

AR1908

TASMANIA



REPORT

OF THE

SECRETARY FOR MINES

FOR

YEAR ENDING DECEMBER 31

1908

Including Reports of the Inspectors of Mines, Government
Geologist, Mount Cameron Water-Race
Board, &c.



Tasmania:

JOHN VAIL, GOVERNMENT PRINTER, HOBART

1909

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REPORT OF THE SECRETARY FOR MINES.

Mines Department,
Hobart, 1st June, 1909.

SIR,

I HAVE the honour to submit my report upon the Mines Department and the Mining Industry for the year ending 31st December, 1908.

GENERAL REMARKS.

The aggregate value of the minerals and metals raised during the year was £1,650,027, being a decrease of £627,132 on the value of the output for the preceding year. This is principally owing to the decline in the market price of metals, for, with the exception of gold, silver-lead, and wolfram, the production of metals has increased.

The average price of tin during the year was £133 2s. 6d., as compared with £175 8s. during the previous year. It started at £124 15s. in January, receding to £123 5s. towards the end of the month, and reached its highest (£145) in April.

Silver started at 2s. 3 $\frac{1}{16}$ d. in February, and gradually receded to 2s. 0 $\frac{3}{16}$ d. in December; the average price being 2s. 2 $\frac{3}{16}$ d., as compared with 2s. 6 $\frac{1}{16}$ d. last year.

The average price of copper was £60 0s. 5 $\frac{1}{16}$ d., as compared with £87 1s. 5 $\frac{1}{4}$ d. last year. The highest price (£63 10s. 8 $\frac{1}{4}$ d.) was reached in November, and the lowest (£57 10s. 8 $\frac{1}{4}$ d.) in May. It will therefore be seen that the

fall in the market value of metals has seriously affected the value of the output for the year.

My attention has been drawn to the state of the tracks from Lynchford to Mts. Jukes and Darwin, and from Mts. Read and Tyndall to Lyell, and the White River Valley track (Godkin's), which are blocked with fallen timber and overgrown with scrub. They should be cleared and opened up again.

It has frequently been suggested that tracks from Howard's Plains to Zeehan, and from Harris' Reward Sections to Flannigan's Flat, would open up country which is well worth prospecting, and doubtless would receive immediate attention by prospectors if facilities were afforded them for getting their provisions and tools packed out.

Considering the importance of the mining industry to the State, and the revenue derived from the rents, dividend taxes, &c., the Department has done very little in return, either to encourage the introduction of capital for the development of mining, or to induce prospectors to go out into new country to prosecute their endeavours in search of new fields.

From time to time amounts have been placed upon the Estimates for subsidising companies to encourage them in their deep-sinking and crosscutting operations for testing the existence of reefs and lodes, and although such operations have not hitherto proved successful in establishing the existence of minerals at any great depth, it is quite possible that the barren zones have not been passed through, and the existence of reefs or lodes below 1000 feet yet remains to be proved. Last year the Zeehan-Western, Limited, Company, was subsidised upon the £ for £ principle to sink from 800 to 1000 feet, but the company was unable to secure any further assistance, and not having sufficient capital to explore at that depth, their operations had to be abandoned, and the problem of the existence or otherwise of silver-lead lodes at that depth still remains unsolved. This is to be regretted, for

the future life of the field depends upon the lodes lying down, as the existing mines will soon be worked out to 500 or 600 feet, and should their lodes cease to exist below that depth they will probably be abandoned, whereas they would be encouraged to sink to greater depths if the operations at only one mine proved that below that depth a barren zone had to be passed through before recovering the lodes.

During the year, an Act to regulate the buying and selling of gold, framed upon the Victorian Act, was passed by Parliament; but it has already been proved to press very hardly upon persons working small claims under their Miners' Rights, and will require amending during the coming session.

The sale of Crown lands for agricultural purposes within mining areas, under Part V. of "The Crown Lands Act," frequently causes a great deal of trouble, and needs careful consideration, until the Act is so amended that the two industries can be carried on harmoniously in the same localities. In some districts there is plenty of first-class agricultural land on the border of known mineral land, and it is very often difficult, without a geological examination, to determine whether minerals are or are not likely to exist below the surface. I regard the reserved right to mine, as secured by "The Crown Lands Act, 1903," under Sections 67 and 68, as illusory, and not offering the freedom of action which a prospector or mineral lessee requires.

Nine miners out of ten will avoid private land, when they have to make formal application and wait until *Gazette* formalities are gone through and assessors appointed, who are to determine an amount of compensation for damage which the owner is likely to sustain, which amount must be paid to the owner before any mining is commenced on the land. This practically blocks prospecting, and it must be remembered that prospectors will not search where they are under the observation of others.

Applications for reward claims for an aggregate area of 250 acres have been lodged for the discovery of galena, copper, tin, and barytes.

APPENDICES.

Appended will be found the following reports and papers:—

- Annual Report of the Mt. Cameron Water-race Board.
- Report of the Government Geologist.
- Report of the Assistant Government Geologist.
- Report of the Chief Inspector of Mines.
- Reports of the Inspectors of Mines.
- Papers by W. H. Twelvetrees on the Geology of Tasmania and the Latrobe Shale Deposits.
- The Government Geologist's Report on the Lisle Gold-field.
- The Assistant Government Geologist's Report on the Mt. Farrell Mining Field.

GOLD-MINING.

The total quantity of gold won during the year was 57,085·124 fine ounces, valued at £242,482, being a decrease of 8259·128 ounces, and £35,126 on the previous year.

Beaconsfield.—The yield from this district was 30,127·65 fine ounces of gold. The Tasmania Gold Mine was the chief producer, having won 27,732 ounces of gold, from 71,040 tons of quartz crushed, an average of 7 dwts. $19\frac{42}{111}$ grs. per ton. The total quantity of gold won by the company to date is 772,890 ounces, from 757,775 tons of quartz crushed. The total amount paid in dividends is £772,671 15s. No dividends have been paid since 1905.

The following is an abstract from the company's report for the year ending 30th September, 1908:—

“At the date of the last annual report, Grubb's Shaft had reached a depth of 1277 feet, and at 1250 feet from

surface, a crosscut was being driven in the direction of Hart's, to reach the lode, which, it was anticipated, would be met with at a distance of some 360 feet. The lode was actually encountered at 335 feet from the shaft. Where struck, it was found to be split into two parts by a horse of waste rock, of a width of 16 feet, the reef itself showing on the hanging-wall 3 feet of quartz, valued at $12\frac{1}{2}$ dwts., and on the footwall, 6 feet of quartz, also valued at $12\frac{1}{2}$ dwts.

“Since then the level has been driven westward $177\frac{1}{2}$ feet, and eastward 270 feet, a total distance of $447\frac{1}{2}$ feet, $421\frac{1}{2}$ feet giving an average width of reef of 7 feet, of an assay value of $12\frac{1}{4}$ dwt. of gold per ton, 'exclusive of blank ground and horses of mullock.'

“The 1100-foot level west was extended 79 feet on the lode, which averaged $6\frac{1}{2}$ feet wide and 15 dwts. per ton.

“Eastward, exploratory work has been carried on beyond the fault existing in that direction, with a view to the recovery of the lode. A mineralised formation has been met with, but as yet the reef is not well defined.

“For the total length the 1100-foot level has now reached (viz., 814 feet), the average width of the lode has been $6\frac{3}{4}$ feet, and the average value 16 dwts.; the 814 feet being exclusive of the distance driven beyond the eastern fault.

“The 1000-foot level west was extended 390 feet, and for the distance of 1292 feet now driven east and west of the shaft, the assay value has averaged $19\frac{1}{4}$ dwts., over an average width of reef of $5\frac{3}{4}$ feet.

“The winzes and rises to effect communication between the bottom levels and to block out the ground for stoping, have shown, in many instances, an excellent grade of ore.

“In regard to the North Tasmania Mine (now known as the North Section), which, as mentioned 12 months ago, had been acquired by this company, the superintendent reports as follows:—

“Work was started here in October, 1907, but before exploration could be carried out it was necessary to repair

the old underlay shaft for a distance of 109½ feet; to lengthen a winze by 6 feet for a depth of 80 feet; to carry a leading stope into the fault a distance of 100 feet; and generally to repair old workings for upcast ventilation. Air-boxes, formerly in use at the mine, were placed from the 327-foot level to the fault at the 400-foot level (a length of 260 feet), and connected to blower at surface by 18-inch diameter pipes. The drive south on fault was then cleaned out, road laid, and driving started in January, 1908. At 223 feet from the main drive the footwall part of lode was cut east of the fault, and the hanging-wall part at 248 feet; the distance driven being 153 feet. The footwall part of lode has been followed east 175 feet, in which distance two faults have been met with, which throw the lode to the south; the average width of quartz has been about 2½ feet, value from nil to a trace. The hanging-wall stone has been driven on for 60 feet; average width, 1 foot; value 3½ dwts. A small chute, not included in the average, about 8 inches wide, of rich stone was met with, assaying 27 ozs. per ton. The total distance driven on the smaller faults was 68 feet."

The following is a summary of the work accomplished during the 12 months:—

	feet.
Grubb's shaft	76
Crosscuts	1187
Main drives	1311
Winzes and rises	1361½
Repairs, drives, &c....	447
Mullock drives	503½

It was not found practicable to continue the sinking of Grubb's shaft beyond the 76 feet mentioned, owing to a large proportion of the output of ore being hauled through it. As soon, however, as a connection has been made at the 1250-foot level, between that shaft and Hart's, sinking will be resumed.

Hart's shaft has also been in abeyance, as it will be more economical, in order to effect a communication from the 1250-foot level, to rise against the shaft rather than to continue its sinking.

With connection between the two shafts once established at the 1250-foot level, enabling the water to be distributed between those two points, it will be practicable to continue the sinking of Grubb's shaft towards a 1500-foot level, whilst at the requisite depth, commencing a 1375-foot level, which will also be the next objective point at Hart's.

The Bonanza Company has sunk its shaft to a depth of 1180 feet.

Lefroy.—The total quantity of gold won from this field during the year was as follows:—

	oz.
New Pinafore Gold Mine	406
Creek Syndicate	422
Wilson's Syndicate	64
Kitto's Chum Syndicate... ..	107
G. Digney	44
Prospectors and others... ..	30.9

Total 1073.9

Beyond a little prospecting work nothing of any consequence is now being done upon this once flourishing field. The New Pinafore Company has not availed itself of the subsidy for deep-sinking passed by Parliament during the session of 1906. The discovery of a reef in the vicinity of the old West Chum Mine was made by Kitto and party early in the year; a small shaft was sunk 62 feet; the lode was cut and driven on some distance. East and west of the crosscut some stoping was done, and 84 tons of stone obtained and sent to Pinafore battery gave a return of 108 ounces of gold, which was considered very satisfactory. The show was then floated into a small company, a steam-winch winding-plant procured, and a shaft 10 ft. 6 in. × 3 ft. 6 in. sunk to a depth of 200 feet. The lode was cut

at two levels and driven on, but results were not satisfactory; the bottom level was disappointing both east and west. Some good stone was to be seen going east at No. 1 level, but the shoot was short, and operations were suspended and the mine closed down.

Lisle, Golconda.—About 33 prospectors were engaged during the year in working the old alluvial diggings, and they obtained 298 ounces of gold. Mr. W. H. Twelvetrees, Government Geologist, who visited and reported upon the Lisle field during the year, says:—

“The field, which was discovered by the Bessell Bros. in December, 1878, became within six months the site of the most extensive alluvial operations that Tasmania has ever witnessed; 2500 souls crowding to the valley, which was found to be clothed with dense, unpenetrated bush. After three or four years' work at high pressure, during which time an enormous quantity of alluvial gold was won, the activity slackened, and the goldwinners gradually withdrew, leaving behind but a remnant, whose numbers decreased slowly, until to-day a couple of dozen workers ply their avocation, where there were formerly a couple of thousand.

“It is difficult to state precise figures of output, because so much gold was taken or sent to Victoria without being reported to the authorities in Tasmania. Consequently figures vary between 80,000 and 300,000 ounces. The estimates which are, perhaps, most worthy of credence place the total output at 250,000 ounces, more or less. This gold has been won from a mere fractional part of the area of a valley, the whole of which does not exceed a mile and a half square in extent. The bulk of it has been sluiced from the bed and banks of the Main Creek, and from terraces sloping down to it on the eastern side of the valley; the remainder has been obtained from small creeks on the opposite side of the basin and from terraces above them.

