700-feet level. To correlate the Flowery Gully and Winkleigh limestone with the Blyth's Creek rock is difficult, though its physical appearance indicates absolute identity. A visit to the Blue Peaked Hill (Sugar Loaf) showed me that the usual dip of the sandstones is reversed there, being to the south-west. Those beds are of the same nature as those of the Blue Tier, which dip in the opposite direction, and it would seem as if those on each range form opposite sides of an anticlinal, the apex of which was once over the flat now known as the Gap, and further south as Flowery Gully. The country between the two ranges is Silurian slate and sandstone. Mr. Gould marked a patch of diabase, which I could not find, but if it exists at the base of the Sugar Loaf it is probably accompanied by Permo-Carboniferous strata. The old Derwent Mine, on a white quartz reef in this valley, was one of the earliest mines outside the Tasmania. At Adams' Hill, south-east of the Blue Peaked Hill, the blue limestone comes in and continues on the Winkleigh road for a couple of miles to the caves on the saddle. This traverse, however, does not show the width of the belt, as the road follows a N.W.-S.E. direction, which is that of the strike of the strata. Further south Permo-Carboniferous mudstones and conglomerates overlie the limestone.

From some calciferous springs in the flat, between the Blue Peaked Hill and the Blue Tier, Mr. Gould thought that the limestone might possibly occur below that plain. If so, the exact connection between the different exposures

is not readily intelligible. But the continuation of the East Tasmania and Dally's Quarry limestone must naturally be sought on the eastern side of the Blue Tier, and the Winkleigh limestone would be a repetition of it, but cannot be a prolongation on its strike, as it is much further east.

The massive exposures of limestone on the road to Winkleigh form a grand asset if any metallurgical works are ever established anywhere in the valley of the Tamar. Immense quantities could be quarried cheaply, and the distance to Beauty Point Jetty is not more than eight miles. If the tramway communication to the port were effected in an economical way, this deposit might be utilised for any metallurgical operations on the North-West Coast. It could be used also for ornamental purposes, for some of it would polish well. It can be recommended to local workers of marble.

Mr. Gould professes to have found evidences of animal life in it in the form of fossils, apparently corals, but nothing at all decisive. It is probable that the Chudleigh and Railton limestones are on the same horizon, and it has been suggested that as those overlie the Cambrian beds of Caroline Creek, the Cabbage Tree Hill auriferous beds may be Cambrian too. An objection to this inference is the absence of any strong unconformability between the sandstones and limestones.

The limestone at Railton (Blenkhorn's Quarries, &c.) contains remains of the shelly parts of cephalopods belonging to the families *Orthoceratidae* or *Cycloceratidae*. Neither of these families go back beyond the Ordovician, so that if all these limestones are of the same geological age, the Beaconsfield limestone cannot be Cambrian, and the sandstone and slate series, of which the limestone forms an integral part, cannot be Cambrian either. The shells of Orthis found by Mr. Joseph Davies in the whitish sandstone of the Tasmania Mine are compatible with the auriferous strata being Ordovician or Silurian.

Specimens of tubular casts from the Tasmania and Imperial mines, and from the hill above the Salisbury Mine, Blue Tier, were sent for identification to R. Etheridge, jun., Esq., of the Australian Museum, and he has very kindly determined them, as follows:—

> "The tubular track on the larger piece of matrix (from Salisbury) may, for the sake of a name, be referred to *Planolites* (Nicholson), a name coined for such problematical markings, but carrying with it no

indication of affinity. The markings on and through the smaller piece (from the Tasmania Mine) are probably fucoid, but I cannot assign a name. It is quite impossible to assign a definite geological horizon to these markings; all that can be said is that they appear to have been plentiful in rocks assigned to the Lower Silurian."

The term planolites has been given to various obscure cylindrical impressions supposed to be casts of the tracks of worms travelling over the surface of sand, but the supposition is obviously doubtful.* In the above we have an opinion on the Beaconsfield "fossils" pronounced by the best authority on the subject.

Permo-Carboniferous Strata.—A great stratigraphical break exists between the highly-inclined Silurian beds of the district and the sandstones, mudstones, shales, and conglomerates of Upper Palaeozoic Age, which have a dip of from 1 ° to 10°, though also in a general north-easterly direction. These Upper Palaeozoic beds fringe both sides of the head of Middle Arm, and extend along its western shore to north of Bowen's Jetty, their junction with the Silurian westwards being concealed by over-lying Tertiary drift. They have a large development on both sides of the West Arm, from Red Hill Point westwards, and re-appear on J. Munro's 640 acres west of the Blue Peaked Hill (Hind's Farm). From here they extend south or south-east to near Adams' Hill, and recur at intervals as far south as Winkleigh, and further. Some fossiliferous mudstone beds crop out in Anderson's Creek south of York Town.

The geological horizon of the series is fixed generally by the fossiliferous beds on the Middle Arm and at York Town. I am told that fossils also occur in the cutting at the end of the old Ilfracombe Tramway.

Mr. R. M. Johnston records the following fossil genera from the marine beds:—Fenestella, Stenopora, Protoretepora, Spirifera, Productus, Terebratula, Eurydesma, Platyschisma, Caupulus, Aviculopecten, Inoceramus, Modiolopsis, Pachydomus, Astartila, Pleurotomaria. These are characteristic of the Lower Marine Series of this system.

---

* See Nicholson, Manual Pal. ed. 2 vol. 1, p. 320 : Zittel, Text Book Pal. (Eastman), 1900, vol. 1, p. 256 : Dawson, on Burrows and Tracks of Invertebrate animals. Q.J. Geol. Soc., 1890, pp. 611-612.

The marine beds at the old Government limekiln on the east side of Middle Arm show a descending cliff section of—

	ft.	*in.*
Laminated marls, weathering greenish ...	10	0
Calcareous conglomerate, fossiliferous ...	6	0
Dark shale, fossiliferous.....	0	3
Calcareous conglomerate, fossiliferous to water-level	10	0
	26	3

The contained fossil shells impart to the stone its calcareous nature. On the west side of the Arm, at Swift's Jetty, white sandstone beds dip to the north-east at an angle of 10°. Further north, at Bowen's Jetty, sandstone, grit, and conglomerate containing fossil wood and obscure crinoids lie on the beach, dipping north-east at an angle of 6°. These grits enclose large pebbles of quartzite and slate.

Sandstones of this age show again west of Inspection Head (Sandy Bay). They stretch westwards from Port Lemprière along the West Arm as far as the mouth of Anderson's Creek, with occasional beds of marl or shale. The same strata occur on the north side of the Arm, dipping 5°-7° north-east, with a north-west strike. The stone is generally soft, micaceous, and ferruginous, showing occasionally the bedding-lines as stripes of yellow, brown, green, white alternately. The prolongation of these strata would come out to the east of the Middle Arm fossiliferous beds, and therefore, geologically, above them. They are also above the fossiliferous beds on Anderson's Creek.

Diabase.—This eruptive rock (dolerite, trap, bluestone, &c.), of Upper Mesozoic Age or at the base of the Tertiary, occurs in several places in the district, and always associated with the Permo-Carboniferous sandstones. It crowns the heights on the west side of Middle Arm, forms Middle Head, Shag Rock, the north side of West Arm opposite Port Lemprière, and as far west as opposite the long jetty at Red Bill Point. On that side of the Arm, just east of Turner's Creek, a point or promontory of diabase exists flanked by sandstone on either side. Flat beds of yellow sandstone on the beach are surrounded by diabase about 40 feet higher, but any actual contact is hidden.

Loose stones of diabase are found in the field south of Hello Creek in J. Munro's 640 acres, Lot 511, west of the

Sugar Loaf; and Mr. Gould records the rock in the flat between the Blue Peaked Hill and the Blue Tier.

This rock, it is needless to say, is useless from a mining point of view.

Tertiary Clays.—The deposits of this age cannot always be distinguished from those belonging to the Recent period, but in some instances we can be tolerably sure that they pertain to the older Tertiaries. For instance, the clays and lignitic material which lie below the basalt at Beauty Point can be put down as Palaeogene (older Tertiary), for we have good reason to believe that the outpourings of basalt in Northern Tasmania marked the close of that epoch, after which the land began to rise again to the elevation at which we now see it. The clays, too, of the deep alluvial deposit along the foot of the Cabbage Tree Hill on both sides and the gravel fringes of the hill a good way up are certainly survivals of the same period. The fruits and leaves found in the clay of the Ophir lead (Spondylostrobus, Plesiocapparis, Platycoila, Cinnamomum) were determined by the late Professor McCoy, and recognised by him as identical with those occurring in the auriferous deep leads of Victoria. It must be admitted, however, that some of the species are also found in the Victorian Upper Tertiaries. Cinnamon leaves are very characteristic of our Tasmanian infra basaltic clays, and these give us clear information as to the age of the Ophir alluvial. This deposit descends there to a depth of 400 feet below surface, or 300 feet below sea-level, filling a channel 400 or 500 feet in width at the present surface. The alluvial on the west side of the hill is of the same age. The lignitic formations at different points on the banks of the Tamar belong to this period.

Where the basalt is absent, there is often difficulty in separating the older from younger Tertiary and more recent drifts. The country between Beaconsfield and the Middle Arm in one direction, and the West Arm in another direction, is covered with a drift which is probably for the most part of later Tertiary and recent dates. Up the valley of the Middle Arm and its tributaries recent drift covers the flat ground near the streams, and it may possibly in some places graduate downwards into the older alluvial.

Basalt.—This is known only near Beauty Point, where it is the remnant of a Tertiary lava-sheet, which extends in the form of a strip along the coast as far south as Thomas' and Broadhurst's farms, and north to Inspection Head. The coastal fringe of basalt is 300 to 400 yards in width on the surveyed township of Ilfracombe. It is the common

variety (labradorite + augite + olivine), and as is always the case with our basalts of this age, there is no visible centre of emission. The absence of cones is, of course, due to denudation, and the necks of the old volcanoes may be very easily overlooked. Nowhere in Tasmania have any ash beds been observed on our basaltic fields, though scoriaceous lava-sheets exist; and where crateriform cones have been recorded, it is just possible that the eruption has been subsequent to the middle Tertiary. For instance, the only known basaltic cones with the characteristic features of craters (without cinders) exist on the Shannon Tier and on Lake Sorell, but there is no evidence to show at what epoch in the Tertiary period they were active.

The above brief *resumé* shows that there are quite a number of geological systems represented round Beaconsfield. Many of them are worth attention from a mining or an industrial standpoint. I now proceed to the specific subjects of the report.

Iron Ore Deposits.

Deposits of brown and red hematite and magnetic iron oxide have long been known to exist in the Anderson's Creek basin, along an approximately north and south line, trending eastwards going south.

Interesting reports and notes on the occurrences are those by the late Mr. Chas. Gould in 1866, and by Mr. T. C. Just in 1891*

The first record of the ore is that a few tons of it were taken away by Colonel Paterson's *Lady Nelson* in 1805, which brought stores from Port Jackson to his new settlement at York Town in 1804. In 1865 or 1866 Mr. Chas. Gould, then Government Geological Surveyor, spent some months on Anderson's Creek, and opened up trenches, &c., in the course of his examination of the deposit. Some of these trenches are still open. His report expresses his opinion that in the future the district will become highly important on account of the abundance of iron ore of good quality, and favourably situated for working.

In 1872, in May, Mr. T. C. Just and Mr. Jas. Scott, M.H.A., visited York Town and the Iron Hills, with the result that they induced Melbourne investors to come into the enterprise, and the Tasmanian Charcoal Iron Company

* Chas. Gould: Report on the country near Ilfracombe, 1866. T. C. Just: Notes on the Iron Ore deposits of the River Tamar District, 1891.

was floated on 400 acres of leased land, with a capital of £80,000, in 40,000 shares of £2 each. Mr. W. Leonard was provisional manager. The original plan was to begin on a small scale, and make charcoal iron by the direct process in open Catalan forges, producing malleable iron blooms to be forged into rough shaftings, &c., for the Victorian market. A jetty was built 310 feet out into the West Arm, and a wooden tramway made up Anderson's Creek to the ore-deposit, 4 to 5 miles distant. The company bought 800 acres of land with a frontage on West Arm for a township, called Port Lemprière after a leading Victorian shareholder, and a second township area was surveyed by the Government further up the creek, and called Leonardsburgh.

The first attempt appears to have been in a furnace designed to reduce the ore by a process invented by Mr. W. H. Harrison. Its foundation-stone was laid December 6, 1872, but I am told that it did not have a fair trial. Mr. Harrison has kindly given me the following authentic information respecting what was done at that time:—

"About twenty years ago I was approached by the Directors of that company, and engaged to erect a small trial plant (of a process which I patented) to see if a direct reduction of the company's valuable iron ores could be effected on a commercial basis. I accordingly put up a furnace on the mine, and, if I remember rightly, had only two or three days' running, resulting in a considerable quantity of high-grade steel, from some of which a Mr. Grayson, a Sheffield cutler, of Melbourne, made a quantity of tools possessing very remarkable qualities. The tensile strength of plates was far in excess of similar plates made from the then best-manufactured steel procurable from Europe and America. From my steel Mr. Grayson, under the hammer, made ribbons which could be tied into knots, and would nearly straighten out again to their original form. He made chisels to cut a groove along the course of a bastard file, the hammer-head of the chisel being so soft it could be notched with a knife by hand. A bar of this steel could be cut and welded in the forge, like common wrought iron, without burning or losing its splendid qualities. So much for the kind of steel which your iron ores can be made to produce. At the time I was erecting this plant, the Directors made the acquaintance of a Mr. Gray, a blast-furnace man, from Melbourne. At his suggestion, my researches were discontinued in favour of the old blast-furnace operations. The chrome in these iron ores was blamed as a factor of failure. As a matter of fact, chromic acid is a

factor going largely to give the splendid qualities named above."

The company having spent £10,000 to £12,000 in preliminary work, was refloated in Victoria as the British and Tasmanian Charcoal Iron Company (capital £100,000), and a blast-furnace plant was ordered from Messrs. A. Barclay & Sons, Kilmarnock, R. Scott being appointed manager. The iron-cased cupola was put up at Port Lemprière. The bricks for the chimney-stack of blowing-engine were specially made and imported from Victoria. All the common bricks used were made at the works, the clay being ground in a steam clay-mill. On June 17, 1876, Governor Sir F. A. Weld inaugurated the new works by blowing the furnace in. The imported coke, which had to be lightered ashore, cost £3 per ton, so it was decided to import the coal and convert it into coke, which would then cost 25*s*. per ton. A range of 40 coke ovens was constructed, with a capacity of one ton each of coke per day. A trial charge of twenty of these was made with Bulli coal, September 4, 1876, and the results proved satisfactory.

A new deep-water jetty, 600 feet long, was built at a cost of £1500, for accommodating vessels of any draught. A line to the mines, 6 miles long, of 4 ft. 8½ in. gauge, was laid with rails 50 lbs. to the yard, completed in May, 1876, and twenty wagons, each to carry five or six tons, were built on the works for the transport of ore, &c.

After the usual preliminary hitches, smelting fairly commenced on 25th October, 1876. For flux, blue limestone was brought by steamer from the River Don. The furnace was blown out about Christmas, having in two months put out between 2000 and 3000 tons of pig iron, or between 250 to 300 tons per week. Some of the softer sorts realised, in Melbourne, £6 10*s*. per ton. On the 5th February, 1877, the furnace was again in blast, and working well. It was cast three times daily, yielding about 13 tons pig iron at each tapping.

The presence of chrome appears by this time to have forced itself on the attention of those carrying on the enterprise. The first assays of the ore showed only small quantities of oxide of chromium. One assay yielded only traces, another 1·2 per cent., but when large quantities of ore were put through the furnace, the objectionable element began to be noted in larger proportions, and the pig was found to contain from 2 per cent. to 10 per cent. of chrome However, excellent cast steel was made in Melbourne from the purest varieties of this iron; a good deal of pig was

used at Langford's foundry, and some splendid castings were produced. For such articles as stamper heads and shoes, and all purposes requiring a combination of hardness and toughness, the iron was looked upon as the best that had come into the Victorian market. But it was soon seen that the local market for these purposes was essentially limited, and endeavours were made to secure an outlet for the product in England. In February, 1877, 1500 tons of pig were shipped to Messrs. Jas. McEwan and Co., London, and numerous experiments and trials were made at the large iron and steel works in England and Scotland, as detailed by Mr. Just in his notes referred to above. It was mixed with other irons, tried for tools, rails, wire, castings, chrome steel, &c., but the net results of experiments made by the largest ironmasters in the United Kingdom were unsatisfactory; the product being too hard and brittle. The iron could not be worked by itself to produce malleable iron, was high in sulphur, produced brittle castings, and excessively hard tool steel. The splendid appearance of the iron exhibited to the Iron and Steel Institute excited such unqualified expressions of admiration, that the result of these trials caused deep disappointment. The company continued its shipments to Melbourne, but the realisations dropped to about £5 5*s*. per ton for the soft grey pig, which was produced in small quantities. Trials were made with charcoal fuel; the fluxes also were varied, but without success. The bulk of the iron was white and hard, and as the Australian market was too limited for the output of the furnace, it was decided in August, 1877, to suspend operations indefinitely. At that time 4000 to 5000 tons of iron were awaiting shipment. There was some idea of procuring a complete foundry plant from England, and establishing a foundry in Melbourne for making gas and water-pipes, but this project does not appear to have been carried out As far as can be gathered from the records of the time, the total output of the furnace was about 10,000 tons of pig iron, and we may approximately reckon the quantity of ore taken from the mine as 20,000 tons.

Since 1877 no smelting has been carried on. The ore was taken from quarries cut into two hills on the west side of Anderson's Creek, the principal ore being on the southern hill. The northerly hill is called Scott's Hill, and is situate on a 40-acre section, 4907-93M, charted in the name of R. Quiggin, about 30 chains south-west of Nicholls' Bridge, where the old tramway crosses Anderson's Creek. The southerly hill is Mt. Vulcan, 30 chains S.S.E. on H. Yeates'

10-acre section, 4567-93M. These hills (Iron Stone Hills) are in serpentine country, close to its contact with the dark granite mentioned before in this report. Their slopes, as well as most of the country between them, are strewn with red hill drift, consisting of brown hematite and magnetite. The drift passes downwards into layers of soft earthy hematite, sometimes hard and cellular, or partially crystallised and nodular, and into serpentine clay, the whole resting ultimately on solid serpentine, which may in places be bedrock, in others wall-rock. Pieces of crystallised columnar magnetite are found in the red ochreous drift, and veins of the same mineral exist in the serpentine. Some of the iron ochre on the hill flanks is now being screened and shipped to Melbourne in small quantities. The tops of the hills show large boulders of iron ore lying upon and embedded in the ochreous clay and drift. This is a common feature of all the deposits; the boulders are no doubt concretionary, and are exposed by the denudation of the surrounding soil. The quarries which have been cut in the hills show similar boulders at different depths, forming part of deposits of red and yellow earthy hematite.

The quarry on Scott's Hill is a small one, and was evidently only a trial cutting, for it is not more than 25 feet in length and 6 feet deep. A small pile of ore is still stacked there; a little of it is said to have gone to the furnace. The ore is concretionary-looking red and yellow earthy hematite, alternately hard and soft, but very little of it really solid. The hill is low, perhaps 100 feet in height, but the ironstone drift is spread all over its slopes down to its base, equal to an area of 500 or 600 square chains. About 100 feet outside the southern boundary of the section is an outcrop of the dark granite rock. Without any deep workings, it is impossible to form even an approximate estimate of the quantity of ore available on this hill, as the extent to which the ochreous drift overlaps the serpentine is unknown.

The principal mine works are on Mt. Vulcan, where quarries have been opened in the face of the hill, the largest one being situate about 60 feet below the summit and 140 feet above the creek. The face of this quarry is nearly 30 feet high. The bottom of it is obscured by talus, so that the quality of the lower part cannot be readily seen. The ore from this quarry was smelted at Port Lemprière. A chain to the south is a small shaft about 20 feet deep, from which hematite and magnetic iron ores have been raised. Boulders of ore can be seen in the walls of the shaft some six or

seven feet down, and ore seems to persist to the bottom. Thirty feet further south and on the crown of the hill is a shaft, from the bottom of which Scott's deep bore was put down. Lumps of hematite and magnetite have been thrown out at surface, and a little serpentine rock is also on the pile. The summit of Mt. Vulcan is widely strewn with boulders of nodular and concretionary brown hematite and magnetite weathering in black nodules and lumps. These radiate from the crown of the hill, and the deposit, judged from the dimensions of the surface drift, would, roughly estimated, be about 600 feet by 300 feet, and of an average depth to creek-level of 100 feet. This would give 18,000,000 cubic feet, or, deducting largely for waste, 10,000,000 cubic feet net. Taking the cubic foot of ore as weighing 200 lbs., the total tonnage might be 1,000,000 tons, which would give 25,000 tons of iron yearly for a period of 20 years.

This calculation is based upon the following assumptions:—(1) That the ore goes down with unimpaired quality to creek-level; and (2) that the width of the deposit down to creek-level is not less than that indicated by the surface drift.

As regards the persistence of the ore down to creek-level, we have really only the quarry, the boring, and some excavations on the hill to guide us in forming an opinion. The mere fact of the ironstone gravel existing at the base of the hill a little above the creek is not sufficient to assure us without some more mining work. Mr. Scott's bore in the shaft at the summit of the hill was put down 176 feet, and the register is as follows:—

	ft.	*in.*
Ironstone	24	0
Hematite	6	6
Ironstone	5	6
Heavy black sand, mostly iron	4	0
Soft ironstone	2	0
Heavy hard ironstone	2	6
Brown hematite	7	6
Decomposed serpentine	30	6
Hard serpentine	5	6
Serpentine mixed with asbestos	6	6
Serpentine and asbestos with magnetite	2	0
Very hard serpentine and asbestos	0	6
Hard serpentine	2	6
Very hard serpentine	1	6

	ft.	in.
Very hard serpentine with magnetite veins	9	0
Ironstone	5	6
Greenstone	14	0
Serpentine with asbestos	13	0
Serpentine with asbestos and iron ore	9	0
Iron Ore	0	2
Serpentine with veins of magnetite	16	4
Iron ore, very hard, dense, and pure	6	5
Serpentine with asbestos	1	6
Serpentine	2	1
TOTAL	176	0

At the first glance this would seem to show that at the level of the quarry-floor serpentine may be expected to come in, for this rock was struck in the bore at 52 feet from surface, and continued for 58 feet further, when 5½ feet of ironstone was intersected, which was succeeded by serpentine for 52 feet; further, 6 feet of iron ore then came in, again followed by serpentine. If this register is reliable, it tends to indicate that the hill is not a mountain of iron ore, but consists of alternations of ore and serpentine, the former occupying only 64 vertical feet out of 176, or in the proportion of 1 ore: 2 rock. Against this it may be said that possibly the bore was not put fairly down in the actual deposit, but may have encountered the wall-rock. There is a strong presumption against the occurrence of the ore as a bedded deposit in the serpentine.

Mr. Scott put down two other bores about here, but I could not find their sites. Their registers are as under:—

Bore No. 1.—	ft.	in.
Ironstone	19	6
Clay with iron pebbles	19	0
Oxidised conglomerate and magnetite	10	6
Pure magnetite	1	6
Decomposed greenstone	29	0
Hard rock, supposed to be ironstone, broke auger	8	0
TOTAL	87	6

Bore No. 2.—

	ft.	in.
Ironstone	19	0
Sand with ironstone pebbles... ...	5	6
Magnetite...	8	6
Decomposed greenstone	24	6
Serpentine	12	6
TOTAL	70	0

Water prevented further boring.

The presence of the serpentine bed-rock in both of these bores a short distance down is disquieting. It has a direct bearing upon the second assumption involved in the estimate of ore available, namely, that the width of the ore-deposit in depth is equal to the observed width at surface. Great caution must be observed in drawing conclusions. On examining fragments of the boulders of iron ore, the earthy interstitial matter between the hard nodules is seen to contain water-worn grains of quartz. From this I draw the inference that these boulders are derivative. Hence, the width of surface over which they are spread is no criterion of the size of the lode whence the iron was derived, except that, as the boulders are in profusion and the surface deposit is wide, it is probable that the present deposit is large.

This leads us to consider the possible origin of the deposit. The English text-books, from the conditions ruling in England, attribute the origin of iron ores largely to the deposition of ferrous carbonate through organic matter, such carbonate being deposited either by evaporation or in replacement of limestones. Oxidation of this, or even of pyrites, produces brown hematite, and the removal of its water in turn evolves red hematite, which, heated in the absence of air, turns to magnetite (the latter also produced by the action of heated vapour of water upon ferrous carbonate). In accordance with this, we are then told that the brown hematites are the most recent, the red hematites the next antecedent in point of age, while magnetite is nearly always associated with the most ancient rocks, the high geological age supplying the element of time necessary for these processes.

There is, however, no absolute rule which can be laid down, and as the Ironstone Hills at Anderson's Creek are in an area of exclusively igneous rocks, the explanations of the text-books do not greatly help us.

It is noteworthy that the deposits are in more or less parallel lines north and south, which is, to say the least, suggestive of lode-origin. Confirmatory of this idea is the fact that the granite outcrops in the serpentine follow the same direction. As the ore-deposits are at or near the contact of these rocks, we may suspect that the concentration of the mineral is connected in some way with the intrusion of the granite. The contamination of the ore with chromium is no doubt due to the influence of the serpentine at the point of contact. Chromite, a mixture of the oxides of iron and chrome, is found always in association with serpentine, and is supposed to have separated (at the time of conversion to serpentine) from the ferro-magnesian minerals of the parent rock and from the chrome spinal which the latter often contains. One view, however, regards it as a primary crystallisation from the magma; while another ascribes it to the "after action" of vapours. An interesting feature of the Anderson's Creek chromite is its derivative nature considered as a constituent of the ore-deposit, only being present when the deposit is influenced by serpentine. A further question of interest is whether the granite intrusion was not the origin of the conversion to serpentine. I am inclined to think this was the case, and thus, another question is raised, namely, whether serpentinisation all through the State is not due to the same cause.

We are led by this evidence to imagine it highly probable that the ore-deposit will, as a contact formation or lode, descend to a much greater depth than the present level of Anderson's Creek. It is likely to be very irregular in form, and to be devoid of the uniform boundaries common to fissure lodes. Its width in the solid rock will probably be found to be much less than it is above the creek-level. Horizontal offshoots may exist in the serpentine, and the existence of these would explain the alternations of ore and rock in the auger-bore. It is quite impossible to obtain reliable knowledge of an irregular, perhaps ramifying, deposit like this from a single bore, which may not have been put down in the proper line of the ore, or may have intersected it on the dip and passed beneath it.

On the whole, it appears unsafe to trust to an estimate of the ore in sight without further work. The deposit at surface should be contoured; a few lines of trenches cut from east to west across the trend of the ore-body, and core bores put down in the trench lines. This work is essential before establishing works or arranging for breaking ore.

A few words on the subject of the chromium which formed such a serious obstacle to the sale of the iron in 1876. It is said that the element which was then so deleterious would now be found advantageous, as important uses for chrome steel have been developed since.

Chrome steel was already being made at the time when the Port Lemprière Works were in full swing, but the iron produced there was not suitable. For making chromic steel, rich alloys containing 30 to 80 per cent. of chrome are used. Under 1 per cent. of such an alloy would be charged into crucible furnaces with wrought iron, or added to the ordinary bath of molten steel. The oxide of chromium is one of the most refractory substances known, and tends (in the presence of carbon) to make iron brittle and hard. The ore forms a good lining for furnaces. The demand for ferro-chrome products fell off very considerably in 1901, and consequently (says the *Mineral Industry*), "several works formerly producing chrome steel and the alloys have altered their machinery for the manufacture of ferro-tungsten and ferro-titanium as a substitute, because tungsten and titanium ores are more easily obtainable, both as to quantity and quality." Ferro-chrome is in a very handy form for use, but pig iron with 6 or 7 per cent. of chrome does not appeal to the makers of chrome steel or the preparers of ferro-chrome, who desire an ore containing at least 50 per cent. of chrome oxide (Cr_2O_3). There are deposits of iron ore in New Caledonia, mentioned by Mr. F. Danvers Power, containing only 3 per cent. of chrome, and comparable in that respect with the Tasmanian ore, but they are unworked, as no use has been found for them. The leanness of the Tasmanian ore in chrome prevents it being used for ferro-chrome. The aim of any one attempting to utilise it should, I think, be in the direction of making it available for a steel containing the desired proportion of chrome for stamp mill shoes, crusher rolls, stone-breaker jaws, safes, dies, bridge, steel, and other uses to which chrome steel is applied. The demand for chrome steel is confined to such uses, and smelters would have to accept the limitations of market thereby involved. They would have to feel their way gradually, and if they succeeded in turning out a uniform product, a market could eventually be established in Australasia, though for some time the sales would be limited. The great desideratum, next to reducing the per cent. of chrome, would be uniformity in the metal produced. The Lemprière Company failed to secure this, after what they considered exhaustive trials. The different

analyses of the ore show that the chromium contents vary very much. It is quite possible that increased depth may disclose increased chrome contents, even to the extent of converting what is now an iron ore with accessory chrome into a chrome ore pure and simple.