“What has puzzled every miner and every visitor who has been confronted with the occurrences on the field is the circumstance that no reefs have been found in the valley or on the surrounding hills from which the gold may have been shed. No gold-bearing quartz has been found in the workings (beyond now and then a minute specimen), nuggets are rare, and the bulk of the creek and terrace wash consists of sandstone. The sole outlet of the valley waters is a narrow gorge at the north end, where the stream flows over a small rocky bar. The visitor, standing on the floor of the valley, finds himself in a locked basin, walled in all round by hills 800 feet to 1200 feet high, and becomes aware that, whatever may be the origin of the gold, the whole of it has been derived from some source within the area upon which he gazes. The floor of the valley is granite, which now and again has been sluiced bare, and which, concealed beneath a heavy overburden of clay and hill detritus, rises up the flanks of the hills to a height of 400 feet or 500 feet. It then junctions with sandstone or slate, in which it has intruded, and which it has profoundly metamorphosed in the way common to granite contacts. Under this influence the sandstone and slate on the eastern side of the valley appear most frequently as a siliceous, dark blue, metamorphic rock, occasionally mistaken for basalt, to which, at a cursory glance, it bears some sort of a superficial resemblance. In places it is a reddish brown, highly micaceous sandstone, becoming argillaceous during decomposition. On the west side of the valley there is much less of the bluish quartzite. In some places this metamorphic rock has been originally a slate. The junction of the granite with the metamorphic rock is always hidden beneath the covering of clay and detritus which clothes the hill slopes. In one instance, however, it has been reached by tunnelling, viz., in C. Bessell's tunnel, on the western hill slope. There the contact was marked by a vein of chalcedony. I have consequently scrutinised closely the nature of the stones with which the gold is

associated in the alluvial workings, in order to see whether any useful information may be gained from them.

" 1. First, an absence of stones of granite may be noticed. These are rare. The granite bottom is always soft, hence no stones could well be released from it.

" 2. Stones of chalcedony (sometimes carrying disseminated pyrite) are common. These have probably proceeded from veins in the granite and from the contact-line.

" 3. Stones of the blue metamorphosed sandstone are the most frequent. These have the habit of weathering to an external crust, until at last very often a small kernel of the fresh rock remains in the centre. The miners call this becoming coated with sandstone.

" 4. Stones of the reddish brown micaceous sandstone are also common in the wash. These weather until they are completely disintegrated.

" 5. Locally, there are large stones of white barren quartz in the wash of detritus. The veins from which they have proceeded have not been found. Such veins have not been noticed in the soft granite bottom anywhere; nor have they been discovered outcropping in the sandstone rock, though it is surmised that that is their home.

" The creek workings have yielded the most gold; the terraces, rich in patches, have given only a fraction of the total output. In the terraces a few feet of clayey bottom wash have contained the best gold; the upper part, consisting of hill detritus and subangular drift, has generally been non-payable, though carrying gold. On the slopes of the hills gold has been found in the very grass. Here and there are signs of the terrace drift having accumulated on a lake shore, but there is no proof that the lake filled the entire basin at any one time.

" Practical miners, with experience gained on the mainland, and experts, have visited the field from time to time, but have gone away baffled and mystified. Recourse has even been had to a theory that the gold has been carried here from reefs on the other side of the Patersonia Divide.

But if there is anything which stands out more clearly than another, it is that all this gold never proceeded from ordinary quartz reefs. If it had, specimens of gold quartz would have been fairly abundant. The absence, or more strictly speaking, rarity, of specimens absolutely precludes the idea that the gold was a constituent of quartz reefs. We seem, therefore, shut up to the idea that the gold was derived (1) either from soft seams in the granite (*e.g.*, of mica or kaolin), or (2) from chalcedony veins at the contact of the granite and sandstone, or (3) from impregnations of the sandstone near the granite contact. No gold has ever been seen in the stones of chalcedony, so there is no evidence that can be appealed to in favour of a chalcidonic source, beyond the fact that I was able to detect pyrite in some of the stones. Apart from this the source of supply would be too limited.

" As for the idea, which I suggest, that some gold may have been released from joints or veins in the granite filled with or composed of micaceous material, I think this may very possibly have been the case, but the proof is difficult.

" With regard to the final suggestion which I advance, I consider it as the solution of the problem. The sandstone near its contact with the granite has on this hypothesis been saturated with silica from the cooling granite, and this gold-bearing siliceous solution permeating the porous rock has deposited its metallic freight in the interstices of the sandstone. The gradual weathering of the rock has liberated the gold, which, together with the sandstone detritus and wash, has found its way down hill to the terraces and creek alluvial. I cannot quote any parallel occurrence, but all the facts and features of this field are in harmony with this view. The pieces of sandstone with crustal weathering are looked upon locally as characteristically the associates of gold; and on this supposition we can readily see why they are.

" Finally, I have detected visible free gold in the dark-bluish sandstone referred to above. One of the rock

specimens which I brought home, on being broken, showed distinct specks of gold free from quartz or pyrite. It is true that I have only been able to observe this in a single specimen, and I have broken hundreds of other samples; but one solid fact outweighs numberless negative results. It may therefore be accepted as an undoubted fact that gold is present in the sandstone, and I have no doubt that the bulk of the Lisle alluvial gold has been derived from the wasting away of the impregnated stratified rock near its contact with the granite. This impregnation may be irregular, and in any case it will not be easy to find the metalliferous patches, and even when found they will not necessarily prove payable. But if it is considered desirable to carry out tests, the first thing to do is to remove the overburden, and lay bare the bed-rock at the contact. It may be that patches of it will be found rich enough to work. The contact line from Donnelly's to behind Bessell's suggests itself as the most likely locality for such work.

"The gold-bearing specimen may be seen at my office by anyone interested in the matter.

"A good deal of alluvial ground in the western part of the valley remains to be worked, and some of this is to be taken in hand directly by the new company lately registered in England.

Mt. Victoria.—One hundred and nine ounces of gold were obtained from quartz, about half a dozen men being employed.

The New River Freehold Mine resumed work in the early part of the year, but operations ceased after a few months' work. Want of capital is the reason assigned for this. It seems a pity that the lode on this company's property has not received a trial at a greater depth, there being, it is stated, a fairly good body of stone carrying gold (ounce stone in places). It has only been tested to a depth of 200 feet.

The New Ringarooma Syndicate is still working with two or three men.

Mathinna.—During the year ending 31st January, 1909, 1903 tons of quartz have been crushed by the New Golden Gate Mine, and 1154 ounces of retorted gold have been obtained at the battery, and 142 ounces of bullion from cyanide plant, valued at £4104 15s. 6d. From this, also, 9 $\frac{3}{4}$ tons of pyrites were obtained by concentrating tables, containing 208 ounces of gold, valued at £607 6s. 6d., which, together with rental of cyanide plant (£76 11s. 3d.) and charge for crushing a parcel of quartz from outside sources (£5), also interest on fixed deposit (£46 4s. 11d.), made a total revenue of £4839 18s. 2d. The cost of raising and crushing quartz, treating concentrates, tailings and slimes, repairs and renewals to plant, progressive and surface works, and all other expenses incidental to working the mine and managing the company, amounts to £4507 9s. 1d., or £2064 16s. 11d. in excess of revenue obtained from the mine.

The total quantity of quartz now obtained from the mine is 273,251 tons, which has yielded 228,990 ounces of gold an average of 16 dwts. 18·21 grs. per ton, and which has realised £870,513 18s. 10d. The total amount paid in dividends is £355,200, or £11 2s. per share; and the total amount paid for dividend tax is £16,638 10s.

The Golden Horseshoe Company has taken up some sections at Dan's Rivulet, near Mathinna, and is actively prospecting them.

The Tasmanian Consols Mine obtained 2459 ounces of gold. The mine has now closed down, the last of the payable stone having been taken out.

The Miner's Dream and Scott and Pickett Mines were closed down towards the end of the year.

The Briseis and North Brothers' Home Tin Mining Companies at Derby obtained 57 and 39·84 ounces of gold respectively from their tin drifts; the South Mt.

Cameron Tin Mining Company, 78.30 ounces; and the Ringarooma, Dorset, and Gladstone Bucket Dredges, on the Ringarooma River, obtained respectively 3769.90 and 41.35 ounces.

Gladstone.—Some work has been proceeding at two points near the Gladstone township, viz., (1) a little north of the old Royal Tasman, by the Dreadnought Gold Mining Syndicate; and (2) at O'Halloran's and Saville's discovery, by the Gladstone Gold Prospecting Association.

(1) Dreadnought Gold Mining Syndicate.—The reef crops out at surface near the old Tasman shaft, and a cut has been put into it showing the stone to be, roughly, east and west. A little stone has been got, and the reef channel proved to be about 4 feet wide; but in the cut it has apparently narrowed somewhat. Below is the North Tasman tunnel, which was driven upwards of 300 feet in a northerly direction, with drives at the end both east and west, but now fallen in.

At present nothing much can be seen of the lode underground, but the stone has apparently come down to this level. The old hands say that the reef-channel was about 8 feet wide, of which 4 feet consisted of a horse of mullock. What stone is visible is mottled and kindly looking, but nothing definite can be learned as to the occurrence before the old drives are cleared out. The reef seems to be a parallel one with the Royal Tasman reef. The latter was expected to be cut in the tunnel, but has not been seen. Some rich samples are stated to have been taken.

(2) Gladstone Gold Prospecting Association.—The ground on which operations are proceeding is across the creek, opposite the Dreadnought. Here, too, a parallel reef is being worked upon. A north and south reef, with stone 6 to 10 inches wide, has been opened upon, and good assays stated to have been obtained. I saw that free gold occurred in the stone. A hundred feet north from the open-cut the reef is intersected by another, which also

yields good prospects, with good gold also in the rubble. A shaft is being sunk near the intersection to test the reef in depth.

If these reefs at Gladstone can be shown to be worth development—and they certainly seem worth proving—good work will have been done.

The occurrence of this gold tends to confirm the old Royal Tasman discovery, which at the time received scant credence, but which, perhaps, after all, deserved better treatment.

West Coast.—The quantity of gold won from alluvial workings was only 24½ ounces.

Towards the close of the year, Mr. W. Davie, of Lynchford, discovered a gossanous gold-bearing formation at the head of the Mt. Lyell Company's tramway-line, about 4 miles from Lynchford, from which some good prospects are said to have been obtained.

On the opposite side of the valley to the gossanous outcrop, Mr. Davie discovered a small quartz reef outcropping on the surface, and is putting in a tunnel to cut the reef 30 or 40 feet below.

The land has since been taken up under lease by the Davie Prospecting Syndicate.

When at Queenstown in March last, I visited the ground, and took a sample of the gossan and had it assayed by the Government Analyst. It gave 6 dwts. 12 grs. of gold and 1 dwt. of silver.

SILVER-LEAD MINING.

The quantity of silver-lead ore produced was 63,116.92 tons, valued at £322,007, being a decrease in quantity and value of 26,645.64 tons and £250,553.

The decrease is principally owing to the temporary stoppage of the Tasmanian Smelting Company's works in April, followed by the temporary closing down of the Magnet and Hercules Mines.

The principal producers were:—

	Tons.	Value. £
<i>Mt. Zeehan.</i>		
Mt. Zeehan (Tas.) Company	4422	51,910
Zeehan-Montana Mine... ..	3572.63	46,456
Zeehan-Western, Limited	1054.17	8413
Zeehan-Queen Mine	234	813
Silver Queen Extended Mine	514.75	2115
Oonah Mine	4553	10,064
Silver King Company	93	797
Florence Company... ..	2809	31,989
Watt's Section	60.76	621
Austral Valley Company	276.58	1204
Zeehan Bell Company	94.30	744
Section 1064-m	63	478
Victoria-Zeehan Mine	29.25	271
Tasmanian Smelting Company (Bal- strup's)	1590	1703
Sylvester Company	50.50	262
New Mt. Zeehan Company	589.37	1076
Colonel North Company	320.47	968
Section 1816-m	67.06	292
Section 1914	20.30	205
T.L.E.	30.21	122
Section 1846	15.75	151
Nubeena Mine... ..	72.90	860
South Comstock Company	22	242
<i>Mt. Dundas.</i>		
Comet Company	8327.11	5116
West Comet Company	2211.35	1171
Hercules Company	12,964	51,447
Adelaide Company	50.74	655
Anderson's	20	255
<i>Rosebery.</i>		
Primrose Company	1649	6034
Tasmanian Copper Company	7610.71	25,245
<i>Mt. Farrell.</i>		
North Mt. Farrell Company	3825	31,796
Mt. Farrell Company	196.85	706
Murchison River Company	279.75	4545
Macintosh Mine	88	1122

Zeehan District.—This district has experienced a period of great depression, owing to the low price of metals, the temporary closing down of the Tasmanian Smelting Works, followed by the fiasco at the Colebrook smelters, and the temporary closing down of the Hercules Mine. A large body of men were thereby thrown out of employment, many of whom left the district, while others who had their homes and families at Zeehan were unable to leave. Such a period of depression cannot possibly be realised by those who have not actually experienced it. Business was at a standstill; tradespeople became alarmed; and a deputation was sent to Hobart to interview the Premier and ask him to consider the position and give some help to keep the place going, as the loss to the State in that way would be less than if the smelters were allowed to close down permanently. The position was saved by the Government making certain freight concessions to the Tasmanian Smelting Company, and by passing a Bill authorising a loan of £20,000 to the company.