Samples of iron ore from Mt. Vulcan, submitted to Mr. W. F. Ward, Government Analyst, were analysed by him, with the following results:—

	Per cent.	
Iron as peroxide	75·80	53·06 per cent. metallic iron
Silica	5·40	
Sulphur	0·13	
Phosphorus...	minute trace	
Chromium oxide	5·90	
Alumina	4·30	
Loss on ignition	7.30	
TOTAL	98·83	

Mr. R. M. Johnston publishes in his *Geology of Tasmania* analyses of some of this ore, made by Mr. Woodgate, as follows:—

	No 1.	No. 2.	No. 3.
Volatile on ignition	11·2	19·5	5·1
Alumina	2·0	15·3	5·8
Sulphur	trace only	...	...
Phosphorus	trace only	...	...
Lime—Magnesia—Alkalies .	...	...	...
Silica	6·1	18·4	4·8
Manganese	0·5	...	...
Chromium—Sesquioxide	trace	3·0	3·4
Iron—Sesquioxide	79·8	...	...
„ Peroxide	...	42·5	80·0
„ Protoxide.....	...	1·0	...
Undefined	0·4	0·3	0·9
	100·0	100·0	100·0

The Government Analyst detected no titanic acid in any of the chromiferous ores. A further sample of ore from Mt. Vulcan was assayed by the Analyst, and yielded 53·3 per cent. iron, with no appreciable chromium.

Mesrs. John Brown & Co., of the Atlas Works, Sheffield, to whom I submitted some of the analyses, reported to me that the composition is too variable for any reliable work to be done with it, but, that if the pig were as good as

Swedish, with a *regular* percentage of chrome, armour-plate makers could use it. However, Mr. Reichwald, Krupp's agent in London, is of opinion that it is not suitable for their Works. This is only what might be expected, as the Krupp firm have a secret process for carburising their armour plates.

Mesrs. Chas. Cammell & Co., Cyclops Works, Sheffield, inform me to the effect that the results of the smelting of chrome iron ores have not been very satisfactory, owing to the iregularity and great density of the iron produced; also, to the great expense of smelting such ores.

The Barrow Haematite Steel Co., Limited, say that they are not aware that any great advance has been made during recent years in the way of utilising ores with a percentage of chromium. Last year they made experiments with an ore containing from 2 per cent. to 4 per cent. of chromium, with the object of using some ores of this class from Greece, but the result was most unsatisfactory, and they had to give up all ideas of using ore of that kind, even in small quantities.

In 1897 Mr. W. C. Dauncey, C.E., in a paper on the Iron Deposits of Tasmania, read before the Royal Society of Tasmania, suggested that a mixture of two ores—chromiferous and non-chromiferous—might be made in smelting, or a percentage of the chromium pig could be added to the pure pig when melting, for the production of steel. The latter could be done by melting pure pig iron in the Bessemer converter and adding the necessary quantity of chromiferous pig; then agitate to ensure perfect mixing, and cast into ingot moulds. He considered that a ready sale could be got for the product, "providing buyers knew that they could buy such material, and could rely upon getting a steel containing the necessary percentage of chromium and not varying between a maximum and a minimum, with a wide range."

From the above it may be seen that experiments with such low chromic ores have not been successful so far. There is, however, probably more hope of success in this direction than in attempting to get rid of the chromium. Some of it can no doubt be expelled in puddling, but the process is described as being difficult, slow, and requiring extra heat; and no malleability nor uniformity in the product can be relied upon. Besides this, there seems to be no certainty as to the chromium percentage remaining within approximately manageable limits. Experience with chromic deposits does not show any constancy as regards

the percentage of chrome. Mr. W. F. A. Thomae, writing of the Aidin chrome ore-deposit in Asia Minor (*Mineral Industry*, Vol. VI., 1898, p. 151), says that the best ore is got near the surface, and that in depth it invariably becomes poorer. But the Port Lemprière Co. found that the proportion of chromium increased as the deposit was worked. It is generally conceded that chrome iron ore varies in composition in different portions of the same mass, and this fact has had a marked effect in limiting the applications of the mineral. In conducting operations at Anderson's Creek, quarries will have to be opened at different points, so as to aim at attaining something like a constant average of composition, and if that had been done in the old days, one drawback might have been neutralised. Mr. Just says:—"The closest supervision was given and details watched most minutely, but we never could get the iron sufficiently grey or soft, nor could we secure uniformity or quality." Some of the difficulty may perhaps be overcome by judicious and systematic blending of different ores, which would now receive far more attention than was paid to it when the smelter was suddenly confronted with a hurtful and somewhat mysterious constituent perfectly new to him.

Barnes' Hill.

On this hill is a large deposit of ore, evidently connected with the one at Leonardsburgh. It is situate about two miles further south, on the east side of Anderson's Creek, in the middle of Lot 730, 640 acres, charted in the name of Wm. Barnes, purchaser. This hill is south-west of the old Ilfracombe Sawmill half a mile from the mill. At the mill the country-rock is soft whitish laminated sandstone of Silurian age. About a chain west of it a north and south quartz reef traverses the country, and about 50 yards still further west stones of serpentine occur in the soil. On crossing the Tasmania water-race, about a quarter-mile west from the sawmill, red ironstone drift (magnetic) begins to appear as the surface-covering, just the same as at Leonardsburgh, and with similar occurrences of fibrous magnetite ("needle iron").

Within about 30 feet of the crown of the hill, which is 160 feet high, boulders or detached masses of hematite and magnetite (as at Leonardsburgh) are strewn over the surface. These boulders measure as much as 9 and 10 feet in diameter, often showing a brecciated and concretionary structure, and appear to be derivative in origin, as evidenced by small pebbles being cemented within their mass. Near the

summit on the western side of the hill, tabular masses of ore, some of them 30 feet long, have been exposed by ripping up the surface-drift. In one place a mass has been cut down into for six feet without any change in the substance of the clayey and concretionary iron ore. There would seem to be a good deal of soft ground between the harder lumps. The most solid part of the deposit is exposed on the western edge of the hill, which is also steepest on that side, where massive blocks of nodular ore are seen for a vertical depth of 40 feet. Going down the hill towards the west and north-west, we find serpentine country descending to Anderson's Creek. The hill immediately to the north is sandstone. It is evident that the Iron Hill is at the contact of serpentine with sandstone, or in serpentine close to the contact. The influence of the granitic intrusion is visible here too, in the form of stones of white aplitic granite on the north-west flank of the hill and down at the base, two chains south of Gale's Gate on the north boundary of the property (and six chains east of Anderson's Creek). Three chains west of the creek is some vesuvianite-chlorite rock in a north and south line, betokening the proximity of a granite contact. About half a mile north-west of the north-west angle of Barnes' land is the southern extremity of the ridge of dark granite coming south from Leonardsburgh.

The area of the iron ore occurrence on this hill of Barnes' is about 1000 feet square, and the ore appears to be in more solid masses and to form a decidedly more important deposit than that on Mt. Vulcan. But the mode of occurrence is similar, and I imagine the origin in each instance to be identical. The analysis of my samples by Mr. W. F. Ward, Government Analyst, is as follows:—

	per cent.	
Iron as peroxide	72·20	50·54 per cent. metallic iron
Silica	6·50	
Sulphur	0·14	
Phosphorus...	traces	
Chromium oxide	6·90	
Alumina	4·00	
Loss on ignition	8·70	
TOTAL	98·44	

Neither titanium nor vanadium was present in appreciable quantity. According to the analysis the ore is practically the same as that of Mt. Vulcan.

The western side of the hill being steep, affords facilities for testing the deposit by a deep tunnel, in addition to which a series of bores should be a part of the programme for exploration. This side of the property can be easily connected with Mt. Vulcan by tramway, and ores from both mines could be mixed at will. As the ore is not really in sight, no definite estimate of quantity can be made, but probably 2,000,000 tons exist in the hill, provided that the width of the deposit does not contract within 100 feet of depth. As said above, these superficial deposits are almost certain to shrink in width as depth is attained and when the channel of the primary ore is reached. This makes exploration in depth highly necessary before laying out the actual work. Once assured as to permanence, quarries can be opened with ease on the west face of the hill, and the output sent down by gravitation to any level selected for the tramway. The distance from here to the old deep-water jetty on Red Bill Point is 7 miles, of easy grade. The ore in this hill is more massive and in larger quantity than in any other known deposit about here, and when operations are resumed in the neighbourhood this ore-body will form an essential part of any scheme.

Ilfracombe Iron Mine.—Two miles south-east of the above is a deposit of hematite, situate on the range of the Blue Peaked Hill, one summit of which is known by the name of the Sugar Loaf. From the eastern side-line of Lot 511, 640 acres, John Munro purchaser, this range rises steeply to 800 feet above the farm land at its base, and attains a height according to my aneroid-reading of 1090 feet above sea-level. The strata of which the range consists are grey sandstones and conglomerates striking N. 20° W., and dipping south-west. Some prospecting for gold, with abortive results, has been carried on in the upper part of the hill. The beds belong to the auriferous series, and appear to be the opposite portion of an anticline, of which the Blue Tier and Cabbage Tree Hill strata form the eastern side. In my traverse of the range I did not see much quartz in the rocks, but small veins have been trenched across on the hillcrest.

A band of brown hematite ore runs up the hill in a north-easterly direction, and is found as loose lumps and blocks for a width of 50 or 60 feet. The hill slope is so densely timbered (with peppermint and stringy-bark) and the lower part of it so overgrown with scrub that the dimensions of this lode (for lode it appears to be, transgressing the strike of the strata) cannot be ascertained without the land being

first cleared. Mr. Gould stated the length of the outcrop as 300 yards, and the average width 66 feet, and he estimated 350,000 tons of ore as existing down to the level of the plain, of an average quality of 55 to 60 per cent. iron for a large portion of the lode. The quality deteriorates towards the upper end. This ore is over a mile from the exposed southern boundary of the serpentine, and as might be expected, is free from chrome, and the Government Analyst reports that it contains no appreciable titanium. Samples analysed by him contained 56·8 per cent. metallic iron. I do not know of any granitic rock near here, but I did not search the basin of Anderson's Creek on this parallel. It would appear, however, that such rock does extend as far south as this, for I was shown a specimen of coarse pegmatitic granite with large crystals of mica from Holwell, three miles further south. I regard the Ilfracombe lode as having the same origin as the ore at Barnes' Hill and Leonardsburgh, the difference being that the two latter deposits followed the intrusion of granitic rock into serpentine, while this results from a disruption of sandstone. Consequently, those are chrome-bearing and this is chromeless.

The continuation of the deposit westwards is concealed below the level farm-land at the foot of the range. Below the soil of this land are flat-lying sandstones belonging to the Permo-Carboniferous system. The iron lode will not be found to live in these, but will be in the Silurian rocks, upon which these sandstones were laid down.

The course of the old Ilfracombe Sawmill Tramway passes this deposit, and the shell of an old blast-furnace is still standing in the field at the foot of the hill. As far as I can learn, this is the oldest blast-furnace in the district. The Ilfracombe Iron Company was formed in the early seventies to work this lode, a manager was procured from Victoria, and the furnace erected. After trials and failures the company stopped, after expending nearly £10,000.

With hard fuel (coke) a medium-sized blast-furnace would smelt the ore estimated to be contained in the deposit above water-level in about seven years, a period insufficient to reimburse the owners for the outlay, so that one of two methods of dealing with this lode would have to be adopted—1. Break out the ore and ship it to iron smelting-works in Australia. After the construction of a tramway (about 7 miles) to Beauty Point on the Tamar, the ore could probably be mined and put on board for 6*s*. per ton. After adding for freight to an Australian port, the cost would not be prohibitive, though quite high enough for

Australian smelters. 2. Amalgamate with a company exploiting the Leonardsburgh and Barnes' Hill deposits, and work the three conjointly. This would allow any desired system of blending to be adopted, and should really be the course to aim at.

If it should be decided to make charcoal iron, production would not go on at a very rapid rate; perhaps 60 tons of ore per furnace per day would be charged, equalling, say, 30 tons of iron. This would mean about 20,000 tons of ore per furnace per year. The capacity of charcoal blast-furnaces is smaller than that of those in which coke is used as fuel. Those in Sweden produce on an average only 13 tons per day; the largest, 40 to 45 tons. (Jas. Douglas, Swedish Iron Metallurgy and its Applications to Canada. *Journal Canadian Mining Institute*, Vol. II., 1899, p. 41.) The two charcoal iron furnaces near Ulverstone produce about 30 tons of iron per week (*Metallurgy of Iron*, T. Turner, 1900, p. 161). The charcoal iron furnace at Swift's Jetty, Middle Arm, used to turn out about 30 tons iron per week. But this rate of production at Ilfracombe would not pay for the plant and tramway.

Whenever the iron enterprise is resumed in this district, I am of opinion that the proper plan to pursue will be to combine operations and work these three properties as one concern. By themselves they do not constitute propositions of sufficient magnitude to attract the capitalist; but conjointly they hold out better prospects, and above all make it easier to attain some degree of uniformity in the product.

Looking at the properties in this light, there remains the question whether it is better to export the ore to smelting works in Australia, or to smelt it on the spot, and in the latter case, whether coke or charcoal would be the more desirable fuel.

First, as regards the cost or raising the ore, mining will perhaps be a little higher than at the Blythe, as the deposits contain a large proportion of smalls and waste, which will have to be separated by sorting. If we put down 5 tons of stuff as the daily duty per man, and two tons of this are rejected as deads, it will leave 3 tons of ore for the daily wage of 8*s*. 4*d*., viz., 2*s*. 8*d*. per ton; allow for sorting 1*s*. per ton. The richer the ore, the greater the necessity for reducing it to uniform and moderately-sized pieces. The poorer ores, with a looser structure, can be taken to the furnace in larger pieces. Ores which are too small resist the blast and present difficulty. They are sometimes briquetted, sometimes mixed with melted slag, and then

charged; they mostly lend themselves to direct processes with charcoal fuel. Tramming 1*s.*; stores, shipping, management, and incidentals, say 1*s.* 4*d.*; making a total of 6*s.* per ton f.o.b. at West Arm or Beauty Point. It may be that these costs could be cut down by carefully planning for a regular and fairly large output.

The ore, if exported, would, owing to its chrome contents, be either treated by itself or appropriately blended with other ores. The net product in any case would be suitable for a special and well-defined market, which it should be the endeavour of the proprietors to thoroughly establish and extend rather than to attempt to introduce the iron for general uses. Crushing-rolls and shoes and dies in stamp mills would constantly absorb the bulk of the steel made from such iron. When made of chrome steel these parts of the battery have a longer life than when they are made of cast iron. T. A. Rickard, in his "Stamp-milling of Gold Ores," gives the duty of chrome shoes in several batteries in the United States and Australia as 202 tons, 251 tons, 585 tons, 190 tons ore, compared with cast iron, 80 tons, 115 tons, 105 tons, 135 tons. Mr. W. Broadbridge (*Mining Journal*, Sept. 13, 1902) cites 390 tons in the Transvaal as the duty reached by chrome steel shoes. The softer metal would come in well for the dies, provided the toughness is maintained.