The Zeehan-Western, Limited, has sunk its shaft a further depth of 200 feet, and is now down 1000 feet, having been subsidised by the Government to the extent of £3000 upon the expenditure of an equal amount by the company. The company has applied for a further sum to enable it to drive at the 1000-feet level to ascertain if the lode, which existed at the shallower levels, continues down. This shaft is the deepest on the field, and it would be a great pity to allow it to be closed down when the expenditure of a comparatively small sum of money would determine whether or not the lodes on the Zeehan field exist at a depth.

The Mt. Zeehan (Tas.) Mine and the Zeehan-Montana Mines continue to be the largest producers on the field.

Florence Mine.—During the latter part of the year the mine became flooded at the bottom level through striking a heavy flow of water, and operations had to be confined to the lodes above water-level, the boiler-power not being

sufficient to contend with the water. This, added to the stoppage of the smelters, caused the output from the mines to be very considerably restricted.

Dundas District.—The Comet and West Comet and Adelaide Mines were the only mines at work during the year. The latter company, during the last quarter, confined its operations to driving the No. 3 level (320 feet), which was extended 142 feet; total, 501 feet. The shaft was sunk 35 feet; total, 89 feet below No. 3 level. At 50 feet below No. 3 level the lode was exposed, 7 feet wide, with 18 inches to 2 feet of galena.

Mt. Read District.—Hercules Mine.—This mine suspended operations temporarily on the 15th May, owing to the closing down of the Tasmanian Smelting Company's works and the difficulty of getting at the zinc-blende ore in the mine, caused through a subsidence. The company resumed operations again early in July, and has been working continuously since.

Rosebery District.—The Tasmanian Copper Company has been opening up its zinc-lead sulphide mine.

The Tri-metallic Company has taken up a large area of ground for the purpose of erecting smelters for treating the complex ores in this locality by a new process, in the hope of recovering a large proportion of the zinc, in addition to the usual yield of silver and lead.

The Colebrook Company completed its smelting plant, but was compelled to close down after a very short run, owing to the grade of the ore mined and the low price of copper.

Mt. Farrell District.—The North Mt. Farrell Company has maintained a steady output, averaging 318 tons of galena ore per week. The old wooden tramway line from the mine to Rosebery has been replaced by a steel tram-line junctioning with the Emu Bay line at Boko Siding.

The Mt. Farrell, Mackintosh, and Murchison River Companies raised respectively 196, 88, and 279 tons of ore.

North-Western District.—The Magnet Silver Mine produced 5170.28 tons of ore, valued at £30,349. The output from the mine was restricted owing to a strike, which occurred in the early part of the year.

Long Tunnel, Mt. Stewart.—Forty-four tons of ore were raised, valued at £581; six men being employed.

Northern and Southern District.—The Devon Mine raised 60 tons of ore, valued at £870, employing seven men.

The Round Hill Mine raised 65 tons of ore, valued at £360; seven men employed.

COPPER-MINING.

The total quantity of blister copper and copper ore produced was 10,018.15 tons, valued at £609,651; being an increase of £982.90 tons on the previous year's output.

The output of the Mt. Lyell Mining and Railway Company, Limited, has been steadily maintained, the mine having produced 8833 tons of blister copper, containing 8722 tons of copper, valued at £533,026 8s. 5d.; 689,985 ounces of silver, valued at £70,035 13s. 11d.; 18,355 ounces of gold, valued at £78,008 15s.—a total value of £681,070 17s. 4d.; being a decrease of £233,496 10s. on the previous year. The amount paid in dividends was £210,000.

Prospecting has been chiefly centred in the Mt. Lyell Company's group of mines—to the North Lyell section—where satisfactory progress has followed their labours. Sinking in both shafts has been kept well ahead of each succeeding level. The landing chambers, or braces, of each shaft are underground and on different levels, but the sumps of both total the same depth from the surface, viz., 1110 feet, where chambers, the necessary crosscuts for

prospecting, ventilation, and other purposes, are being prosecuted.

Developments in keeping with the values on the higher levels have been firmly established in the Nos. 23 and 24 stopes of the 1000-foot level. The lastmentioned stope is situated about 250 feet north-east of the main shaft, where, in a southerly direction for a length of 170 feet, rich bornite has been carried through and still continues in the face. Beyond these works this level is practically intact, and with that of the 850-foot, whose stopes 18, 19, and 20 are still really on the ground-floor, may safely be said to comprise the reserve stores of the mine. To facilitate despatch an electric winding hoist, capable of raising 30 tons per hour, together with a compressor of 2400 cubic feet of free-air capacity, have been erected and placed in commission.

At the Iron Blow extractions continue apace, the depletion of the pyrites up to the No. IV. bench being now almost accomplished, while that of the last, or No. 5, is already commenced. Between these sub-benches, A, B, and C benches intervene; and the last official records state those remaining will produce some 700,000 tons more of this class of ore, after which underground mining will, in all probability, be resorted to.

Next to the Mt. Lyell Company, the more persistent investigators have been the Crown Lyell Extended Proprietary, who have devoted much time and capital to the development of their property, which is situated in the valley between Mts. Lyell and Sedgwick. At present a substantial 2-ft. wooden tramway is being laid down to connect the mine with a like gauge on the Mt. Lyell Company's service, which, when completed, will permit of consignments of copper-zinc and silver-lead ores being prepared and made marketable for outside competition.

The Comstock Copper Mine adjoins the foregoing property, and has had several of its adits extended and other-

wise prospected by means of a portable diamond-drilling plant driven by an oil-engine.

The Blocks, Consols, Crown Lyell, and Copper Mines of the Mt. Lyell West have been practically idle throughout the year.

At the Lyell Extended a prospecting shaft has been sunk 50 feet, and at this depth driven a like distance on exceptionally rich copper clays that are still receiving attention.

Darwin.—The Thompson P.A. and Darwin Syndicate have each done serviceable work on their respective properties, and bulk samples from the latter were treated at the Mt. Lyell Company's works, and gave satisfactory results.

The Jukes Proprietary, Lake Jukes, Hydes' show, and other sections remain idle, but there is very little doubt, with the prospects present in all of these cases, further trials will hereafter be allotted to each and all of them.

Mt. Balfour.—This is a new copper field, and is attracting a considerable amount of attention. A geological survey inspection of the field will shortly be made by the Assistant Government Geologist.

From the 1st February, 1907, to the 31st December, 1908, the Murray Bros. raised 501 tons of copper ore, valued at £6289, and shipped it to New South Wales.

The Mt. Lyell Mining and Railway Company has taken up a number of sections on the Norfolk Range, and is systematically prospecting them, with very encouraging results.

TIN-MINING.

The quantity of tin ore raised was 4520·80 tons, valued at £421,580, an average of £93 5s. 1d.

This shows an increase of 177·80 tons on the previous year.

The statistics for the year were:—

	Ore won.	Miners employed.	
	tons.	European.	Chinese.
Northern and Southern Division	89·95	33	—
North-Eastern Division	2857·15	696	61
Eastern Division	331·60	256	33
North-Western Division... ..	1107·19	402	—
Western Division... ..	134·91	103	—
	4520·80	1490	94

Considering the very dry summer, when many of the mines were idle for want of water, the output is very satisfactory.

Northern and Southern Division.—The only mine working in this Division during the year was the Shepherd and Murphy Mine, near Middlesex; 89·95 tons of tin ore were obtained, and 33 men employed.

North-Eastern Division.—The Briseis Tin Mines, Limited, has been the largest producer, with 1046·73 tons, and has distributed in dividends £60,000. In addition to its original property, the company is engaged in removing the overburden from the section formerly held by the New Ringarooma Tin Mining Company. The New Brothers Home Mine, which adjoins the Briseis Mine, is being worked by the latter company. It has produced 340·73 tons of tin ore, and has paid £12,000 in dividends.

The Arba Tin Mining Company raised 118·95 tons of ore.

The Pioneer Tin Mine raised 446 tons of ore, and paid £15,965 in dividends. This company has constructed a large dam on the Frome River for providing water-power for generating electricity for the electric plants, and water for sluicing purposes. The dam is 625 feet long, and 54

feet deep, and its capacity is 420,000,000 gallons of water up to the 51-foot level.

The Gladstone Tin Mines suffered considerably owing to the very dry summer. The principal producers were:—

	Tons.
South Mt. Cameron Company	95·65
Purdue Tin Mine	87·05
Dorset Bucket Dredge	61·55
Ringarooma Bucket Dredge	53·30
Argus Mine	40·05
Garibaldi Company	28·25
Gladstone Bucket Dredge	16·8
New Aberfoyle Company	8·95
Mussel Roe Company	7·55
Scotia Mine	6·70

Eastern Mining Division.—The Anchor Tin Mine raised 129·68 tons of ore, employing an average of 95 men. During part of the last quarter the mine was idle owing to the drought. The company has entered into an agreement with the Australian Tin Mining Company to work its property on the Blue Tier, in conjunction with its own, and to connect the properties by an aerial ropeway.

The alluvial tin mines have contributed rather less than their usual output, having been considerably hampered by the want of water for sluicing purposes.

Western Mining Division.—Heemskirk.—Very little tin has been raised from this field.

The Federation Tin Mine has been prospecting, and has obtained some very encouraging results. Interest seems to be reviving in some portions of the district, and small parties are obtaining a little tin under miners' rights.

North-East Dundas.—Renison Bell Tin Mine.—The work done during the year was mainly upon the hill slope above the Emu Bay Railway-line. Sluicing the decomposed lode-capping, from which marketable ore has been won,

was continued for a considerable portion of the year during the period water was obtainable. The total sales of this detrital ore have now reached about £6000 since sluicing was started. As work proceeded up the hill the material became much harder and deeper, frequently requiring blasting out; but the larger portion after water had been brought upon it by nozzle became friable and easily broken up. This was then run through the sluice-boxes and dressed for market. While treating this ore for sluicing a large quantity of quartz of various sides was uncovered, some blocks being several tons weight; this has been stacked for crushing by battery. It is estimated that there are fully 1000 tons of this high-grade ore at this spot uncovered. Some 2 tons of stone, which will assay 50 per cent. tin, were also obtained from here. The company have now purchased a first-class battery and dressing-plant, and are erecting it close to the Emu Bay Railway-line. A self-acting tram from the Blow, and two branch trams to connect with it to convey ore to battery, are about to be constructed.

The other mines in this district are being prospected, and some very rich deposits have been discovered; and the district promises to add very materially to the tin output of the State in the future.

The Assistant Government Geologist has been spending some time on the field, and has prepared a very extensive report upon the tin ore-deposits.

North-Western Mining Division.—The Mt. Bischoff Tin Mining Company has raised 930 tons of tin ore, and has paid a sum of £36,000 in dividends. The total quantity of tin ore produced by this company is 67,493 tons, and the total amount paid in dividends is £2,160,000.

The Mt. Bischoff Extended Company has erected its 10-head battery, boiler, and engine, and has raised 125·35 tons of ore. A new lode in the bottom level was discovered, giving good value in tin oxide.

The Waratah Alluvial Company has raised 14·60 tons of ore, employing 5 men.

Whyte River.—The Mt. Cleveland Company has erected a 10-head battery and concentrating plant, capable of treating 1000 tons of ore per month. The battery was started in September, and during the last quarter of the year 22 tons of tin ore were obtained.

COAL-MINING.

The total quantity of coal raised amounted to 61,067·75 tons, valued at £51,907; being an increase of 2156·75 tons on the previous year.

The raisings at the different collieries were:—

Colliery.	Tons.	Average number of men employed.
Cornwall	37,098	84
Mt. Nicholas	18,441	60
Tasmanian Wallsend... ..	2499·75	20
Mt. Cygnet	1333	2
Spreyton... ..	851	5
York Plains... ..	652	2
Woodbridge... ..	110	2
Illamatha	60	2
Jubilee	23	3
	61,067·75	180

The principal producers have been the Cornwall and Mt. Nicholas Coal Mines. The output of the former company shows a considerable increase on the previous year, while that of the latter company shows a decrease.

The Sandfly Colliery has changed hands during the year, and is now held by the Tasmanian Wallsend Colliery Company. Mr. R. H. Stokes, late of the Stockton Colliery, New South Wales, is in charge, and the mine is being opened up in a very systematic manner under his management.

IRON ORE.

The quantity of ore mined by the Tasmanian Iron Mines at Penguin was 3600 tons, valued at £1600; 12 men employed.

This was the only mine at work during the year.

WOLFRAM ORE.

The output of wolfram ore was as follows:—

	Tons.	Value. £
Shepherd and Murphy Mine,		
Middlesex	0·90	62
Ben Lomond Mines	3·93	276
	—	—
	4·83	£338
	—	—

BISMUTH.

The Shepherd and Murphy Mine at Middlesex obtained 3·75 tons of bismuth from its tin ore, valued at £462.

SCHEELITE.

This mineral has been discovered on the south coast of King Island, on a reward claim taken up in the names of A. T. Winterbottom and M. Parer. The lode is stated to be from 12 to 20 feet wide, the walls well defined, and there are 200 feet of backs. There is a plentiful supply of wood and water, and a good shipping port within half a mile. The lode is said to carry, in addition to sheelite, considerable quantities of molybdenum, bismuth, and tantalum. A bulk assay of the ore, made at the British Flag Company's plant on the Fraser River, has proved that 80 per cent. of the ore-contents can be saved in treatment.

BARYTES.

The presence of this mineral in appreciable quantities has been brought into prominence by Mr. W. H. T aylour,

who is engaged opening up a clean reef or deposit on a north-eastern flank of Mt. Darwin, from where he has obtained extensive bulk samples that have merited the approval of intercolonial investors who are at present interested in the property.

From American files it is gathered that some 89,000 crude tons of barytes were disposed of some 12 months ago for, approximately, 277,000 dollars.

On Howard's Plains, within a mile of the Mt. Lyell Company's Office, Mr. W. H. Wesley has obtained a reward section for this mineral. It is stated to be a large and very rich deposit.

SLATE.

A deposit of slate of good quality has been discovered on King Island. This is now owned by a company having a working capital of £3500.

BUCKET-DREDGING.

The only bucket-dredges in the State are those engaged dredging for tin on the Ringarooma River.

The Dorset Bucket-dredging Company, No Liability.—This company obtained 65·55 tons of tin ore and 58·95 ounces of gold; 20 men employed.

Ringarooma Bucket-dredging Company, No Liability.—53·30 tons of tin ore and 89·90 ounces of gold were obtained; and 17 men employed.

The Gladstone Tin Development Company, No Liability.—16·80 tons of tin ore, and 28·40 ounces of gold were obtained during the first half of the year; 16 men employed. The paddock having been worked out,

the company has been waiting for a flood to enable them to remove the pontoon lower down the river.

THE following Return shows the Quantity and Value of Mineral Products for the State of Tasmania during the Year ending 31st December, 1908.

Mineral.	Quantity.	Value.
		£
Gold *..... ozs.	57,085·124	242,482
Silver-lead Ore tons	63,116·92	322,007
Blister Copper † "	8833	603,063
Copper and Copper Ore... "	1185·15	6588
Tin Ore..... "	4520·80	421,580
Iron Ore "	3600	1600
Coal "	61,067·75	51,907
Wolfram "	4·58	338
Bismuth "	3·75	462
Total .....	...	£1,650,027

* Fine gold, including gold contained in blister copper and silver-lead bullion.

† Value of gold deducted.

GEOLOGICAL AND MINERALOGICAL.

During the year the Government Geologist has examined and prepared reports on the goldfields of Lisle and Cradle Creek, the Gunn's Plains and Alma mineral districts, North-West Coast; and the Assistant Government Geologist has prepared a report on the Mt. Farrell mining

field, and made a geological examination of the North Dundas tinfield, and at the close of the year was engaged in preparing his report thereon.

Special attention has been devoted to the production of improved geological bulletins. In this respect the method of procedure adopted, and the material which is presented, will, it is believed, prove of permanent value and assistance to the mining industry. Maps are being issued with each publication, which represent the geologic structure of each district examined, with a certain degree of finality, and questions of tectonic geology, lode-structure, and vein-types, are discussed and treated in a way which aims at exhibiting the intimate connection existing between general and economic geology, and stating and elucidating numerous problems and facts connected with the deposition and occurrence of ores. The results are not only useful at the present time, but will be of value also in the future as the development of the mining fields proceeds.

It is satisfactory to be able to note that the survey has been successful in accomplishing economic work which is of admitted benefit to the mining community. It commends itself as good policy, as far as finances permit, to foster and develop this growing and useful branch.

During the year the geologists took charge of exploring parties from Tyenna to the Gordon and from the Linda Track down Jane River towards the Gordon, and their reports and maps of these areas will be in the annual report of the Surveyor-General. Nothing was discovered on these journeys to encourage the hope that any mining fields of first-class importance will come into being, though naturally the observations made were confined to the country in the immediate vicinity to the route followed, and in an area so extended unsuspected indications may still lurk unseen.

This track may possibly, in the future, develop into a through route to the Gordon to Macquarie Harbour.

INSPECTORS OF MINES.

The three inspectors have satisfactorily discharged their duties in the districts severally allotted to them. Their reports are appended.

MINING MANAGERS' EXAMINATION.

The annual examination of candidates for mining managers' certificates was held in March. One candidate presented himself for examination, and succeeded in obtaining a first-class certificate.

DIAMOND-DRILLS.

No. 1 diamond-drill was engaged by Messrs. Otto and Eiszele from the 3rd to 27th June, to bore for coal on their private property at Sorell Creek. Their efforts were unsuccessful. One bore only was put down 218 feet 2 inches.

MT. CAMERON WATER-RACE BOARD.

The report of the Board is appended.

DEPARTMENTAL STAFF.

The only changes which took place in the staff during the year were the appointment of Edward Henry Fowell as temporary Registrar of Mines at St. Helens, *vice* A. D. Soutar, resigned; P. J. E. Grant, Registrar of Mines, Waratah, *vice* J. Lonergan, removed; and the transfer of E. Rule.

REVENUE.

The net revenue for the year amounted to £20,311 3s., being a decrease of £4483 4s. 7d. on the previous year. This amount does not include the sum of £2454 7s. 11d. deposited as survey fees with applications for leases.

CONCLUSION.

In conclusion, I desire to thank officers of the Departmental staff for the loyal and efficient manner in which they have performed the duties allotted to them.

I have, &c.,

W. H. WALLACE, Secretary for Mines.

The Hon. DONALD CAMPBELL URQUHART,
Minister for Mines.

DIAMOND-DRILL

DIAMOND-DRILLS.

Statement of Work done to 31st December, 1908.

Year.	Locality.	Direction of Bore.	No. of Bores.	Total Distance Bored.	Average cost per foot, inclusive of Labour and Fuel.
No. 1 DRILL.					
				feet.	£ s. d.
1882-3	Back Creek—For Gold	Vertical	7	1330	0 10 9
1883	Lefroy—For Gold	Ditto	4	1011	0 5 3
1884	Tarleton—For Coal	Ditto	1	401	0 5 6
1886	Longford—For Coal	Ditto	2	1585	0 4 0½
1886-7	Harefield Estate—For Coal	Ditto	1	725	0 6 5
1887	Cardiff Claim, Mount Malcolm—For Coal	Ditto	1	562	0 17 11¼
1888	Killymoon Estate—For Coal	Ditto	1	504	0 4 7¼
1888-9	Seymour—For Coal	Ditto	5	2266	0 7 8½
1889	Beaconsfield (Phoenix G.M. Co.)—For Gold	Ditto	1	781	2 0 2
1890	Beaconsfield (East Tasmania G.M. Co.)—For Gold	Ditto	1	978	0 14 9½
1891	Spring Bay—For Coal	Ditto	4	937	0 6 10
1891	Ravensdale—For Coal	Ditto	1	114	0 11 1¼
1891-2	Back River, Prosser's Plains—For Coal	Ditto	2	854	0 6 1¼
1892-3	Lefroy (Deep Lead Syndicate)—For Gold	Ditto	4	979	0 15 9
1893	Lefroy (East Pinafore Co.)—For Gold	Ditto	1	317	0 10 3
1895-6	Sandfly—For Coal	Ditto	4	2130	0 11 5
1898	Blue Tier (Anchor Co.)—For Tin	Ditto	9	876½	0 9 1¼
1900	Blue Tier (Anchor Co.)—For Tin	Ditto	9	876½	0 9 1¼
1901-2	Llandaff—For Coal	Ditto	3	1944	0 7 4
1902	Recherche (Catamaran Co.)—For Coal	Ditto	2	956	0 9 3
1903	Ditto (Moss Glen Co.)—For Coal	Ditto	2	667	0 7 6
1908	Sorell Creek, New Norfolk—For Coal	Ditto	1	218	Not obtainable
TOTAL			57	20,135½	

32

No. 2 DRILL.					
1882	Beaconsfield—For Gold	Horizontal, underground	1	68	No record
1883	Mangana—For Gold	Ditto	1	546	0 15 1
1884	Guy Fawkes Gully, near Hobart—For Coal	Vertical	1	612	0 5 6
1885	Malahide Estate, near Fingal—For Gold	Ditto	5	1397	0 5 6
1886	Carr Villa, near Launceston—For Coal	Ditto	1	571	0 5 4
1886-7	Waratah (Mount Bischoff Alluvial T.M. Co.)—For Tin	Ditto	7	1548	0 6 1½
1887	Waratah (Mount Bischoff T.M. Co.)—For Tin	Ditto	7	841	0 11 8
1887	Ditto	Horizontal, underground	1	53	0 7 8
1888	Old Beach—For Coal	Vertical	1	593	Abt. 0 10 9
1888	Campania—For Coal	Ditto	1	600	0 7 7½
1888	Richmond—For Coal	Ditto	1	500	0 5 1¼
1889	Back Creek—For Gold	Ditto	4	787	0 8 5½
1891	Macquarie Plains—For Coal	Ditto	2	989	0 4 5½
1891	Jerusalem—For Coal	Ditto	1	344	0 4 9½
1892	Langloh Park—For Coal	Ditto	4	1249	0 5 3¼
1893	Southport—For Coal	Ditto	1	612	0 5 3
1894	Zeehan (Tasmania Crown S.M. Co.)—For Silver	Horizontal, underground	2	319	1 0 2½
1902	Eden—For Coal	Vertical	2	566	1 0 7½
1902-3	Farm Cove—For Coal	Ditto	1	571	0 5 6
TOTAL			44	12,766	

33

Aggregate number of bores 101
 Total distance bored 32,901½ feet

W. H. WALLACE, Secretary for Mines.

RETURN showing the Quantity and Value of Gold won during the Years 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1889, 1890, 1891, 1892, 1893, 1894, 1895, 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.	Value.
	ozs. dwts.	£
1880.....	52,595 0	201,297
1881.....	56,693 0	216,901
1882.....	49,122 6	187,337
1883.....	46,577 10	176,442
1884.....	42,339 19	160,404
1885.....	41,240 19	155,309
1886.....	31,014 10	117,250
1887.....	42,609 3	158,533
1888.....	39,610 19	147,154
1889.....	32,332 13	119,703
1890.....	20,510 0	75,888
1891.....	38,789 0	145,459
1892.....	42,378 0	158,917
1893.....	37,687 0	141,326
1894.....	57,873 0	217,024
1895.....	54,964 0	206,115
1896.....	62,591 0	237,574
1897.....	77,131 0	296,660
1898.....	74,233 0	291,496
1899.....	83,992 0	327,545
1900.....	81,175 0	316,220
1901.....	*69,491 0	295,176
1902.....	*70,996 0	301,573
1903.....	*59,891 0	254,403
1904.....	*65,921 0	280,015
1905.....	*73,540 10	312,380
1906.....	*60,023 8	254,963
1907.....	*65,354 5	277,607
1908.....	*57,085 2	242,482
	1,587,761 4	6,273,153

* Fine Gold.