As regards smelting on the spot, the plan would be either, (1) to produce pig iron by blast-furnace smelting with coke, either imported or made from imported coal; or, (2) to produce it with small blast-furnaces built for the use of charcoal fuel.

I suppose that coke could not be imported for less than 18*s.* or 20*s.* per ton, and it would have to be of good hard and strong quality, low in sulphur and ash, and free from phosphorus, say not exceeding 1 per cent. of sulphur and 10 per cent. of ash. Gas-coke is generally objectionable, being soft and sulphurous and rich in ash. The quantity required for each ton of pig iron produced would be from 17 cwt. to a ton. If coal is used, the quantity needed is greater; ordinary bituminous non-caking coal will be consumed in the ratio of 30 cwts., or even 2 tons, to each ton of iron. It is sometimes used in conjunction with coke.

But it would appear that the cost of delivering coke and coal to blast-furnaces near the mines must be, for the present, a drawback, which could be minimised only by some special circumstances.

The alternative fuel is charcoal. In America, Austria, and Sweden this fuel is still made use of, and in the last-named country to a large extent and with remarkable results. Sweden occupies a pre-eminent position in charcoal iron-making, but it is not generally appreciated with what continuous and strenuous effort she maintains it. Her output is small, but the purity of the metal produced compensates for this, otherwise we may be sure that the Swedish iron companies would increase their produce with the aid of mineral fuel. But everything is done with a view of attaining the desired end, viz., quality in preference to quantity. The quantities of iron ore smelted annually throughout Sweden do not amount to much more than a million tons, less than the output of one of the large mines in the United States for a single year, and yet the iron industry is the basis of Sweden's prosperity. Large forest areas are utilised in connection with the smelting works; the best quality timber is used for wood pulp-making; the second-class stuff goes to the sawmill, and the lowest grade is used for charcoal-making. Everything is turned to account. From the sawdust and bark is extracted gas, which is employed for converting charcoal iron into open hearth steel. The greatest attention is paid to the nature of the wood. Timber is sought which contains the least phosphorus, and the predilection for such wood is carried to extreme lengths. Excessively minute differences may not seem to matter much, but the pine in Sweden contains a little less phosphorus than the birch, and the latter has actually been known to be systematically destroyed in order to plant the fir in its stead, merely because by this means the proportion of that undesirable ingredient would be reduced by 0·001 per cent. The furnaces in Sweden are small, not exceeding a capacity of 40 or 50 tons a day, but every ingot is individually and conscientiously examined and smoothed, and the utmost is done which can be done to produce high-grade metal fit for tools, watch-springs, bicycles, &c.

Our deposits on Anderson's Creek are, so far as can be seen at present, likely to yield only a few million tons down to creek-level (though it is possible that as much more exists below that level before the deposit contracts in width), and the question of devoting attention to quality of product rather than to quantity deserves consideration.

From 16 cwt. to 1 ton of charcoal would be requisite as fuel for each ton of iron produced. For a small furnace

producing 15,000 tons a year, 10,000 to 15,000 tons of charcoal would have to be supplied.

Mr. C. H. Curtain, Inspector of Mines at Queenstown, in a report to me upon charcoal-making, states as a result of actual experiment in the timbered country on the West Coast, that 162 tons of wood could be got per acre (= about 40 tons of charcoal). This yield is a high one, and perhaps would not hold good over any large area. Great discrepancies exist in the statements of the wood and charcoal yield per acre in other countries. We know that charcoal weighs 20 per cent. to 25 per cent. of the wood from which it is made, but there the agreement ends. Forests in France are stated to yield 1½ ton dry wood per acre, and this is high compared with some countries. In Sweden the yield used to be about ¼ ton per acre (large wood only), and in the United States ¼ ton is also calculated, though some actual work there has resulted in a yield of nearly 2 tons per acre. Manifestly, all depends upon how heavily the ground is timbered. Although Sweden is covered with forest for three quarters of its entire area, the individual trees are of no great size, and I think we may estimate a much greater cut per acre for the Tasmanian bush. It is probable, however, that 1000 acres annually would be required to supply each furnace. The Asbestos Range for miles would be available for this, not to mention the more lightly-timbered land nearer to the mines.

For limestone, practically inexhaustible sources can be resorted to. The massive occurrences of pure Silurian limestone on the road to Winkleigh could be used, and the stone conveyed by tramway to the furnace.

Therefore, provided the desired quality could be produced, I do not think there is any radically fatal obstacle in the way of using charcoal fuel. The sulphur per cent. is rather high, but good authorities give the assurance that this can be greatly reduced by melting the pig with an admixture of ferro-manganese. The quantities of pig produced would be comparatively small, but the extra price commanded would compensate for this. Just as Swedish iron has been made a speciality, I believe the time will arrive when the special features of the Anderson's Creek iron will be recognised, and if uniformity in the quality can be maintained it will fetch special prices. The splendid appearance of the iron which was sent from here to England for exhibition attracted universal admiration, and if it can be made a saleable commodity, a demand for it for special purposes would soon spring up in the Commonwealth.

It seems to me that the time has come for a renewal of the experiments, with the added aid of modern knowledge. With the approaching establishment of the iron industry in Australia, these fine deposits of ore, surrounded by plentiful timber, near ample supplies of flux, within easy reach of deep water, ought not to be suffered to lie neglected because some trials a great many years ago were not successful. With renewed trials, designed and carried out under the best technical supervision, the result might now be very different, and I would commend the undertaking to any who are prepared to go thoroughly into the matter, and see what can be done in the way of turning these famous ores to practical account.

Swift's Hematite.—There is a further deposit of iron ore in the Beaconsfield district, situate on the west side of Brandy Creek, covering an area of a few hundred square feet, in the form of tabular masses of concretionary hematite and impure ironstone, met with just below the covering of surface-drift. It has probably a downward extension in the form of veins of hematite of no great size. A prolongation of the belt in a south-easterly direction is observable along the east side of the Cabbage Tree Hill. It is noteworthy that no eruptive rocks are exposed anywhere in the neighbourhood, and that the ore is free from chrome. The country-rock is Silurian sandstone. The deposit is probably connected with the quartz-reef epoch of intrusive activity. My samples of the ore, assayed by the Government Analyst, yielded 51·5 per cent. metallic iron.

The best of the deposit has been worked out by the Tamar Hematite Iron Company, who put up a charcoal iron furnace on the Middle Arm (Swift's Jetty), and produced 500 tons of excellent pig in the first half of 1875. The furnace was lighted on January 1st, 1875, and after a few initial mishaps, was soon got into satisfactory running, showing a capacity of about 5 tons of iron per day. A trial casting of the iron was made at Peter's Foundry in Launceston. Two tons of it were run into moulds of fly-wheels for chaff-cutters, tramway wheels, small wheels for the Launceston and Western Railway, panels and rails for palisading, various parts of ovens, &c. It proved easy to melt, free from sulphur, and was pronounced soft and highly creditable in respect of texture, fracture, and grain. It was considered tougher than the Scotch iron which was tested at the same time. In the trials the pig was sorted, so as to separate the very hard or white iron. The softest was selected for the castings, and was smelted without any

mixture with other irons. When run, it proved soft enough to take the finest impressions in the moulds. The castings made in Melbourne were also stated to be superior to those obtained from the ordinary Scotch pig, but as the company could not obtain superior prices in Melbourne, they shipped a couple of hundred tons to Glasgow to try the home market. It was estimated that they could produce and land pig iron in London at a cost of from £4 to £4 10*s.* per ton. The parcel sent home was sold at £6 7*s.* 6*d.* and was reported "of good quality, though rather rough." The analysis was:—

	Per cent.
Iron	94·40
Combined carbon	0·96
Graphite	3·08
Silicon	0·89
Sulphur	0·22
Phosphorus	0·09
Manganese	0·24
Loss	0·12
	100 00

Between 1873 and 1875 a drop in the market value of pig iron to the extent of 50 per cent. took place, and in June, 1875, the furnace was blown out. The published reasons for suspension were various. The depression in the iron trade was one; another was that it was intended to raise fresh capital and add to the plant.* No doubt the fall in prices affected the enterprise materially, added to which was the small scale on which work was carried on. The deposit was never opened up extensively, and it is still impossible to say what quantities are available beyond the limited exposures at surface.

Coal Measures.

In various parts of the Beaconsfield district beds of Permo-Carboniferous age are exposed, and appear to repose horizontally or at slight angles of inclination (1° to 10°) upon the tilted or truncated edges of the Silurian slates and sandstones. They are exposed on both sides of the Middle and West Arms, a little way up Anderson's Creek, and on Lot 511, 640 acres, John Munro purchaser, west of

* Mr. A. H. Swift, the Manager, died February, 1876, and work was never resumed afterwards.

the Blue Peaked Hill, near the old Ilfracombe blast-furnace. They extend southwards thence, and re-appear in the neighbourhood of Winkleigh. They are believed to be represented further west across the valleys of the Franklin and Rubicon, and thus to effect a connection with the Mersey basin. If there has been an uninterrupted layer of Permo-Carboniferous sediment over this area, there is no reason why the Mersey coal seam could not have extended as far east as Beaconsfield; and even if disturbed by subsequent greenstone intrusions, surviving fragments of the seam might still occur, if (and this is an important proviso) not removed by denudation. Lithologically, the sandstones on the West Arm correspond well with some of the coal-bearing series in the Mersey basin. On the other hand, there may have been separate basins in which the vegetable matter now existing as coal accumulated under identical conditions prevailing throughout the whole area. Only actual trial and observation can show whether any survivals of these hypothetical deposits are concealed within the strata observed.

Ilfracombe Coal.—On John Munro's purchased Lot 511, 640 acres, at the western base of the Blue Peaked Hill and on the old Ilfracombe Tramway, is Hinds' Field, a flat plain, the bed-rock of which consists of nearly horizontally-bedded soft sandstones, alternating with shales. Three bores were put down near Hello Creek 36 years ago, but it is difficult now to obtain a reliable account of the results; one of the bores is said to have reached some coal or coaly matter. The creek runs through the field at the base of rising ground a little south of the furnace, and exposes the beds of a soft micaceous sandstone. The south bank is about 25 feet in height, and a cut was made into it for my inspection. This showed a vertical section, as under:—

	ft.	in.
Soil and sandstone	15	0
Light-coloured soft laminated sandstone...	1	0
Dark soft sandy shale with carbonaceous markings	0	6
Grey and yellow bedded sandstone	3	0
Grey and dark soft sandy shale, finely laminated and stained with carbonaceous matter	2	6
Strata concealed down to level of creek ...	2	0
	24	0

The beds dip east at an angle of two or three degrees. They are 220 feet above sea-level. There is nothing immediately adjoining the occurrence to fix its geological age. On the high field east of the creek are stones of bluemetal (diabase, greenstone) which have been brought down from still higher ground. This rock is the constant associate of our Coal measure formations. From what indications are available, I am inclined to rank these sandstones as above the Lower Marine beds, and therefore roughly corresponding with the Mersey Coal Measure sandstones. If the diamond-drill is brought into the neighbourhood by the East Tasmania Company, it would be a good opportunity to test these beds, and see definitely whether any seams of coal exist in them. No positive knowledge is obtainable without boring. If a bore is put down on the bank of the creek, the eastern bank is preferable, as the indications of coal have been found on that side, and from the difference in the height of the banks it is quite possible that the creek is along a line of faulting.

Middle Arm.—The sandstones on the west side of the Arm were tested by Mr. Dally a long time ago. Mr. David Dally tells me that a shaft at the Scotsman's Point, near the smelting furnace, was sunk 20 feet down to water-level in sandstone containing small carbonaceous seams. Dally's shaft up Brandy Creek was also sunk 20 to 30 feet, and then a bore continued 80 feet through sandstone into the supramarine conglomerate. Another bore up Brandy Creek, 225 feet deep, traversed the mudstones. No satisfactory result was obtained from any of these bores; unfortunately, the boring-registers are not now available. The sandstones overlying the marine series are the proper home of coal seams, and the test-boring was a perfectly legitimate undertaking. So little being known about these bores, I cannot say whether the tests were adequate or not. Certainly it would have been useless to go below the Lower Marine beds. The general disposition of the strata here seems to be as follows, in descending order:—

Drift of the recent and late Tertiary periods.	Overlying flat country, a little inland from Middle Arm : and between here and York Town.
Tertiary Basalt.	On the coast along east side of surveyed Township of Ilfracombe, terminating northwards at Inspection Head.
Lower Tertiary clays with lignite.	Below the basalt at Beauty Point: Ophir alluvial, &c.
Mesozoic diabase.	At Port Lempriere, north side of West Arm : crown of hill east of Middle Arm.
Permo-Carboniferous :—	
Sandstones.	Middle and West Arms : west of Sugar Loaf.
Conglomerate.	Middle Arm.
Lower Marine Series.	Calcareous mudstones : east side of Middle Arm, York Town.
Pebble beds.	Middle Arm : base of system.

and continuing the succession downwards elsewhere in the district as under :—

Devonian.	Granite at Anderson's Creek. Serpentine at Anderson's Creek and Blue Tier
Silurian.	Slates, sandstones, quartzites, conglomerate, and limestone at Cabbage Tree Hill, Blue Tier, &c.
Cambro-Silurian.	Slates and schists of Asbestos Range.

Between 30 and 40 years ago a bore was put down west of Beauty Point by Mr. Zephaniah Williams. I am told that it went down 80 feet, and struck some coal or lignite. From its position, I should think it would be the latter. Mr. Dally tells me that the same formation was bored into 200 feet by Rawson on F. Y. Wilmore's land east of Middle Arm. These strata fringe the Tamar River higher up its course, at Muddy Creek and elsewhere, and belong to the early or Palaeogene division of the Tertiary system. The

development of lignite in this basin suggests the desirability of some careful tests being made of its quality, with a view of ascertaining whether there is any approach towards the so-called bituminous nature of some brown coals, also the proportion of ash, and generally the constitution of the substance. Although our coal is fairly cheap, it is conceivable that a lignite fuel duly compressed and prepared as brown coal briquettes at a very low cost might appeal to some householders if anything like a reasonable quality, say, half the heating-power of our usual coals, could be maintained. It would practically be equivalent to wood fuel in the convenient form of briquettes. There is at present no demand for such an article, and good deposits of lignite have not been opened up, but the occurrence of small quantities at several points makes it possible that there may be more of it.

West Arm.—The sandstones which line the northern and southern shores of West Arm are appropriate beds for Permo-Carboniferous coal seams. A few trials have been made, but without finding anything of value. A bore at Port Lemprière had no result. I visited the north side of the Arm, and found a short cut into the bank, called Dally's Tunnel, north-west of Red Bill Point, across a bed of yellow and grey sandstone, banded with carbonaceous matter, dipping about 7° N.E. Beyond these small coaly sandy seams in the tunnel, nothing is disclosed. About 50 yards west of this is a small shaft sunk 18 or 20 feet, but Mr. Dally states that only fossil-wood was found in it. On the beach near here, at low tide, an outcrop of stony carbonaceous matter is visible, and this would come below the beds shown in the short tunnel. There is also an old bore about a chain from the shore, put down by Mr. D. Dally for 75 feet in sandstone, but I could not find the exact site, and I understand no coal was struck.