Diagram showing Total Quantity & Value of Gold won in Tasmania during the years 1880-1908

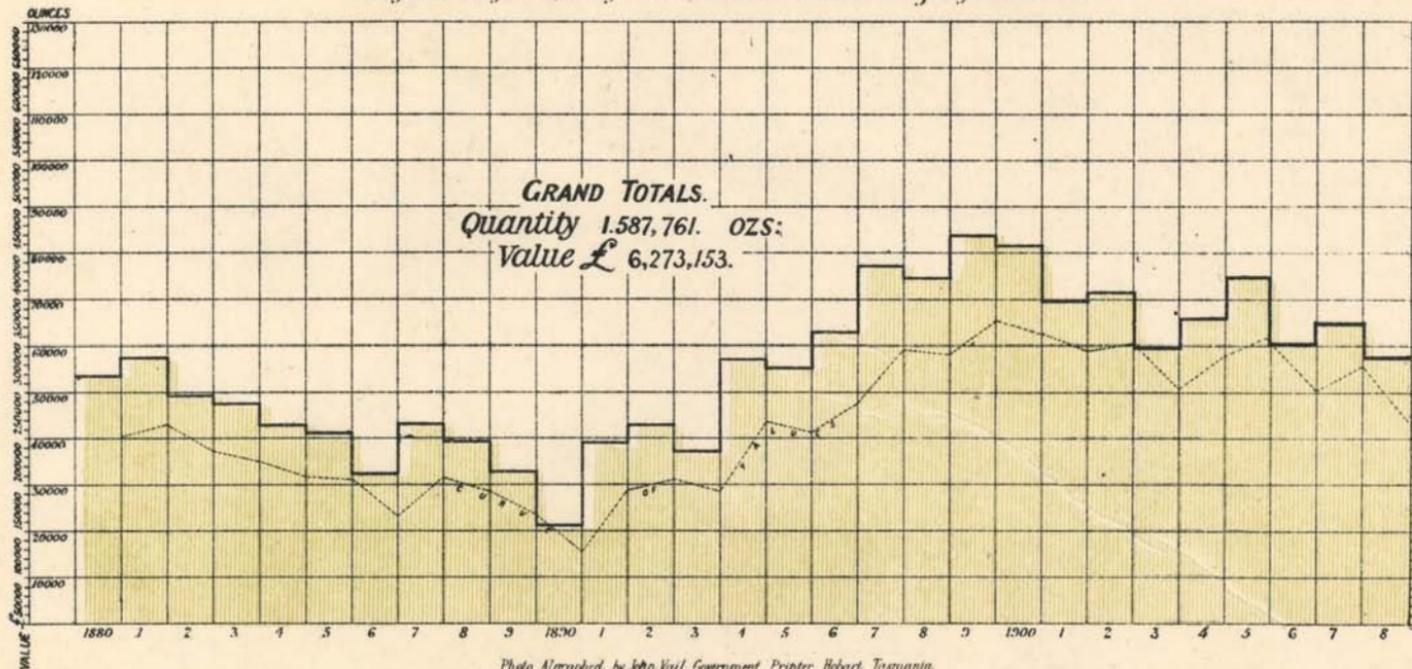
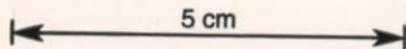


Photo Algraphed by John Vail Government Printer Hobart Tasmania.



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Diagram showing Total Quantity & Value of Coal raised in Tasmania during the years 1880-1908



Photo Algraphed by John Veil Government Printer Hobart Tasmania.

No. 2.

RETURN showing the Quantity and Value of Coal raised during the Years 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1889, 1890, 1891, 1892, 1893, 1894, 1895, 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.	Value.
	Tons.	£
1880	12,219	10,998
1881	11,163	10,047
1882	8803	7923
1883	8872	7985
1884	7194	6475
1885	6654	5989
1886	10,391	9352
1887	27,633	24,870
1888	41,577	37,420
1889	36,700	33,030
1890	50,519	45,467
1891	43,256	38,930
1892	36,008	32,407
1893	34,693	27,754
1894	30,499	24,399
1895	32,698	26,159
1896	41,904	33,523
1897	42,196	33,757
1898	47,678	38,256
1899	42,609	38,349
1900	50,633	44,227
1901	45,438	38,451
1902	48,863½	41,533
1903	49,069	41,709
1904	61,109	51,942
1905	51,993	44,194
1906	52,895½	44,962
1907	58,891	50,057
1908	61,067½	51,907
	1,053,226	902,072

RETURN showing the Quantity and Value of Tin exported from Tasmania during the Years 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1889, 1890, 1891, 1892, 1893, 1894, 1895, 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, and 1904, compiled from Customs Returns only, and Tin Ore produced during the Years 1905, 1906, 1907, and 1908.

Year.	Quantity.	Value.
	Tons.	£
1880	3954	341,736
1881	4124	375,775
1882	3670	361,046
1883	4122	376,446
1884	3707	301,423
1885	4242	357,587
1886	3776	363,364
1887	3607 $\frac{1}{2}$	409,853
1888	3775 $\frac{1}{4}$	426,321
1889	3764	344,941
1890	3209 $\frac{1}{4}$	296,368
1891	3235	291,715
1892	3174	290,083
1893	3128 $\frac{1}{2}$	260,219
1894	2934	198,298
1895	2726 $\frac{3}{4}$	167,461
1896	2700	159,036
1897	2423 $\frac{1}{2}$	149,994
1898	1972	142,046
1899	2239 $\frac{1}{4}$	278,323
1900	2029	269,833
1901	1789 $\frac{1}{2}$	212,542
1902	1958 $\frac{1}{4}$	237,828
1903	2376 $\frac{3}{10}$	300,098
1904	2171 $\frac{1}{2}$	255,228
1905*	3891 $\frac{1}{2}$	362,670
1906*	4472 $\frac{3}{4}$	557,266
1907*	4342 $\frac{3}{4}$	501,681
1908*	4520 $\frac{3}{4}$	421,580
	94,036 $\frac{1}{4}$	9,010,761

* Tin Ore produced : Customs having ceased to issue Returns.

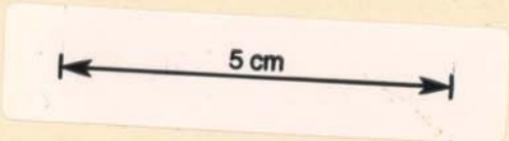


Diagram showing Total Quantity & Value of Tin exported from Tasmania during the years 1880-1904 and Tin ore produced during the years 1905 and 1908

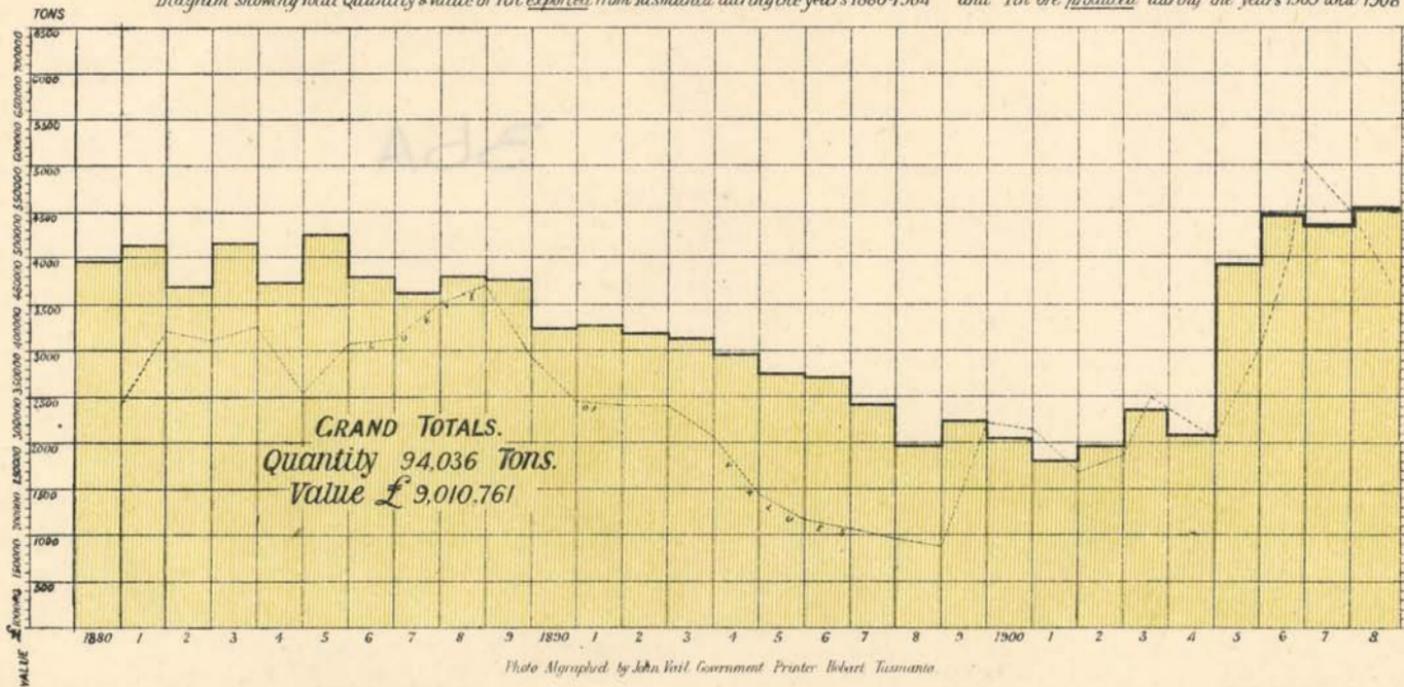


Photo Micrographed by John Veil Government Printer Hobart Tasmania

No. 4.

RETURN showing the Quantity and Value of Silver-Lead Ore produced during the Years 1888, 1889, 1890, 1891, 1892, 1893, 1894, 1895, 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.	Value.
	Tons.	£
1888	417	5838
1889	415	7044
1890	2053	26,487
1891	4810	52,284
1892	9326	45,502
1893	14,302	198,610
1894	21,064	293,043
1895	17,980	175,957
1896	21,167	229,660
1897	18,364	200,167
1898	15,320	188,892
1899	31,519½	250,331
1900	26,564	279,372
1901	28,774	207,228
1902	46,480	218,864
1903	42,422	192,492
1904	51,138	203,702
1905	75,270½	246,888
1906	87,117¾	462,443
1907	89,762½	572,560
1908	63,116 ¹⁸ / ₁₀	322,007
	667,383 ³ / ₁₀	4,379,371

No. 5.

RETURN showing the Quantity and Value of Blister Copper produced during the Years 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.		Value.	
	Tons.	£	Tons.	£
1896	41½	1245		
1897	4700	322,500		
1898	4955½	400,668		
1899	8598	735,305		
1900	9449	907,288		
1901	9981	879,625		
1902	7745	*462,151		
1903	6684	*478,023		
1904	8371	*582,540		
1905	8610	*704,287		
1906	8708	*862,444		
1907	8247	*832,691		
1908	8833	*603,063		
	94,923	7,771,830		

* Value of Gold contained deducted.

No. 6.

RETURN showing Quantity and Value of Copper Matte exported during the Years 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.		Value.	
	Tons.	£	Tons.	£
1902	2500	50,112		
1903	3727	83,624		
1904	—	—		
1905	—	—		
1906	—	—		
1907	—	—		
1908	—	—		
	6227	133,736		

No. 7.

RETURN showing the Quantity and Value of Copper Ore produced during the Years 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.		Value.	
	Tons.	£	Tons.	£
1896	34	1020		
1897	75	2250		
1898	394	8128		
1899	1695	26,833		
1900	4221½	63,589		
1901	11,221	130,412		
1902	5994	65,270		
1903	102	790		
1904	104	1640		
1905	1150¾	52,939		
1906	2234½	72,480		
1907	788½	36,975		
1908	1185	6588		
	29,199	468,914		

No. 8.

RETURN showing the Quantity and Value of Iron Ore produced during the Years 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.		Value.	
	Tons.	£	Tons.	£
1897	894	812		
1898	1598	1598		
1899	3577	3474		
1900	5375	5995		
1901	612	417		
1902	2386	1075		
1903	5980	2905		
1904	6840	2975		
1905	6300	2600		
1906	2600	1100		
1907	3000	1150		
1908	3600	1600		
	42,762	25,701		

No. 9.

RETURN showing the Quantity and Value of Asbestos produced during the Years 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.	Value.
	Tons.	£
1899	200	363
1900	128	113
1901	46½	45
1902	—	—
1903	—	—
1904	—	—
1905	—	—
1906	—	—
1907	—	—
1908	—	—
	374½	521

No. 10.

RETURN showing the Quantity and Value of Wolfram produced during the Years 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.	Value.
	Tons.	£
1899	3½	99
1900	53½	2058
1901	—	—
1902	—	—
1903	—	—
1904	15½	1147
1905	32½	2371
1906	19½	1465
1907	40½	4411
1908	4½	338
	170	11,889

No. 11.

RETURN showing the Quantity and Value of Bismuth produced during the Years 1904, 1905, 1906, 1907, and 1908.

Year.	Quantity.	Value.
		£
1904	6 cwt.	15
1905	3½ tons	800
1906	6 cwt.	24
1907	3½ cwt.	27
1908	3¼ tons	462
	8 tons ½ cwt.	1328

No. 12.

RETURN showing the Quantity of Silver-Lead and Copper Ore smelted for period 25th June to 31st December, 1896, and 1st January, 1897, to 31st December, 1908.

Year.	Ore Smelted.	Products.			Yield.			
		Silver-Lead Bull'n.	Blister Copper.	Matte.	Copper.	Silver.	Gold.	Lead.
	Tons.	Tons.	Tons.	Tons.	Ozs.	Ozs.	Tons.	
1896	26,028 ^{1/10}	—	—	2417 ^{5/10}	1235 ^{1/10}	75,951	4707	
1897	90,773½	—	3476½ ^{2/10}	257 ^{1/10}	3589½ ^{1/10}	334,349	16,485	
1898	170,933	—	4992	—	4783	606,123	24,418	
1899	275,239	2295	8463	89 ^{8/10}	8362	1,089,657	27,615	
1900	363,113	4817	9449	—	9341	1,215,036	26,255	
1901	355,528	1839	9982	50	9880	800,317	21,717	
1902	411,736	6825	7727	2882	8841	1,674,816	24,719	
1903	399,032	7560	6683	3413	8094	1,855,158	25,238	
1904	433,366	—	8371	—	8265	1,896,134	26,809	
1905	466,578	9422	8611	—	8596	2,075,431	26,460	
1906	479,775	9380	8708	—	8613	2,150,405	24,986	
1907	472,658	10,590	8248	—	8145	2,147,120	24,531	
1908	440,145	7181	8834	—	8723	1,654,350	22,008	

No. 13.

RETURN showing the Average Number of Persons engaged in Mining during the Years 1880 to 1908 inclusive.

Year.	Number.	Year.	Number.
1880.....	1653	1895.....	4062
1881.....	3156	1896.....	4350
1882.....	4098	1897.....	4510
1883.....	3818	1898.....	6052
1884.....	2972	1899.....	6622
1885.....	2783	1900.....	7023
1886.....	2681	1901.....	6923
1887.....	3361	1902.....	5934
1888.....	2989	1903.....	6017
1889.....	3141	1904.....	6194
1890.....	2868	1905.....	6581
1891.....	3219	1906.....	7005
1892.....	3295	1907.....	7516
1893.....	3403	1908.....	6466
1894.....	3433		

No. 14.

RETURN showing the total Area of Land and Number of Sluice-heads of Water applied for during the Year ending 31st December, 1908.

Mineral.	No. of Applications.	No. of Sluiceheads.	Area.
Barium Sulphate	1	...	Acres.
Coal	10	...	80
Copper	79	...	2200
Galena	5	...	3645
Gold	104	...	210
Iron	2	...	1374
Lead	1	...	15
Minerals	110	...	40
Phosphate Rock	5	...	5037
Silver	23	...	22
Tin	181	...	1854
Wolfram	3	...	3777
Machinery Sites	5	...	84
Dredging Claims	15	...	14
Water-rights and Easements	99	...	204
TOTAL.....	643	339	108
		339	18,664

No. 15.

RETURN showing the total Number and Area of Leases issued during the Year ending 31st December, 1908.

Mineral.	Number.	Sluiceheads.	Area.
			Acres.
Antimony	3	...	240
Asbestos	1	...	10
Coal	6	...	852
Copper	43	...	2627
Gold	86	...	946
Iron	6	...	270
Minerals	122	...	6144
Manganese	1	...	63
Silver-Lead	30	...	2233
Shale	7	...	899
Tin	235	...	5759
Zinc-Lead.....	1	...	40
Machinery Sites	8	...	53
Mining Easements	30	...	105
Dredging Claims	22	...	255
Water-rights	138	489	50
	739	489	20,546

RETURN showing the Total Number of Leases in force on 31st December, 1908.

Mineral.	Number.	Sluiceways.	Area.
Antimony	3	..	Acres. 240
Asbestos	1	..	10
Bismuth	1	..	40
Coal	25	..	5623
Copper	44	..	2523
Gold	111	..	1344
Iron	15	..	758
Limestone	4	..	383
Lithographic Stone	1	..	97
Minerals	177	..	11,384
Marble	1	..	317
Manganese	1	..	63
Nickel	1	..	20
Phosphate of Lime	1	..	3
Precious Stones	1	..	80
Silver	124	..	7465
Slate	1	..	200
Shale	1	..	2125
Tin	13	..	21,099
Wolfram	894	..	374
Zinc-Lead	5	..	40
Machinery Sites	33	..	133
Mining Easements	88	..	453
Dredging Claims	64	..	916
Water Rights	511	2000	1003
	2121	2000	56,698

RETURN showing the Average Number of Miners employed during the Year ending 31st December, 1908.

	No. 17.	
	Europeans.	Chinese.
Northern and Southern Division	803	—
North-Eastern Division	700	62
Eastern Division	550	33
North-Western Division	517	..
Western Division	3801	..
	6371	95

No. 18.

RETURN showing the Number and Area of Leases held under "The Mining Act," in force on 30th June in Years 1901 to 1903 inclusive, and on 31st December, 1903, 1904, 1905, 1906, 1907, and 1908.

Nature of Lease.	In force on 30th June, 1901.		In force on 30th June, 1902.		In force on 30th June, 1903.		In force on 31st December, 1903.		In force on 31st December, 1904.		In force on 31st December, 1905.		In force on 31st December, 1906.		In force on 31st Dec., 1907.		In force on 31st Dec., 1908.	
	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.
For Minerals, Silver, Tin, &c.	1388	60,865	1063	45,399	950	40,068	826	33,325	868	33,824	944	34,325	1307	43,036	1844	65,047	1269	44,099
For Coal, Slate, Shale, &c.	55	7566	52	7819	66	10,767	54	9119	47	7546	45	7185	35	6025	45	7962	45	8745
For Gold	566	6091	425	4166	310	3117	243	2505	222	2268	195	2087	167	1836	222	2671	111	1344
Dredging Claims	—	—	—	—	—	—	15	124	29	469	51	1196	91	2027	79	1494	64	916
Mining Easements	—	—	—	—	—	—	34	225	39	234	45	282	47	298	75	436	88	453
Machinery Sites	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33	133
Water-rights Mineral and Gold	267	1318 sluice-heads	300	1691 sluice-heads	299	1514 sluice-heads	281	1460 sluice-heads	346	1495 sluice-heads	251	1477 sluice-heads	391	1606 sluice-heads	490	1978 sluice-heads	511	1003 & 2000 sluice-heads

No. 19.

RETURN showing the Amounts paid in Dividends by Mining Companies during the Year ending 31st December, 1908.

Mines.	Dividends.		
	£	s.	d.
Copper	210,000	0	0
Gold .....	...	
Tin	126,298	0	0
Silver	11,462	0	0
Coal.....	906	0	0
TOTAL	£348,666	0	0

No. 20.

RETURN showing the total Amount of Rents, Fees, &c., received by the Mines Department during the Year ending 31st December, 1908.

Head of Revenue.	Amount.		
	£	s.	d.
Rent of Auriferous and Mineral Land.....	18,937	19	0
Fees, ditto ditto	1373	4	0
Survey Fees	2454	7	11
TOTAL	£22,765	10	11

No. 21.

RETURN showing the Mining Companies registered during the Year ending 31st December, 1908.

Number of Companies.	Capital.
11	£106,850

In addition to the above, 14 Agents for Foreign Companies and 5 Syndicates, under 60 Vict. No. 51, were registered.

Diagram showing the Annual Value of Minerals & Metals raised in Tasmania from 1880-1908

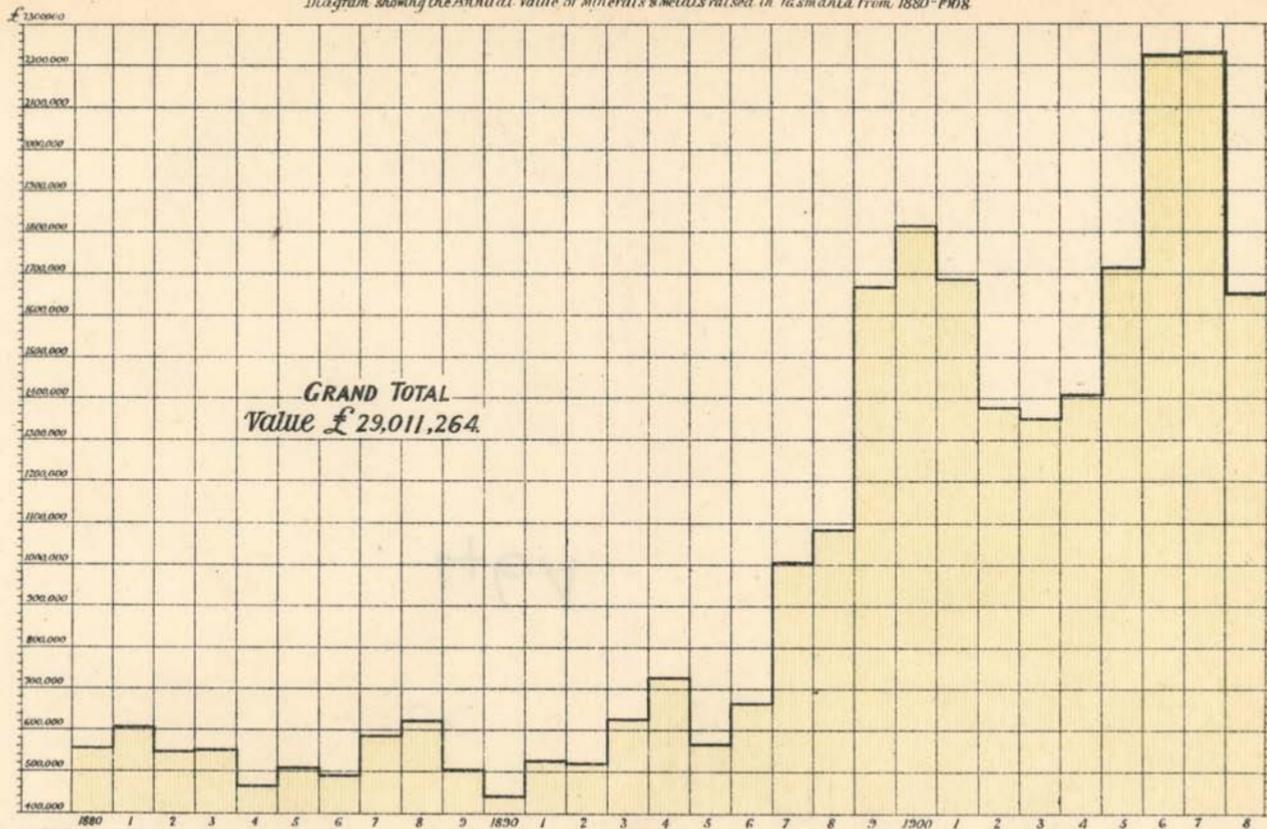


Photo Algraphed by John-Vuil Government Printer Hobart Tasmania

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No. 22.

RETURN showing Quantity and Value of Minerals and Metals raised in Tasmania from 1830 to 1908 inclusive.

Mineral or Metal.	Quantity.	Value.
		£
Gold	1,587,761 ozs.	6,273,153
Silver-lead ore	667,383 tons	4,379,371
Blister Copper.....	94,923 "	7,771,830
Copper Matte	6227 "	133,736
Copper and Copper Ore.....	29,199 "	468,914
Tin	94,036 "	9,010,761
Iron Ore	42,762 "	25,701
Coal	1,053,218 "	902,072
Wolfram	170 "	11,889
Bismuth	8 "	1328
Asbestos	374½ "	521
Unenumerated prior to 1894...	...	31,988
Total .....	...	£29,011,264

No. 23.

COMPARATIVE Statement of Revenue from Mines, being Rents, Fees, &c. (exclusive of Survey Fees), paid to the Treasury for the Years ending 30th June, from 1880 to 1903, and for Six months ending 31st December, 1903, and for the Years ending 31st December, 1904, 1905, 1906, 1907, and 1908.

Year.	Amount.	Year.	Amount.
1880.....	£ 8944 5 11	1895.....	£ 15,323 1 9
1881.....	20,936 5 5	1896.....	20,901 13 2
1882.....	23,077 1 9	1897.....	25,631 0 3
1883.....	15,439 14 5	1898.....	33,661 13 9
1884.....	6981 11 10	1899.....	24,696 10 5
1885.....	11,070 5 7	1900.....	28,380 11 10
1886.....	12,523 10 4	1901.....	21,569 5 2
1887.....	14,611 11 5	1902.....	19,471 0 1
1888.....	23,502 8 4	1903.....	17,776 14 3
1889.....	17,254 9 0	1903, 1 July to 31 Dec.	14,758 17 1
1890.....	26,955 4 9	1904, Jan. to Dec.	16,631 8 2
1891.....	37,829 16 5	1905.....	20,208 17 0
1892.....	17,568 18 4	1906.....	24,186 12 5
1893.....	16,971 9 2	1907.....	24,794 7 7
1894.....	16,732 7 7	1908.....	20,311 3 0

The above Statement does not include Stamp Duties upon Transfer of Leases and Registration of Companies, nor the Tax payable upon Dividends, from which sources large sums are derived.

REPORT OF THE MOUNT CAMERON WATER-RACE BOARD FOR THE YEAR ENDING 31st DECEMBER, 1908.

8th April, 1909.

SIR,

We have the honour to submit the report of the Board for the year ending 31st December, 1908.

Repairs.—That part of No. 13 flume, between the spot where Cascade Creek is picked up and the outlet of No. 1 syphon, a distance of about 6 chains, was overhauled and put into as good order as was possible under existing conditions. The best of the planks from the remainder of No. 13, which was replaced by a race cut into the solid, were used for this purpose; but the whole flume was in such bad condition as to render any lasting repairs out of the question. The Cascade Creek is one of the best summer supplies on the race, and it is advisable, when funds will permit, to extend the race which has recently been cut right up to the creek. The intake works and about 24 feet of the flume were wrecked by the heavy flood in February, 1907; this has been made good.