These beds cross the Arm to the South-east, and crop out on the south shore at the base of the promontory of Red Bill Point. A deep bore near Port Lemprière (but not too far east or it would catch the intrusive diabase) would intersect them and prove the strata down to the fossiliferous mudstones. As, however, the edges of the strata, which are crossed in descending order by walking along the beach between Port Lemprière and the mouth of Anderson's Creek, do not show any coal outcrops, I fear there is not much chance of good seams being found. At Monk Town the fossiliferous horizon (Lower Marine) is reached, and below this we need not look for coal. The country south

of the Arm is covered with recent drift, which conceals the bed-rock from view and the beach, therefore, is the best place for examining the outcrops of the strata. The indications are not encouraging; at the same time, the possibility of the existence of seams is not excluded.

The net result of my examination of all these Permo-Carboniferous sandstone beds is as follows:—

1. They may, I think, be assigned to the geological horizon of the Mersey measures.
2. There is a possibility of coal seams existing in them, but the few trials made have been unsuccessful.
3. There are no favourable indications in the shape of coal outcrops. Coal markings are the only visible signs.
4. There is, accordingly, great uncertainty as to the occurrence of payable seams.
5. The indications admit of the use of the drill. The two best sites for boring are on the Ilfracombe Tramway at the Sugar Loaf and at Port Lemprière. At Middle Arm I think the Lower Marine series would be reached too soon to make it worth while to put any more bores down there.

It is needless to add that the discovery of coal in the district would have an important effect on the iron enterprise.

East Tasmania Mine.

This property comprises the sections east of the Tasmania Mine, and the work done consists of a shaft sunk to a depth of 213 feet and levels driven at 100 and 200 feet.

The shaft being down to 29 feet from the surface, sinking was resumed in May, 1889, under the direction of Mr. J. G. Payne. By January, 1890, it was sunk to 213 feet, when, there being no change in the country, a prospecting drive was started at the 200-foot level. In the upper part of the shaft poor quartz veins were freely met with. Below 100 feet the country became hard, and below 200 feet some of the hardest ground known in Beaconsfield came in, and sinking left off in very hard country.

A level north was driven at 200 feet for a distance of 351 feet in sandstone and slate without result. At 100 feet two levels were driven, one north-west for 517½ feet, another south-east for 580 feet. In the north-west drive, at 350 feet, a quartz leader, 4 to 6 inches wide, of strong hard stone, was cut, running parallel with the drive. It pitched underfoot, but on cutting up the bottom of the level it was

not found to improve. The sandstone, which carries honeycombed quartz here, is much disturbed for 8 to 10 feet, loose blocks existing with crevices between them fully half an inch across. These are filled in with quartz. The formation was cut into east for a few feet, when limestone was met with. A few feet were also driven west into blue slate. At the time a suggestion was made that it might be the heaved channel of the Tasmania reef. I dissent from this idea. Such belts of shattered rock are not infrequent in these strata. At 387 feet the drive passed through a narrow band of limestone (12 feet), and then into brown sandstone full of small veins of quartz.

The level driven south-east for 580 feet was in dark grey and greenish sandstone and slate. Some small veins of quartz were passed through, and these were prospected before finally suspending work. All underground operations ceased at the end of December, 1890.

The object of the above shaft and drives was to intercept the eastern extension of the Tasmania reef. Assuming the reef to continue to that distance and to approach the surface, and to have preserved anything like its observed course, or if faulted, to have been heaved only a moderate distance north or south, the work was calculated to attain the aim in view. It completely failed, however. Before considering reasons for the want of success, the diamond-drill bore must be mentioned, which was put down 6 chains south of the shaft to intersect the reef in depth. This was started on the Tasmania Company's ground in April, 1890, and was continued to a depth of 978 feet 4 inches, passing through—

	ft.	in.
Surface clay	12	0
Sandstone	68	10
Slate	35	2
Impure limestone	64	0
Slate	278	0
Into dark-blue limestone	520	4
TOTAL	978	4

The bore left off in the limestone, which forms a thick bed along the eastern side of the Cabbage Tree Hill, and is referred to earlier in this report. It appears to be conformable with the sandstone and slate with which it is associated, and accordingly, I estimate that its base would

be reached at a depth of 200 feet from the bottom of the present bore. The bore was in a position to strike the Tasmania reef on its normal course, but nothing approaching the nature of a reef was intersected. The conclusion which was arrived at was that the Tasmania reef had been faulted so as to escape both the bore and the drives. In addition, it was thought that in any case, whether faulted or not, the reef may have failed to rise to the surface in the East Tasmania ground, and that the levels may have passed over it.

A consideration of the state of things in the eastern workings of the Tasmania Mine will help us in coming to a conclusion as to what we may expect to find in the East Tasmania ground.

The 700-foot level is the one which has been driven furthest east. It would be about 650 feet from the surface in the East Tasmania sections if extended so far, and the level end is 655 feet from the boundary (or 374 feet from the vertical bore).

At 66 feet behind the face the level entered the limestone, which continues to the end, and as the bore is in limestone of identical nature, it is reasonable to suppose that similar rock occupies the intervening space. Behind the limestone, conformable with it and underlying it, the level passed through a bed of dense, tenacious clay, about $36\frac{1}{4}$ feet thick in the drive, equal to a true thickness of $32\frac{1}{2}$ feet (about). This clay band is known in the mine as "the dyke." Westwards it merges gradually into a zone of what can best be described by the term "broken formation," or "broken country." This consists of sandy material showing lines of false deposition, and containing angular fragments of sandstone, giving place to the west to more solid remnants of rock, and conveying the impression of shattering and disintegration *in sitû*. Hard blocks of sandstone are met with, having the sandy material between them, for a length of about 60 feet. It is noteworthy that the reef in this section of the level became irregular, splitting and jumping up and down. The reef tails out just where the broken formation begins; its track goes into the broken for a little way and then disappears.

In the level above the 600 feet, the reef behaves in the same way when the broken country is entered. The end in that level does not go far enough east to reach the clay "dyke." It has been driven parallel with the country in the sandy broken formation to provide filling for the stopes, and consequently does not enter the limestone.

The alluvial gutter, which was entered in the upper levels of the mine, does not descend to this depth; the broken formation is *in sitû*, and not alluvial.

Connected with the shattering of the rock, it is quite possible that some faulting of the country took place, reducing the original clay slate to the present clay band or "dyke" by rubbing against the limestone. Between the clay and the limestone I certainly saw a gap of 3 or 4 inches, but this may be due to dissolution of material. If a heave has taken place, it is the best thing that could happen for the East Tasmania Company, provided the heaved portion of the lode is in their ground. A far more serious occurrence would be the dying out of the reef before reaching the company's sections.

The actual appearance of the reef in the east end of the 700-foot level is sufficient to cause anxiety. It feathers out when entering the broken country. It has no appearance of having been sheared off by a fault, and there is no track or channel in the limestone. From this I deduce that the chances are rather in favour of the reef not re-appearing in the strata lying east of the limestone belt. If so, the way to find it eastwards would be to bore deep enough to reach the downward prolongation of the sandstone below the limestone, below the clay, and below the broken formation. Assuming 50° as the mean dip of the strata, the present bore would have to be deepened to 1290 feet, or a bore within the boundary sunk to 1624 feet in order to intersect the limestone, the clay "dyke," the broken formation, and touch the solid sandstone which may be expected to enclose the reef in its normal state. These figures are subject to alteration by any variation in the dip of the strata in depth. To work the reef east of the boundary still greater depths would be requisite. This calculation is on the supposition that the reef feathers out all the way down in the broken country, and does not continue into any formation east of that.

There is another supposition which accounts for the absence of the reef in the broken formation and limestone owing to a pinch, and which assumes a re-appearance of it east of the limestone belt at the same level. There is, of course, a chance of this. To prove it a line of bores ought to be put down along the East Tasmania boundary, which would touch the limestone at 800 feet. By boring in the Tasmania Company's ground at the distance of the old borehole from the boundary a line could be selected in which the limestone could be reached at less than 500 feet.

to the south
WSW

Down to a depth of 100 feet, the ground has been proved by the 1100 feet of driving from the Tast Tasmania shaft, and to a depth of 200 feet by the deeper level for about 351 feet. There remains, therefore, to prove by bores the ground between the 100 and 500 feet.

It has to be borne in mind that, in the event of faulting, the missing part of the reef may have been heaved a considerable distance north or south. As far as the East Tasmania is concerned, the line of bores would extend along the south-west boundary lines of Sections 251, 252, and 62. On the boundary of 252 the bore would have to be 300 feet deeper. This line would be 2112 feet long north-west to south-east, and the bores would certainly prove the ground down to the level of the limestone. If the reef really makes again east of the limestone, it would be intercepted by these bores, which, to preclude any possibility of it passing between them, must not be more than 240 feet apart.

The reef in the upper part of the Tasmania ground has been eaten away by the well-known alluvial channel, but the 600-foot and 700-foot levels are below this, in country which is not the filling of a river valley, as is proved conclusively both by the nature of the rock and the inclination of the hanging-wall to the east. The inclination would have been in the reverse direction if this wall had been the eastern bank of a river basin.

In conclusion, I will concede to those who hope to find the reef again east of the limestone the liberty to argue that the broken country represents the plane of a large fault which has displaced the reef, and that it will be found either in or beyond the limestone heaved north or south. This is not impossible, and I do not press my objection to it, which is that the reef shows symptoms of degeneration before it actually enters the broken zone. Looking at the indications, I am rather disposed to connect the rock shattering with the actual formation of the reef, that is to say, that both occurred at the same time. All reefs must have a termination somewhere or other, and I conceive it highly probable that this broken ground formed the end of the fissure, and received only the final, uncertain tricklings, so to speak, of the silica solutions which, in the more defined channel to the west, crystallised as the famous reef. I am ready to allow, however, that this is only reasoning from facts which may be susceptible of another interpretation, and may, as far as the East Tasmania Company is concerned, be put to the test by the boring alluded to above. I say, as far as the East Tasmania is concerned, because the

possibility exists of the reef being heaved outside its property altogether.

Ophir Mine.—This is now being worked by the Tasman Ophir Company in the alluvial lead which runs along the base of the eastern slope of the Cabbage Tree Hill. The main shaft is sunk to 405 feet. At 300 feet and 400 feet levels have been driven east. The 300-foot level extends 58 feet; the first 14 feet are in solid sandstone, dipping 45° to the north-east; the ground then changes for 6 feet to a soft sand and clay, succeeded by 25 feet of black clay. A body of wash was then struck, composed of sand, water-worn pebbles, and angular stones of quartz. Two sets of timber were put in in a drive south, but the wash ran and the drive had to be blocked. When I was there, this wash yielded a few colours of gold per dish.

The 400-foot level has been driven about 140 feet. For the first 85 feet the ground is solid sandstone; at that point a rise has been put up 34 feet, but without meeting with any wash. The western rim-rock of the lead bounds it most probably just above the top of this rise. The level was blocked here with mullock from the rise, but I understand that it has been driven between 50 to 60 feet further, and that the end (in wash) has run for want of timber. About 30 feet of wash is reported here. A short crosscut south is stated to be wholly in wash. At 140 feet a winze was sunk 60 feet, and a drive opened east for 200 feet. This is 460 feet from the surface. The country is sandstone for 184 feet, then a belt of broken country comes in, succeeded by limestone. No wash has been found in this drive, and I am of opinion that it is below the horizon of the gutter.

Ten tons of the wash were being crushed at the time of my visit; the return being 8 ounces of amalgam and 2 tons of concentrates containing 25 per cent. of auriferous pyrites. The gold contents of the wash are supposed to be in excess of these figures, owing to probable loss in carting wet stuff to the battery at the Wonder Mine three-quarters of a mile distant.

The Ophir Mine is now being put in order for working, and when properly equipped, it is intended to sink the main shaft further 55 feet, then to drive east and connect with the 60-foot winze. From this bottom drive (460-foot level) a rise will be put up, and the wash tapped in advance of the upper level.

The position of the mine with reference to the hill is encouraging, and the gold which has been won at surface

on the lower part of the hill certainly indicates the Ophir ground as being favourable for a payable channel. But its history has been disappointing. Its special feature seems to be that the gutter has been enriched from its flank, *i.e.*, from the Cabbage Tree Hill. Although it carries some alluvial gold, I think the bulk of the gold is contained in the angular fragments of quartz, which have simply rolled down the hill from the wasting veins. It is probable that this reef-gold gives the deposit its value. It is satisfactory to know that the bottom of the gutter will now be proved, and it is to be hoped that the results will justify the outlay.

Moonlight-cum-Wonder Mine.—The company has opened out by tributors at the 500-foot level in the main shaft, and driven 25 feet east and 20 feet west. In the east end three veins of quartz were visible, the thickest 2½ inches. The courses of these were irregular. The country sandstone formed large heads. The lode is rather inconstant, swelling and closing up alternately. In the west drive there were 3 to 6 inches of stone in the back, but this had died out in the end, and a rise was going up on a little quartz. A small crushing of 10 tons has been taken out, returning 3 ozs. 17 dwts. 21 grs. gold. The drive east is being pushed forward to connect with the bottom of the winze from the 400-foot level. This will require another 80 feet of driving. If in this distance no payable reef is found, I do not think there is any great inducement to persevere further unless there is a change when the winze is reached.

On the Olive Branch section some 6-inch gold-bearing stone was recently cut at surface, and an open-cut was started to intersect this at a depth of 30 to 40 feet. This cut would be across a belt of quartz leaders, altogether 50 or 60 feet wide. None of the veins cut would pay to work singly, but it is hoped that they may be payable if worked together. A good vein, 18 inches of clean stone, was followed down a few feet into white friable sandstone, but broke up into strings. Parallel veins, 6 or 7 feet apart, traverse the country, but wind about and terminate. Good specimens of gold are visible in the quartz, but no pyrites. Some 16 or 18 years ago, 50 tons of 2-oz. stone were won, but the 11 tons recently crushed for the present tributors only returned 3 ozs. 11 dwts. 22 grs. Old workings are continually met with, and the prospects are very irregular.

Bonanza Mine.—The proprietary is sinking a shaft on the east slope of the Cabbage Tree Hill, with the intention of intercepting the Tasmania reef on its underlay. The shaft is now down over 250 feet, and is in hard conglo-

merate. Opening sets will probably be placed at the 300-feet, but the programme is to go down to a great depth before opening out.

Amalgamated West Tasmania.—Work has been resumed at this mine, and the south drive at 359 feet has been extended to about 35 feet from the shaft. It is expected to pick up a vein of quartz which was passed through in the shaft in about 50 feet of driving.