Alterations.—No. 13 flume, from the outlet of No. 1 syphon downwards has been replaced by a race cut into the solid. This was an expensive work, owing to the steep cross-section of the country, the number of large floating boulders, solid rock, and the proximity of the old flume. The new race is very solid and satisfactory, and disposes of trouble at that place for all time. It was necessary, if reasonably possible, to keep the water going during the cutting of the race, and great care had to be exercised to prevent damage to the flume from shots and spoil from the cutting. A part of the flume did collapse during the progress of the work, but fortunately the engineer was able to turn the water into the new race without much delay. He had started operations from the lower end to provide for such an emergency, as far as possible.

Renewals.

No. 4 Syphon.—This work, commenced the previous year, was completed in June last. The pipes are 30 inches in diameter, made of mildsteel plates 5 feet wide and $\frac{1}{4}$ inch in thickness, single riveted, and coated with a mixture of asphaltum and coal tar. The column is 3129 feet in length, fitted with 13 3-inch ball air-valves and two scour-valves. The joints are a combination of slip and flange, the general design being that four pipes are slipped together, the two end pipes having flanges on the outer ends. Two such sections are bolted together, and then a single pipe flanged at both ends, and carrying an air or scour valve, is bolted on. The course is straight; greatest depth below race-bottom at intake about 66 feet; fall between intake and outlet, 7.5 feet; pressure and discharge boxes are made of wood. The column

is laid on a different site from that previously proposed, giving a better pressure, and allowing the length to be shortened by about 540 feet, and the diameter by 3 inches; logs about 1 foot in diameter and 5 feet long are used as sleepers. About 10 chains of race was necessary to connect the new and old work at the intake end, and 5 chains at the outlet end. The new syphon was designed to take water from No. 1 dam, as well as from the main race. A low-level race had been cut from the dam and led into old No. 4 syphon at a level about 10 feet below the intake. The water is conveyed from the main race by means of an iron flume about 30 feet long, with a fall of about 6 feet, and then drops into a chamber in the new work on the same level as the race from the dam. The sides and bottom of the chamber are lined with logs about 1 foot thick.

No. 5 Syphon.—This was commenced during the year under review, and is nearing completion. The pipes are to be made similarly to those for No. 4, but will be 27 inches in diameter. The length of the column will be 4131 feet; difference of level between pressure and discharge-boxes, 15.5 feet; and the greatest depth below race-bottom at intake end, 82 feet. The column will be laid and fitted with valves similar to No. 4. A different course has again been selected, giving a straight run, sounder ground, and better facilities for junctioning with the race at either end, with an increase of only a few feet in the length of the column. About 4 chains of race had to be cut at the intake, and 1 chain at the outlet end.

Other Syphon Pipes.—Syphon pipes Nos. 1, 2, and 3.—These pipes are 30 inches in diameter, and were laid down at the same time as Nos. 4 and 5. Up to the present time, however, they have not given much trouble, but are now showing signs of corrosion, and a few bands have been put on where bursts have occurred.

No. 6 Syphon.—This pipe is 2503 feet in length and 36 inches in diameter. Frequent bursts have occurred during the year, and 56 bands have had to be put on to repair the damage. It is only reasonable to expect that as time goes on more frequent breaks will occur, but with constant care and attention we hope to be able to keep it in repair for a couple of years.

Flumings.—Out of 23 wooden flumings, 12 have been replaced by earth and rock cuttings and embankments, and made permanent, leaving 11 still to be done, as already informed in previous reports. These flumings are in a very bad condition, and must be cut out or replaced by earth and rock cuttings as soon as possible. It was hoped that the revenue derived from the sale of water during the year would have been sufficient to provide for the expense, but unfortunately our hopes were not realised owing to the very dry winter and to the collapse of No. 5 syphon, there not being sufficient water to meet the requirements of customers.

Maintenance and Management.—The Board has been as economical as possible during the year, and has been able to reduce the expenditure by £341 16s. 9d., as compared with the previous year. The services of one of the channel-keepers

were dispensed with, the work being undertaken by the manager, thus saving an expenditure of £120 16s.

The revenue amounted to £649 6s. 7d., being a decrease of £307 6s. 2d., as compared with the previous year.

Statistics for the year are as follows:—

Average per week of claims supplied, 12.	
Greatest number supplied in any one week, 16.	
Total number of heads supplied:—	
Under fixed or cash scale	42½
Under royalty or credit scale	1973
Total	2015½

Tin ore raised for the year:—Royalty scale, 28 tons, 12 cwt. 1 qr. 17 lbs.; Fixed scale, 16 tons 8 cwt. Total, 45 tons 1 qr. 17 lbs.

Average number of men employed per week, 23.

Total receipts for the year:—Water sold, fixed scale, £47 10s. 3d.; water sold, royalty scale, £589 4s. 10d.; other receipts, £12 11s. 6d. Total, £649 6s. 7d.

Expenditure.—Cost of maintenance and management:—

	£	s.	d.	£	s.	d.
Salary and wages	483	4	0			
Repairs to syphon pipes	42	14	9			
Repairs to flumings	3	8	0			
Travelling expenses	8	19	10			
Stores and tools	3	3	5			
Stationery and printing.....	1	13	1			
Insurance	3	6	0			
				546	9	1
No. 13 flume, repairs and deviation				304	7	4
No. 4 syphon (6 Edw. VII. No. 23)				2873	2	6
No. 5 syphon (7 Edw. VII. No. 31)				560	12	5
Completion of overflow channel at intake				15	13	4
				£4300	4	8

Moiety of rents of mineral land served by the race paid to Public Debts Sinking Fund for the year ending 30th June, 1908, £32 7s. 6d.

W. H. WALLACE, Chairman.
 W. H. TWELVETREES,
 EDWARD L. HALL,
 JOHN SIMPSON,
 SAMUEL HAWKES, } Members of the Board.

The Hon. the Minister for Mines.

MINE MANAGERS' EXAMINATION.

MARCH 24TH, 1908.

SUBJECT—MINING.

- 470A
1. A mine has been opened up to a depth of 150 feet, and there is a daily flow of 30,000 gallons of water, of which $\frac{1}{4}$ is making in the sump. What size of pump would you put in to allow opening up to a depth of 500 feet? What size of shaft would you require? Show by sketches how you would place the pitwork in the shaft. Assume various conditions.
 2. Describe in detail the method you would adopt for signaling in a shaft at present 500 feet deep, and which, in addition to an output of 100 tons a day, has to be sunk 100 feet a year in wet ground.
 3. A lode, dip about 60 degrees, varies in width from 3 to 6 feet, and is payable throughout. Describe how you would stope it out, and at what vertical distances apart you would place your levels—
 - (1) With good standing walls;
 - (2) With bad standing walls.
 4. Describe the safety appliances you consider necessary in connection with winding from mines, and how you would test winding-ropes and connect them to winding-engine and cage.
 5. A drive on a lode is timbered with 12-inch timber; a stope is being brought up below it. How would you pick up the level—
 - (1) In good ground;
 - (2) In heavy ground.
 Give sketches.
 6. Describe the various machines and appliances used in connection with the ventilation of deep mines, and methods of distributing fresh air to the various working faces.
 7. Describe the different methods of driving in running ground.
 8. Describe, with sketches, a rock-drill.
 9. Describe the ordinary explosives used in mining, and for what special purposes would you use each, and what precautions would you take in using them.
 10. What would you consider the most economical method of removing 1,000,000 cubic yards of overburden 100 feet deep, consisting of partly decomposed basalt containing boulders up to a ton weight? Describe the methods and the plant you would use.
 11. Describe the methods and appliances used in a hydraulic-slucing machine.
 12. You are required to work a deep alluvial gold lead with much water in it. Describe, with sketches, how you would set about it.

SUBJECT—ORE-DRESSING AND SAMPLING.

1. Describe a canvas table. What are its advantages and disadvantages?
2. Compare a jaw-breaker with a gyratory-breaker. Which would you prefer, and why?
3. Describe a system of sampling from the faces of a quartz mine to the tail-race, to obtain the value of the ore in the mine, to test the different appliances in the battery, and to test the saving of the battery as a whole.
4. Describe the appliances you would use in a concentrating plant to treat 20 tons of silver-lead ore per 8 hours when the ore is in coarse and fine particles through the gangue.
5. How would you sample a shipment of 20 tons of black tin?
6. Describe in detail a machine for treating coarse sand containing 5 per cent. of—
 - (1) Iron pyrites;
 - (2) Galena;
 - (3) Cassiterite;
 and state what percentage of the contents you would expect to save in each case, and what weight of concentrates you would obtain from 100 tons treated.

SUBJECT.—SURFACE WORK.

1. Give sketch design of a trestle bridge 30 feet high for a train of mine trucks.
2. Give sketch plan of an ore-bin to hold 100 tons of quartz.
3. Give sketches showing pit-head gear for a self-dumping skip in a vertical shaft.
4. In designing a water-pipe for a power scheme, do you consider it wise to have large pipes at the top of the column and smaller ones at the bottom?

Give your reasons in the following cases:—

 - (a) A column everywhere under a low head;
 - (b) A, say 30' column, for first 200 feet under 60-foot head, and for last 1000 feet under head rapidly increasing to 600 feet.
5. How would you make comparisons between the motive-powers for machinery of a large mine in a locality where fuel is fairly cheap and inexhaustible, and water-power may be obtained at considerable initial cost?
6. Two steel plates, each $\frac{3}{4}$ -inch thick, are lap-jointed and riveted together by two rows of $\frac{3}{4}$ -inch steel rivets, the pitch being 3 inches, and the rows $1\frac{1}{2}$ inch apart. What is the least percentage of strength of the joint?
7. If a water-pipe be made with joints as in the previous question, and is 36 inches internal diameter, what head of water would it safely carry?
8. Neglecting friction and the weight of the lever and valve, what proportions must exist between the different parts of a safety-valve of the lever and ball type in order that the addition of each pound weight on the end of the lever just balances an increase of one pound pressure in the boiler?
9. What would be the indicated horse-power of a single-cylinder high-pressure steam-engine having a cylinder

- 20 inches in diameter by 36 inches stroke: revolutions, 60 per minute; average pressure throughout the stroke 30 lb. per square inch? What brake horse-power would you expect from the above engine?
10. The lower end of a water-pipe 600 yards long from a reservoir is under a head of 115 feet. For the first, or upper, 400 yards this pipe has an internal diameter of 6 inches; at the lower end of the pipe a jet $1\frac{1}{4}$ inch in diameter discharges 227 gallons per minute. What is the smallest diameter of the lower 200 yards of the pipe?

SUBJECTS.—ARITHMETIC, MENSURATION, AND MINING ACCOUNTS.

1. Find the value of

$$\frac{(3\frac{1}{2} - 2\frac{1}{4}) \div \frac{1}{2} \text{ of } \frac{3}{4}}{2\frac{3}{4} \div (\frac{1}{2} + \frac{1}{4})}$$

and express the result as a decimal.

2. Two cog-wheels work together, one having 360 teeth and the other 100. If the first revolves 20 times in one minute, how many times will the second revolve in an hour? And if the latter turns a drum whose circumference is 5 feet, how many miles of thread will it wind upon the drum in a working-day of 11 hours?
3. Find the number of tons of firewood contained in a stack of the following dimensions:—Bottom length, 90 feet 6 inches; top length, 45 feet 9 inches; height, 10 feet; in 5-foot lengths; reckoning 50 cubic feet per ton.
4. Find the dividend on £6894 13s. 4d., at 1s. 3d. in the £
5. Four men dig a trench in $15\frac{1}{2}$ days, working 10 hours per day each. Supposing them to have worked 8 hours a day, how many days would they have occupied?
6. Describe the books and form of accounts which you consider desirable for controlling the receipts and distribution of stores.
7. Name, describe, and give illustrations of the accounts and statistical returns which a mining manager might be expected to send in monthly to the head office.

SUBJECT—MINING GEOLOGY.

1. Explain briefly the various theories which claim to account for the filling of metalliferous veins.
2. Define the terms—
Zone of Oxidation;
Vadose Circulation;
Barysphere.
- Give the chief ores of silver, lead, copper, and zinc existing at depth and those usually met with near the surface, accounting for the presence of the latter.
3. Describe briefly the development of methods for the recovery of faulted veins, and illustrate present-day methods by an example.
4. Give any examples of secondary enrichment you know of, with your explanation of the occurrences.
5. Give any examples you can of the effect of wall-rock on the metallic contents of lodes.

6. What do you understand by the terms slickensides and flucan, and what class of vein do they usually indicate? Give examples; or give examples of banded structure with your explanation of its formation.
7. Describe any system of deep leads with which you are acquainted, and discuss the probable source of metallic contents as a guide to exploitation.