Auriferous Conglomerate at Beaconsfield.

Some assays of rock from beds of conglomerate in the eastern part of Cabbage Tree Hill were reported recently as returning promising and payable gold contents.

This belt of rock crosses the Phœnix crosscut at the 718-feet level in the Tasmania Mine. The succession of the strata at this point from east to west is—(1) white sandstone, (2) light sandstone, (3) dark sandstone, (4) pebble-bed 2 or 3 inches thick, (5) dark sandstone, (6) conglomerate (true thickness 18 feet, but 30 feet as passed through in the crosscut), (7) dark sandstone (6 feet), (8) conglomerate (2 feet 6 inches) (9) dark sandstones and conglomerate.

These dip regularly to the north-east at an average angle of 50° from the horizontal, and strike north-west. They occupy the position of the series marked as "dense black sandstones with occasional beds of grit" on Mr. Montgomery's chart, and are succeeded to the west by the main series of dark grits, sandstones, and conglomerates in the centre of the range. These beds in their north-westerly extension are intersected by the Olive Branch or Moonlight tunnel at about 300 feet from the air-shaft. Further north-west it is likely that they are still ahead of the north drives from the Wonder shaft, and must have been passed through in Statton's old tunnel from the east side of the hill. They apparently continue to the west side of Brandy Creek. Everywhere their outcrop is concealed under superficial detritus, and even at the Gorge their position can only be inferred, as there is loose ground just where they might be expected to be exposed. The main body of grits and conglomerates, however, is plainly shown there, and can be followed south all the way along the Blue Tier Range to Salisbury.

The conglomerates are neither more nor less than the shingle of an ancient shore-line, sorted by the water until the only pebbles remaining are those of quartz (both white and dark), with an occasional fragment of slate. Sometimes these pebbles are loosely compacted together, so that

they drop apart upon the rock being broken up with a hammer; but at other times they are cemented in a matrix of secondary quartz which holds the component stones firmly together. Apart from the main reefs of auriferous quartz, veins and veinlets traverse the rock in places, though sometimes these are entirely absent over a considerable space. Some of them may be simply segregation veins due to excess of silica, others traverse the beds across the stratification, and are the filling of fractures. Iron pyrites impregnate the matrix sparsely as a whole, though sometimes rather plentifully. The pebbles are small as a rule, ranging from the size of peas to that of marbles, sometimes larger. They are either sub-angular or well water-worn and smoothly oval. Where silicification of the matrix has taken place, the rock resembles in aspect some of the conglomerate on the Rand, and bearing in mind the auriferous nature of the Cabbage Tree Hill, intersected as it is by gold-bearing reefs and shedding quantities of auriferous detritus, it is not surprising that an attempt has been made to test the conglomerate for gold. Mr. C. F. Heathcote, A.M.I.C.E., the General Manager, has kindly given me the following details of the trials which he caused to be made.

No. 6 band above-mentioned was sampled in three sections of 10 feet each, and No. 8 sampled over the 2 feet 6 inches of wall. Where the conglomerate passed through to the 718-foot level, it narrowed to 25 feet, and samples were taken there in two sections of 12 feet 6 inches each.

The three 10-foot samples from the No. 6 conglomerate in the Phœnix crosscut were assayed at the Tasmania Works by Mr. Boyd ,and in Launceston by Mr. Austin Allom, and gave the following results:—

	oz.		Mr. Boyd. oz.	dwts.	grs.	Mr. Allom. ozs.	dwts.	grs.
First 10 feet.....	1·257	=	1	5	3	1	3	11
Second 10 „	0·587	=	0	11	17	0	12	9
Third 10 „	0·597	=	0	11	22	0	13	8
Average of above.	0·810	=	0	16	4	0	16	9

The 2 foot 6 inch band of conglomerate was sampled, and assays were as follows:—

Mr. Boyd.	Mr. Allom.
·522 oz. = 10 dwts. 10 grs.	11 dwts. 17 grs.

The whole 38 feet of Nos. 6, 7, and 8 were also sampled *en bloc*, and Mr. Allom's assay of this sample returned ·733 oz. gold = 14 grs. 15 dwts.

The same belt of rock was followed through to the 718-foot level, where two sets of samples were taken in sections of 12 feet 6 inches each, as well as one of the following band. The rock was found poorer here, the assays turning out as follows:—

First	12 ft. 6 inches	= ·342 oz.	= 6 dwts. 20 grs.
Second	12 „ 6 „	= ·097 „	= 1 dwt. 22 „
Next band..	.....	= ·153 „	= 3 dwts. 1 gr.

Samples of similar rock collected at surface round the shaft of the Imperial Mine assayed ·114 oz. gold 2 dwts. 6 grs.

the same band of rock was also sampled in the Olive Branch or Moonlight tunnel, and assayed as follows:—

22-foot band of conglomerate—

First	6 feet.....	·065 oz.	= 1 dwt. 7 grs. gold.
Second	6 „ (west)	·195 „	= 3 dwts. 21 „ „
Third	10 „	·114 „	= 2 „ 6 „ „

20-foot—

Chiefly sandstone, 4 feet	.....	·081 „	= 1 dwt. 14 „ „
Conglomerate, 6 ft.		·055 „	= 1 „ 2 „ „
Conglomerate and sandstone, 10 feet		·081 oz.	= 1 dwt. 14 „ „
	Average of 22 feet		= 1 dwt. 23 grs.

The conglomerate in the 600-foot level of the Tasmania Mine was also sampled, and assayed as follows:—

Footwall side, 10 feet east of No. 8 pass—

10 feet wide.....	·75 oz.	= 15 dwts.

33 feet west of above—

5 ft. 4 in. wide.....	·635 oz.	= 12 dwts. 16 grs.

The assay results from the samples taken in the Phœnix crosscut and the 600-foot level naturally excited hopes that the beds in question would prove to be of great economic value, and further tests were arranged with a view of confirming the results obtained and proving the contents of the conglomerate. As these tests proceeded, it became apparent that the results obtained by the assays above quoted were not sustained, only traces of gold being obtained from subsequent samples from the Phœnix crosscut.

Sampling in other places has also failed to reproduce anything like the first assay figures. The intermediate level over the 818-foot level was sampled in three 18-foot sections, and assayed—

18 feet of hanging-wall country					7½ grs.
18 feet	„	„	„	(next band)...	7½ grs.
18 feet	„	„	„	„ ...	traces

In the 500-foot level 3 lengths of 18 feet each were sampled, of which the first and second returned traces and the third 15 grs. per ton.

Assays of conglomerate elsewhere did not offer any fresh ground for hopes. Samples from the Bonanza dump returned only traces. The first, second, and third bands of conglomerate in the Gorge were also sampled, and yielded only traces of gold.

A drive from the Phœnix crosscut is being advanced south, opposite the wall where the samples were taken, for 30 feet. The assays from this drive have not yielded more than traces.

On my visit the General Manager allowed me to sample the mine wherever I wished, and I took bulk samples from the 30-foot conglomerate wall in the Phœnix crosscut, from the face of the south drive in that crosscut, from the 10-foot band of conglomerate in the 600-foot level, from the 5-foot 4-inch band of conglomerate in the same level. I also sampled the 22-foot and the 20-foot conglomerate and sandstone wall in the Olive Branch tunnel. All the samples were assayed by Mr. W. F. Ward, the Government Analyst, who reports as follows:—

"No sample showed more than traces of gold."

The cause of the discrepancy between the earlier and later results at the mine is not known, but we must take for the present the occurrence of payable gold in the conglomerate, apart from auriferous veins, as not established. If gold is ever found in the country-rock, the most likely varieties of conglomerate are not the loosely compacted ones, but those in which the pebbles are tightly cemented by the secondary quartz. It is not probable that the gold would be contemporaneous with the deposition of the sedimentary beds. Its introduction in all likelihood would be connected with the quartz veins and the silicification of the strata. The precipitation of gold in the country-rock would thus be a part of the great process governing its precipitation in the reefs. The possibility of its existence in the con-

glomerate should not be neglected, and search should be continued. The discovery of a band of auriferous rock would mean much to the industry of the district.

Gold Mining at Salisbury, Blue Tier.

The mines in this district are on the Blue Tier, a rather unfortunate name, for it is also used in Tasmania for the granite range on which are situate the tin mines near Lottah, on the East Coast. The Salisbury Tier is a N.W.-S.E. hill range, which is the direct continuation southwards of the Cabbage Tree Hill, from which it is severed by the gorge of Middle Arm Creek. The range is about 2½ miles long, and the mines are clustered at its southern end. The strata dip to the north-east, as at Beaconsfield, and the same succession approximately prevails, viz., conglomerates and grits in the western and central parts of the range, and light-coloured sandstones in the eastern part. The late Mr. Gould was of opinion that the limestone of Middle Arm Creek possibly continued along the eastern base of the Tier. A bed of dolomite, or dolomitic limestone, over 25 feet thick occurs in the Salisbury Mine adjacent to a dyke of serpentine in the new tunnel now being driven. This dolomite was in all probability originally ordinary limestone, and if so, it would strengthen the proof of the geological identity of these strata with those at Beaconsfield. In conformation of this, similar fossil remains are found in each.

Geological History.—These Lower Silurian (or Ordovician?) strata were at some time previous to the formation of the granites and quartz reefs of this part of the Island invaded by the pyroxenic rock which was subsequently converted into serpentine. It is true that the Tier is separated by a distance of 2½ to 3 miles from the exposed serpentine mass on Anderson's Creek, but that it was within the influence of the latter magma is evident from the occurrence of the serpentine minerals, nickel, chrome, and platinum, as well as from the existence of a dyke of serpentine in the new tunnel from the shaft of the Salisbury Mine. In Mr. W. F. Petterd's "Catalogue of the Minerals of Tasmania," platinum is reported (doubtfully) from the Tier in the form of small cubes, and millerite (sulphide of nickel) from a dyke in the old Victoria tunnel. The same Catalogue and its author's supplementary notes (Pro. Roy. Soc., Tas., 1902) register the occurrence also of nickel and chrome sulphates from the old Victoria Mine. Mr. W. F. Ward

analysed for me a sample of the green serpentine from the new tunnel as follows:—

	Per cent.	
Silica	34·0	
Oxide of iron, Alumina	7·0	
Lime	small	
Magnesia	38·0	
Carbonic acid, Water	20·0	lost at red heat.
	99·0	

The existence of a dyke of serpentine in this locality is of distinct interest, and explains much that was previously obscure. The dyke has been driven across in the tunnel for 25 feet. It is of a greenish hue, and is plentifully impregnated with grains of magnetite. As far as I can discover, there is nothing to show that the serpentine intrusion in this range brought any gold with it. On the other hand, there is proof that gold is contained in some of the veins of quartz, and, together with silver, in some of the pyrites of the quartz veins. Whenever it is found associated with any of the serpentine minerals, it is in connection with chalcedony, the origin of which is later than that of the serpentine. I infer that the primary gold of the range is connected with the formation of the quartz reefs (which may be supposed to have taken place during the cooling of the great granite mass which underlies the field). The geological student will find food for reflection in the circumstance of granite and serpentine, rocks at the extreme opposite ends of the scale (acid and basic) being found in juxtaposition in so many parts of our island, viz., here, at Heemskirk, Meredith Range, Heazlewood, Magnet Range, Dundas, and with no great geological lapse of time intervening, as if the underground magma had got rid of its basicity by the crystallisation of its basic components as the parents of our serpentines, leaving the more acid residue from which our granites were eventually evolved.

Mining at the Tier.—Only two companies, the Duchess of York and the Salisbury were at work when I visited the Tier. In the old days a good deal of gold was recovered from the detritus of the range, and phenomenal patches were met with. I was taken to several of these places on the crest of the spur. They appear to be along the line of a lode formation, and were, some of them, worked about 20 years ago. Patches of free gold were met with in sugary

quartz and soft seams of pug. It is singular that £20 or £30 worth of gold would be taken out of a small excavation in a week's work, though prospecting close to it would be absolutely fruitless. The quantity of gold found was surprising, but its irregularity was a marked feature of the field.

Salisbury Mine.—The Salisbury Gold Mining Company, Limited, holds the present sections, which consist of two 10-acre, one 20-acre, with a dam site of 2 acres on Sassafras Creek, and a water-right of 2 sluice-heads. The old Victoria tunnel which was driven over 20 years ago has fallen in, and is now quite inaccessible. It was driven west into the hill for 605 feet, and thence nearly 600 feet in a northerly direction, the latter course following the track of a lode at a depth of about 180 feet below the crest of the hill. Mr. Thureau mentions a nickel-bearing dyke in this tunnel, but without giving its position, and quotes returns of 1 to 13 ozs. of gold per ton of dressed pyrites derived from veins. He also states that at that time (1883) sulphurets were decomposing and forming new compounds with evolution of heat, 120° F. being registered in the drive at 1000 feet from the adit entrance. He says nests of free gold occur in the soft decomposed slate, locally called pug.

Information given to me by Mr. H. Masters respecting work done in 1894-6 is to the effect that a winze was sunk in the floor of the level, and at 25 feet down arsenical pyrites worth 2½ dwts. per ton were obtained. From this winze northwards a pyritic lode was followed, varying in width from 10 inches to 2 feet 6 inches. This very often dwindled to a mere track, but it may be said that as a rule the best yield was derived from the lode where it was comparatively narrow. I am told that the rich part of the vein carried 10 to 20 per cent. pyrites, with from 4 to 48 ozs. of gold per ton, though it is also stated that assays of rich concentrates gave as much as 122 ozs. This was just above where the tunnel now being driven is expected to cut the lode. At 100 feet behind the end of the old adit a gold-bearing pyrites lode was also intersected. Throughout the drive, however, beyond irregular assay returns, raising high hopes, nothing substantial seems to have been met with.

The present work comprises a shaft sunk on the eastern slope of the hill to a depth of 200 feet, from which a cross-cut is being driven to intersect the lode at 150 feet below the old Victoria workings. This has now been driven 330 feet north-west. Up to 280 feet it was in sandstones, with an easterly dip, and then passed into an intrusion of

serpentine 25 feet in thickness. The eruptive rock is green, and has a vertical lamination. It is succeeded in the tunnel by a reddish rock of great toughness, and showing massive heads. The drive is still in this. Its specific gravity is 2·9. A portion of it effervesces in heated acid. Mr. Hartwell Conder, M.A., has kindly made a determination of its silica percentage for me, and finds it to be 58·4 per cent. The rock is sprinkled all over with the glistening, pearly cleavage faces of dolomite, which, in transparent slices, show the optical properties of dolomite and calcite. The reddish portion of the rock appears to consist of some opaque form of silica not readily determinable. It seems safe to call it a siliceous dolomite. The habit of this rock in the tunnel is not that of an eruptive mass. Although serpentines are sometimes dolomitised, I think this dolomite never formed part of the adjoining dyke, but that it was at one time a bed of ordinary limestone, which was subsequently converted to a magnesian limestone, possibly under the influence of the neighbouring intrusive rock. Later still it became permeated by aqueous siliceous solutions, which resulted in giving it its present chalcedonic and jaspery nature; that of a chalcedonised or jasperised dolomite. It is somewhat singular that this bed has not been met with in the Duchess of York drives, unless the green, cavernous, sintery rock in the winze is a survival of it.

At 260 feet in the tunnel a vein of pyrites and quartz was cut, 18 inches wide, the concentrates from which returned by assay 3 ozs. 13 dwts. per ton. Another sample from the same vein returned 18 dwts. gold. I took several samples of the pyrites, and the Government Analyst's assay returned—

Gold, 3 dwts. 6 grs. per ton;
Silver, 2 ozs. 12 dwts. 6 grs. per ton.

Another pyritic vein was cut just before the tunnel entered the serpentine dyke. These veins are dipping west, that is to say, against the dip of the strata.

The crosscut is designed to cut the Victoria lode below the point where very rich concentrates were obtained in the old workings. The enterprise is a highly legitimate one, as if anything permanently remunerative is to be found in this hill, it must be sought by deep mining in order to get below all these sporadic irregular deposits into the better-defined channels and primary ore concentrations, which may be assumed to exist in depth. The work which is being

carried out now ought to have been undertaken long ago. I look upon the free gold which has been found in such quantity in the surface workings as being mainly derived from the decomposition of pyritic quartz veins, which will be found in depth in an unaltered state, possibly of fair size and richness.

Duchess of York Mine.—The Duchess of York Gold mining Company holds two 10-acre sections, a 7-acre section, and a 3-acre machinery site south and west of the Salisbury ground. Its main tunnel is the old Gladstone tunnel, which was named subsequently the Santa Claus Tunnel. This is a crosscut driven into the hill on a bearing of one degree south of west across yellowish and light-coloured sandstone strata dipping 45° to 50° in an easterly direction, and striking N. 40° W. The first reef struck in the tunnel is the Gladstone, a reef of favourable-looking, yellow stained, laminated quartz, with a hackly fracture and often friable. Its width is 3 feet 6 inches. It runs with the country, but dips south-west against it. Its footwall is irregular. Singularly enough, it carries only traces of gold. Some years ago it was driven upon north-west, but the old drive, said to be 70 or 80 feet long, is now blocked. Twenty feet further in the tunnel a winze has been sunk about 20 feet deep to intersect this reef, but does not appear to have done so.

A few yards beyond the winze veins of white quartz are seen dipping west against the country at about 50°. These are genuine fracture veins, 3 inches and 4 inches wide. Three of them occur in about a yard, and there are others in the back of the north-east drive where it starts from the tunnel. Just beyond this turn-off the main tunnel crosses a hard body of bluish chalcedonic quartz of a somewhat opaline look, with an irregularly distributed greenish stain, and impregnated with iron pyrites. This, assayed by Mr. W. F. Ward, returned 1 dwt. of gold per ton, and the pyrites contained a little nickel. Immediately on its western side it is succeeded by gossanous and cellular quartz, with nickel or chrome-stained clay seams and a cement of iron oxide. These chromic and steatitic seams are numerous; the former are apple-green in colour, the latter pinkish-yellow. This ferruginous and siliceous (chalcedonic) formation continues to the end of the tunnel, 30 feet beyond the nickeliferous quartz.

The drive north-west to the nugget chamber follows the eastern boundary of this iron-stained siliceous formation, and the chamber itself is excavated in it. The formation here has the aspect of a rock saturated with hydrous silica;

its structure is often cavernous. The nugget chamber is a small excavation 10 feet high, in which a clay or pug seam yielded 60 ozs. of gold, generally blackened superficially with manganese. Since then, however, no more gold was found. The discovery caused some stir, and a search was made for a lode by sinking a winze on the underlay of this formation for about 50 feet. The seam of pug, as it went down, at first yielded 1½ dwt. per dish, and afterwards barely prospects. A few tons from the winze were sluiced, and between ½-lb. and 1 lb. of pyrites obtained, which assayed 21 and 28 ozs. of gold per ton of sulphide. The bottom of the winze is about 200 feet from the surface, and the formation dips east (with the country) all the way down. I took samples from all round the chamber, and these were assayed by Mr. W. F. Ward, with the result—"traces of gold." Some bulk samples were taken for the company by Mr. A. Allom, who, with the company's permission, has kindly communicated to me his assay results, as follows:—

"Sample from about 2 feet of clayey matter, quartz, black oxide of manganese, &c., in the nugget chamber, 3 dwts. 13 grs. gold per ton.

"Sample from roof of chamber (2 feet sampled), 1 dwt. 22 grs. gold per ton.

"Sample from western side of chamber (2 feet sampled), 1 dwt. 7 grs. gold per ton.

"Two samples from north part of chamber, result unimportant.

"The gold was not disseminated throughout the stone, but the results were derived from single pieces in one part."

The drive was continued 100 feet further north-west, and then turned west and driven 50 feet across a bed of slate and conglomerate veined with quartz and impregnated with pyrites. These strata have the character of country near to, and mineralised by an adjacent lode; and have the strike and dip of the adjoining country. The belt is known in the mine reports by the name of the pyrites lode. Mr. Allom took and assayed samples consisting of slate and a little pyrites from the face when the crosscut was started, and obtained 1 dwt of gold per ton. I took samples, 3 feet apart, for the whole 50 feet of cross-cutting, and these, when assayed by Mr. W. F. Ward, yielded only traces of gold. The rock is soft, and the large pebbles of conglomerate have

been cut in half by the drive, showing strikingly on the walls of the crosscut. The face is in tough conglomerate. Some of the slate passed through is graphitic.

A shaft has been started 200 feet north of this pyritic slate band, and about 100 feet above tunnel-level. It is now down 40 feet, but has been stopped recently for financial reasons. The shaft ought to be carried down 200 or 300 feet, and then connected with the nugget formation, which may be found to have undergone some change at that depth. The pyritic slate beds will underlie the nugget formation, and can also be driven through in depth, but I am inclined to regard them as of subsidiary importance, owing their mineral contents to the proximity of the more siliceous formation.

For the sake of completeness, the main tunnel ought to be extended right across the lode formation. If the latter represents a channel, its walls are likely to be more favourable for mineral than its centre.

Further work is necessary to explain positively the origin and nature of the nugget chamber, but a tolerably safe guess can be made already. It is evident from the appearances, that there are three distinct periods or epochs represented. Firstly, the sedimentary beds of sandstone and slate were laid down; secondly, an intrusion of the rock, which is now serpentine, took place. I do not find any solid mass of serpentine in the Duchess of York, but the chrome and nickel and magnesian clay suggest that the nugget formation is a decomposed survival of it, or has been affected by its existence close by. There is probably a continuation of the serpentine from the Salisbury tunnel, and the nugget formation is along this line. I believe the serpentine intrusion to be anterior to the deposition of gold. Thirdly, the quartz reef epoch ensued, which veined the Blue Tier and Cabbage Tree Hill strata with auriferous lodes. Where the veins pass through sedimentary strata (slates, sandstones, and conglomerates) the gold deposits are of the ordinary nature, but when they either pass into serpentine or along the boundary-line of serpentine at its contact with other rocks, they put on an unusual appearance. The quartz becomes chalcedonic, being a mixture of crystalline and hydrous silica, and both wall-rocks (serpentine and sedimentary rock) are saturated with it to an extent which renders them barely recognisable. In this way two separate formations may be blended into one at the contact and carry minerals of two distinct periods, viz., the nickel and chrome of the older period, and the

gold and arsenical pyrites of the quartz reef period. I interpret the occurrence at the Duchess of York in this sense.

Now, whether the formation will carry more gold at a greater depth can only be proved by actual work. It is useless to argue probabilities or otherwise in advance. But certainly the existence of gold in the chamber indicates that it exists also lower down. The work necessary to prove the value of the formation should be undertaken, even if the chances of success cannot well be estimated at the present stage. In favour of the enterprise is the fact that so much gold has been won on the surface of the hill. Though this gold has the appearance of being re-precipitated gold, it must have been derived from veins or lodes, and these must exist in the rock below. In the nugget chamber area the gold has apparently been transported by the aqueous solutions of silica into the country rock outside its proper channel and precipitated there by agents which cannot be defined at present. The consequence is that the miner does not know in which part of the formation to search. I do not think that there is any encouragement to go on exploring the different parts of the gossanous and silicified formation at this level. It is true that isolated slugs of gold have been found, but there is no continuity in the channel, and no guarantee that continued search would be rewarded by further finds. The gossanous or oxidised portion of the formation will give place to solid rock at a greater depth, while the chalcedonic portion may continue downwards indefinitely. What I rather expect in depth would be quartz-pyrites veins carrying gold side by side with the chalcedony, and more likely to be regularly payable than the latter. The chalcedony carries, as it were, merely the overflow gold contents of the veins, and does not appear to be worth working by itself. The aim should be to get down to a good depth and open out on the normal lodes, proving, however, the chalcedonic formation at the same time.

What is really wanted, is not a little sinking here and there intermittently, but to sink a main shaft to the depth of several hundred feet, and then prove the strata by a long crosscut. Such an undertaking would be well warranted by the discoveries in the past.

On the saddle of the hill the company has sunk a prospecting shaft 50 feet without results. On the western side a connection has been made with the eastern side of the range by a winze from an old tunnel meeting a rise from

the Victoria tunnel. A phenomenal quantity of gold was obtained from this winze.

The "dyke tunnel" on the western slope was driven 151 feet north-east, first through sandstone, then slate strata, all dipping east. In the end is dark-blue quartzite or conglomerate, and from the plan there appears to be only 40 feet between it and the pyritic slate crosscut. There is some difference of level, but it would be easy to connect the two for ventilation, and the hill would then be completely pierced through at this point.

At the south end of the spur a bare rock face is exposed, from which the Salisbury Hydraulicking Association washed the superficial detritus some years ago. A succession of quartz veins is shown in this face. The sandstones seem friable all through, and carry stains of chrome or nickel. Mr. Austin Allom sampled this face, as follows:—

> "On west side, for a width of 27 feet, 1 dwt. 7 grs. gold per ton.
> "On east side, for a width of 33 feet, 2 dwts. 22 grs. gold per ton."

Assays from the extreme eastern and western points of the face had unimportant results.

A tunnel has been driven north into this face for 161 feet through silicified sandstones and quartz. At 27 feet a drive was opened east for 20 feet and a winze sunk 20 feet. At 62 feet a drive west has been carried 40 feet, and at 104 feet another drive west for 45 feet. Mr. Allom's assays from the drive west at 62 feet of samples taken for a distance of 10 feet were 3 dwts. 6 grs. gold per ton, and from the tunnel north of the drive for 21 feet, 1 dwt. 22 grs. per ton.

These results are confirmatory of the statements made to me that 3 dwts. per ton were obtained from the tunnel 23 years ago. I also gathered that a shaft has been sunk at the south end of the hill 80 feet, and 60 feet driven from it, and that a foot of stone cut assayed only a trace of gold in the quartz and 2½ dwts. in the pyrites.

The value of the Tier gold is stated at £3 17*s.* 6*d.*

From the above remarks it appears that the Blue Tier ground has not yet been proved in the mining sense of the term. Only surface and shallow explorations have been conducted. These, such as they were, showed the existence of gold in good quantity, though with a highly irregular distribution. Deeper work is essential to establish the nature of the deposits. If such work prove successful, the

ground to the north of the present mines will also deserve exploration.

In concluding this report, I beg to thank the mining managers of the Beaconsfield and Salisbury fields for information and assistance readily given; also, Messrs. Adye Douglas, jun., T. H. Walduck, M.H.A., D. Dally, H. Masters, Mr. Leonard, and others for many useful particulars.

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

W. H. TWELVETREES,
Government Geologist.

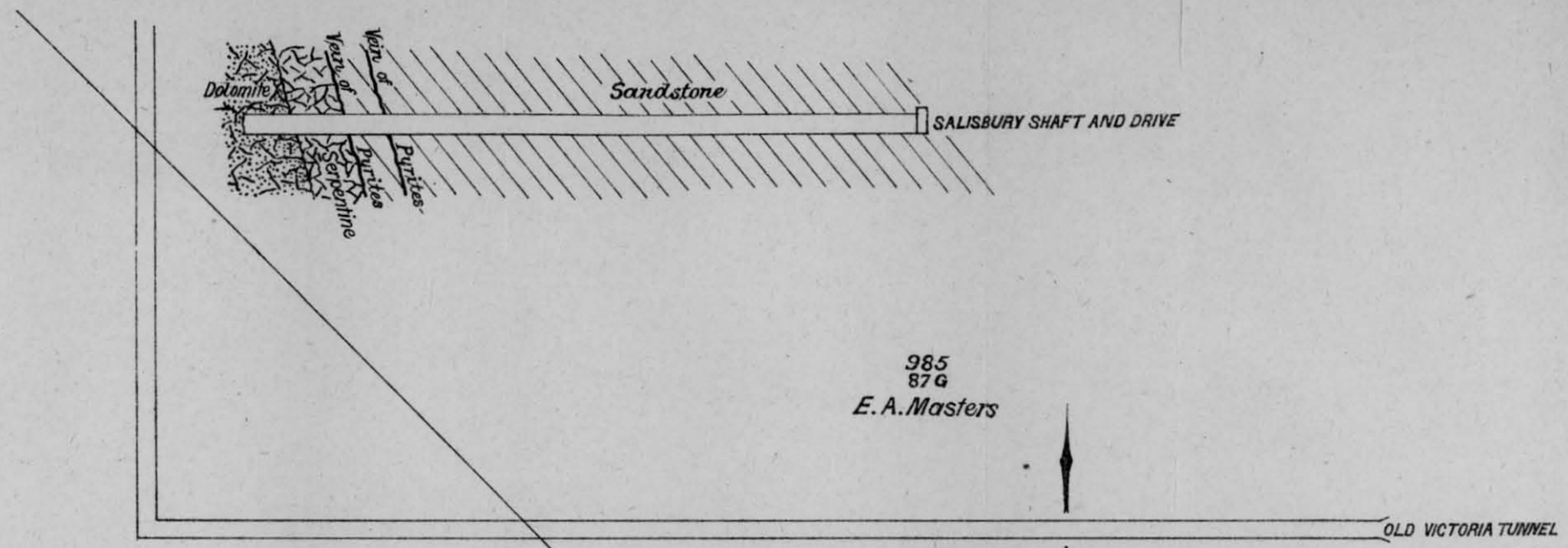
W. H. WALLACE, *Esq.*,
Secretary for Mines, Hobart.

JOHN VAIL,
GOVERNMENT PRINTER, TASMANIA.

PLATE I

(63)

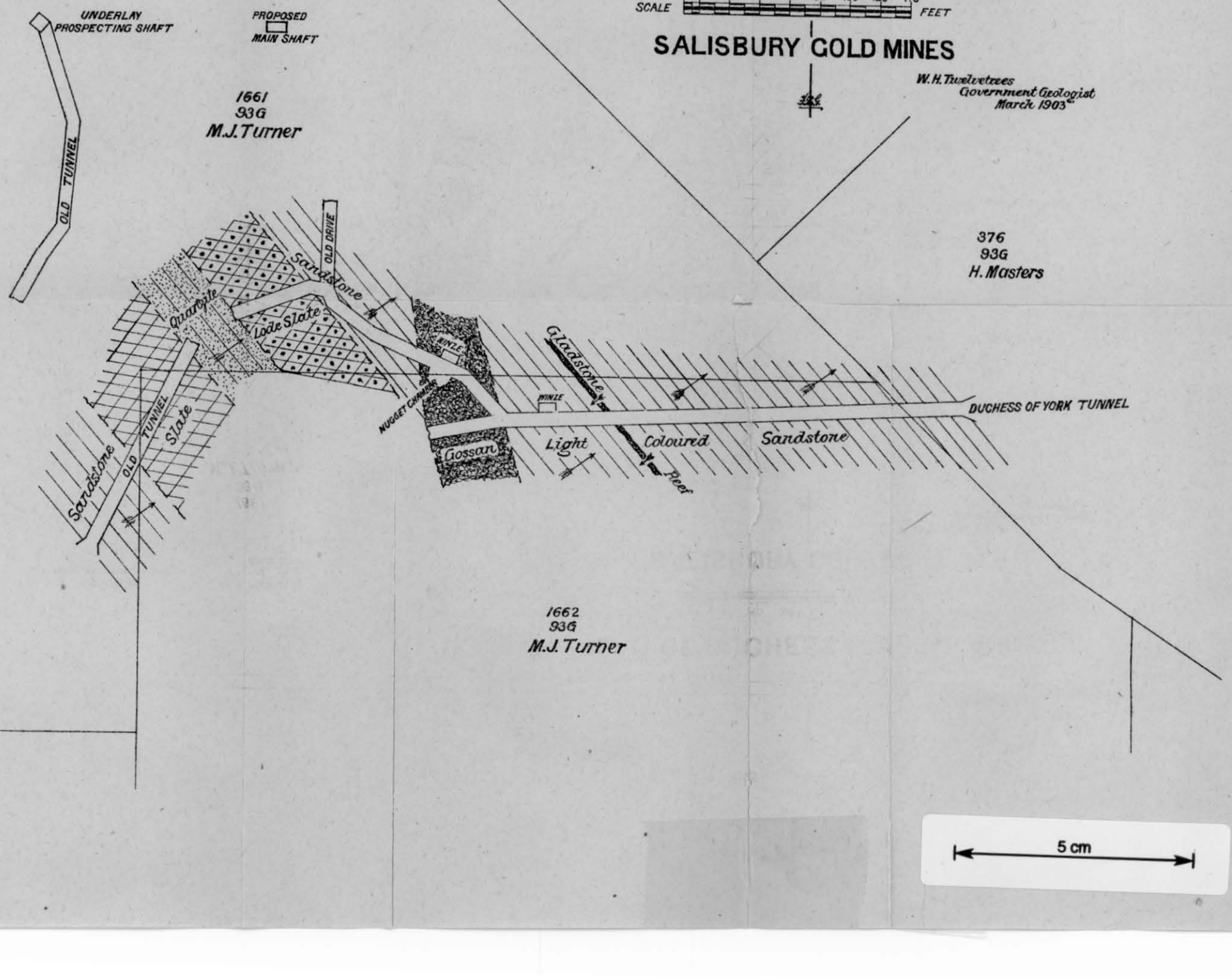
63/66



PLAN OF DUCHESS OF YORK AND SALISBURY GOLD MINES

SCALE 10 0 20 40 60 80 100 120 140 FEET

W. H. Twelvetrees
Government Geologist
March 1903



5 cm

JOHN VAIL, GOVERNMENT PRINTER, TASMANIA.

PLATE 2

SECTION OF STRATA

BETWEEN 700ft LEVEL (EAST) TASMANIA G.M. AND EAST TASMANIA BOUNDARY

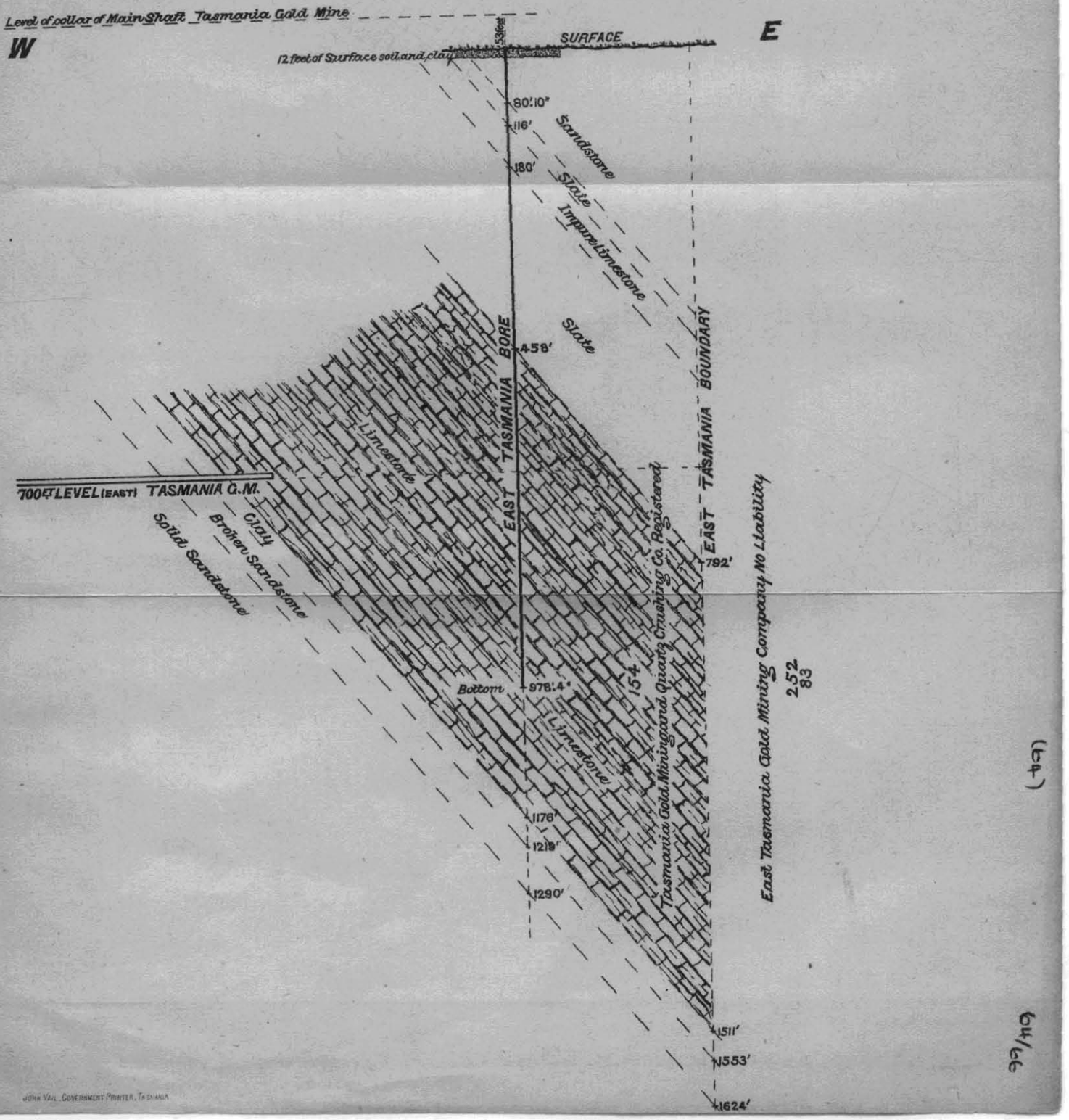
FEET 100 50 0 100 200 FEET 300

Scale, Vertical and Horizontal

1/10.

5 cm

W. H. Twelvetrees
Government Geologist
March 1903



(64)

64/66

JOHN VAIL, GOVERNMENT PRINTER, TASMANIA

PLATE 3

SKETCH MAP OF IRON-ORE DEPOSITS
ANDERSON'S CREEK

Scale 10 5 0 10 20 30 40 Chains

Granite

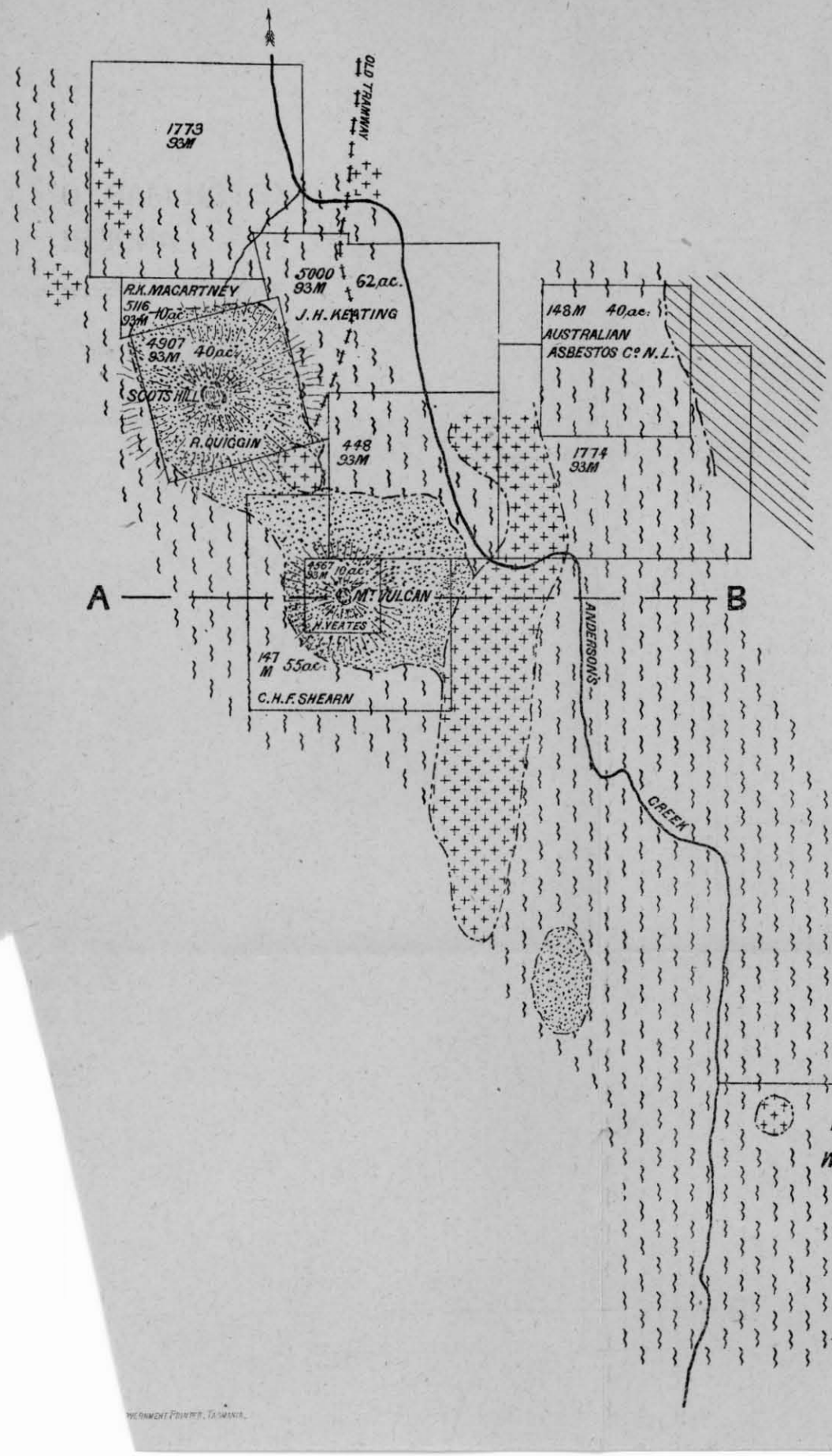
Sandstone

Serpentine

Iron-ore

W.H. Twelvetrees
Government Geologist
March 1903

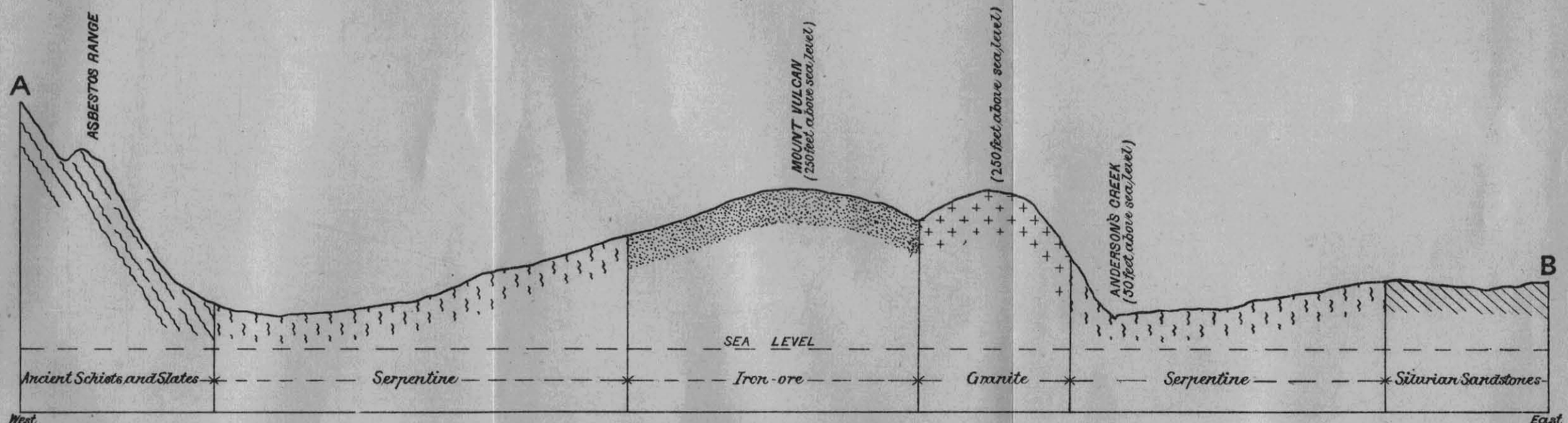
5 cm



GOVERNMENT PRINTER, TASMANIA.

PLATE 4

IDEAL SECTION ON LINE A–B



HORIZONTAL 5 4 3 2 1 0 10 20 30 40 CHAINS

VERTICAL 100 50 0 100 200 300 400 FEET

T.S.L.

W. H. Twelvetrees
Government Geologist
March 1903

JOHN VAIL, GOVERNMENT PRINTER, TASMANIA.

5 cm