SUBJECT—MINING SURVEYING.

1. Describe the usual methods of ascertaining horizontal distances in surveying.
2. Give field notes of the survey of a mine with a main shaft and two levels, as required annually by the Mines Department.
3. In selecting a theodolite, what would be the principal points of construction to which you would pay attention, and how would you test them?
4. Describe carefully the adjustment of the transit theodolite.
5. Describe the level, and the precautions you would take in using it to ensure accurate work.
6. A winze is sunk on a vein of varying underlie. Describe your method of survey, and give field notes.
7. The tangents of a 10-chain curve include an angle of 120° . Shew how to set the curve out by offsets and deflection angles, giving the necessary calculations.
8. In a certain traverse, it is impossible to measure the lengths of two sides not contiguous, but their bearings and lengths of other sides and bearings are obtained. Shew how you would obtain by latitude and departure the length of the sides and area of figure.
9. Describe any method of ascertaining the True Meridian.

SUBJECT—MINING LAW.

All questions are required to be answered.

1. How would you neutralise the fumes arising from an explosion of nitro-glycerine which cannot be effectively disposed by ventilation?
2. How should cages be covered for protection to persons ascending or descending shaft?
3. At what angle should ladders be placed in a shaft for the convenience of miners? What space should be allowed between the rungs of such ladders; and what space must be allowed between the rungs and the wall?
4. What is the limited length of rope or chain ladders which may be used in a shaft during sinking operations?
5. In raising or lowering men, what is the limited rate of speed at which a cage or bucket is allowed to travel?
6. What provision is required to be made in a mine which is liable to an inundation or burst of water?

The following Lists of Certificates granted since the inception of the Board of Examiners for Mining Managers' Certificates are published in accordance with a resolution passed at the Interstate Conference of Boards of Examiners held in Melbourne in March, 1906 :—

SERVICE Certificates of Competency granted by the Board of Examiners.

No. of Certificate.	Name.	Date of Certificate.
1. 92	Davies, Joseph	28 Sep. 1892
2. 92	Ruffon, Geo. Donald	28 Sep. 1892
3. 92	Sinclair, George Peace	28 Sep. 1892
4. 92	Heighway, John Felton	28 Sep. 1892
5. 92	Irvine, Peter	28 Sep. 1892
6. 93	Daniel, John	29 Mar. 1893
7. 93	Marshall, John Henry	29 Mar. 1893
8. 93	Aaron, Gabriel	29 Mar. 1893
9. 93	Webb, George	29 Mar. 1893
10. 94	Payne, John Greaves	3 Apr. 1894
11. 94	Wesley, William Henry	3 Apr. 1894
12. 94	Andrews, Thomas	3 Apr. 1894
13. 95	Richards, Moses John	17 Apr. 1895
14. 95	Richards, Stephen Eddy	5 Nov. 1896
15. 98	Stubs, Joseph Thomas	20 Jan. 1898
16. 98	McCrackan, John	20 Jan. 1898
17. 98	Heery, Luke	5 Mar. 1898
18. 98	Curtain, Cornelius Henry	13 Apr. 1898
19. 98	Clerk, Frederick Malcolm	14 Apr. 1898
20. 99	Craze, John	25 Jan. 1899
21. 99	Tilley, George Reynolds	17 Apr. 1899
22. 99	Hooper, Thomas Martin	17 Apr. 1899
23. 99	Vincent, Thomas	17 Apr. 1899
24. 1900	Brown, William	9 Jan. 1900
25. 1900	Rosewarne, David Davey	4 Oct. 1900
26. 1901	Buddon, William	1 Mar. 1901
27. 1901	Yeates, Alexander	29 Apr. 1901
28. 1902	Ireland, Mark	22 Apr. 1902
29. 1902	Woolcock, John	23 Sep. 1902
30. 1903	Powell, Robert William	5 May, 1903
31. 1904	Muir, John James	27 July, 1904
32. 1904	Moyle, John	5 Dec 1904
33. 1904	Ridley, John	12 Dec. 1904
34. 1906	Brough, Daniel	23 Apr. 1906
35. 1906	Berrill, Samuel	23 Apr. 1906
36. 1906	Barker, George	24 July, 1906
37. 1907	Wisch, John G. A.	6 Nov. 1907

COLLIERY Certificates of Competency granted by Board of Examiners.

No. of Certificate.	Name.	Date of Certificate.	Class of Certificate.
1. 92	Brain, Austin Lionel Bennet	28 Sep. 1902	First class
2. 1907	Wallace, Archibald Campbell	23 Apr. 1907	Second class
3. 1907	Williams, Thomas James	8 May, 1907	First class

CERTIFICATES of Competency granted by the Board of Examiners.

No. of Certificate.	Name.	Date of Certificate.	Class of Certificate.
1. 92	Dunstan, Alfred John	28 Sep. 1892	First class
2. 92	Ekborg, Benjamin Pher-son	28 Sep. 1892	Second class
3. 92	Hill, Charles	28 Sep. 1892	Second class
4. 92	Booth, John Robert	28 Sep. 1892	Second class
5. 92	Stapleton, Michael	28 Sep. 1892	Second class
6. 92	Lewis, Philip	28 Sep. 1892	Second class
7. 92	Hanlon, Christopher	28 Sep. 1892	Second class
8. 92	Williams, Luke	28 Sep. 1892	Second class
9. 92	Macandrew, Harold	28 Sep. 1892	First class
10. 92	Harris, William	28 Sep. 1892	First class
11. 93	Stapleton, Michael	29 Mar. 1893	First class
12. 93	Hanlon, Christopher	29 Mar. 1893	First class
13. 93	Potter, Joseph Matthew	29 Mar. 1893	First class
14. 93	Hilder, Alfred	29 Mar. 1893	Second class
15. 93	Matthews, Peter	29 Mar. 1893	Second class
16. 93	Richards, Stephen	6 Sep. 1893	First class
17. 94	Brain, Austin Lionel Bennet	3 Apr. 1894	First class
18. 94	Thorpe, Walter	3 Apr. 1894	Second class
19. 95	Williams, Luke	17 Apr. 1895	First class
20. 96	Levings, Joseph Henry	6 May, 1896	First class
21. 99	Goodall, Thomas Charles	14 Apr. 1899	Second class
22. 1900	Schloesser, Robert	19 May, 1900	First class
23. 1900	Nicholls, Charles Berresford	19 May, 1900	First class
24. 1900	Sale, William Robert	19 May, 1900	Second class
25. 1900	Williams, Richard	19 May, 1900	Second class
26. 1900	McPeake, John	1 Aug. 1900	First class
27. 1901	Sawyer, Basil	20 Feb. 1901	First class
28. 1902	Provis, John	22 Apr. 1902	First class

CERTIFICATES of Competency—continued.

No. of Certificate.	Name.	Date of Certificate.	Class of Certificate.
29. 1902	Bird, Robert Chisholm	22 Apr. 1902	Second class
30. 1902	Briggs, William Albert John	22 Apr. 1902	Second class
31. 1902	Bartlett, William Henry	22 Apr. 1902	Second class
32. 1902	Phoenix, William	22 Apr. 1902	Second class
33. 1902	Wright, Herbert E.	22 Apr. 1902	Second class
34. 1902	Craze, John	30 Apr. 1902	Second class
35. 1903	Waller, Richard Fitz- arthur	5 May, 1903	First class
36. 1903	Brickhill, Hector Gordon	5 May, 1903	First class
37. 1903	Barker, Reginald Fredk.	5 May, 1903	First class
38. 1903	Vincent, Thomas Henry	5 May, 1903	First class
39. 1903	Crittendon, James Henry	5 May, 1903	First class
40. 1903	Weston, Eustace Moriarty	12 Aug. 1903	First class
41. 1903	Clark, Lindesay Colin	31 Aug. 1903	First class
42. 1904	Martin, Edward Patrick	17 Feb. 1904	First class
43. 1904	Herman, Hyman	29 Apr. 1904	First class
44. 1904	Murray, Russell Mervyn	29 Apr. 1904	First class
45. 1904	More, George Allan	14 Oct. 1904	First class
46. 1905	Beamish, William Abra- ham	3 Jan. 1905	First class
47. 1905	Andrews, Thomas J.	1 May, 1905	Second class
48. 1905	Hitchcock, William E.	1 May, 1905	First class
49. 1905	Smith, George Oliver	18 July, 1905	First class
50. 1906	Rockett, Hildreth Peyton	23 Apr. 1906	Second class
51. 1906	Hales, Richard Chilman	23 Apr. 1906	Second class
52. 1906	Debenham Arthur John	28 June, 1906	First class
53. 1906	Coote, Charles Edward	18 Oct. 1906	First class
54. 1907	Marks, Oscar Sidney	8 Mar. 1907	First class
55. 1907	Phelan, Bernard Fredk.	23 Apr. 1907	Second class
56. 1907	Moline, Arthur Howard Pritchard	23 Apr. 1907	First class
57. 1907	Macartney, Ross Kenneth	23 Apr. 1907	First class
58. 1907	Williams, Thomas James	8 May, 1907	First class
59. 1908	Hooke, Arthur Warner	18 Mar. 1908	First class
60. 1908	Adams, Oliver Linley	25 Apr. 1908	First class
61. 1908	Seal, Leonard Presley	19 Nov. 1908	First class

GEOLOGICAL SURVEY OF TASMANIA.

REPORT OF THE GOVERNMENT GEOLOGIST.

Geological Survey Office,
Launceston, 1st June, 1909.

SIR,

I HAVE the honour to present my report for the year ending 31st December, 1908.

During the year I have made the following examinations:—

1. The Country in the Vicinity of the Great Western Railway-line.
2. The Goldfields of Lisle and Cradle Creek.
3. The Gunn's Plains and Alma Mineral Districts, North-West Coast.

The report on Gunn's Plains was not finished at the end of the year.

Mr. L. K. Ward, B.E., Assistant Government Geologist, has been engaged on the following work during the year:—

1. Preparation of Bulletin No. 3 on the Mt. Farrell Mining Field.
2. Exploration of the Route of the Great Western Railway Survey.
3. Geological Survey of the Tinfeld of North Dundas.

The preparation of the North Dundas Bulletin was in progress at the end of the year. Mr. Ward's annual report is attached hereto.

Western Exploration.

For the first three months of the year, the services of Mr. Ward and myself were utilised by the Lands Department, under an Exploration Act passed by Parliament in 1907, for or towards effecting the following purposes, viz.:—

1. Exploring the country lying within 20 miles or thereabouts north and south of the route surveyed for the Great Western Railway.
2. Constructing tracks and means of crossing rivers to enable prospectors to reach any apparently mineral-bearing places which may be discovered or are already known.
3. Obtaining a report upon—
 - (a) The agricultural land;
 - (b) The timber;
 - (c) The minerals;
 - (d) The scenery and probable tourist resorts in the region to be explored.

The geological survey was charged with the duty of exploration and reporting upon the geological and scenic features of the country explored. The reports were furnished to the Surveyor-General, and published in the report of the Department of Lands and Surveys for 1907-8, with accompanying topographical and geological maps.

My exploring party traversed the country from Tyenna as far north as the Gell River, and west to the Prince of Wales Range.

Mr. L. K. Ward took a party from Gormanston to the King William Range. I started from Hobart on the 24th January, and returned on the 2nd April; Mr. Ward left Launceston on the 18th February, and returned on the 9th of April.

Our reports deal in detail with the geology and physiography of the country traversed, and it would be out of place to reproduce them here; but it is perhaps advisable to refer to the results, and repeat some of the published observations, in view of the circumstance that the publications of the Mines Department circulate principally among those interested in mineral exploration.

Although the examination of this *terra incognita* did not result in any important discoveries of mineral, the journeys may be said to have been useful in more than one respect. They served to dispel the vague, nebulous ideas which have so long floated in the minds of many respecting the mineral wealth of this unknown tract of country. Sound and definite information has now been gained, dissipating the haze which engendered false hopes, and might even injuriously affect public policy itself. It is now known that though sporadic and limited occurrences of ore may be met with, the geology of the area is such as to forbid the hope that any part of it will ever yield a first-class mining field. However unpleasant this conclusion may be, it was worth while going to the trouble and expense of the examination necessary to arrive at it. It is better to know the worst than to dream dreams. Another and important direction in which the exploration has certainly given results of value, is the opportunity which it has afforded geologists of becoming acquainted with geological features, which are proving of the utmost use in correlating and interpreting strata in the mining fields of the north and west. A basis has been in this way secured for conclusions hitherto only drawn tentatively in more than one mining district. Journeys of this kind are a necessity for compiling our long-proposed geological sketch-map of the island, and connecting stratigraphically widely separated mineral fields. In still another respect the exploration has been of use, namely, in placing us in a position to produce a geological section of nearly the entire width of the island. To complete the traverse the line requires to be continued down the Gordon from the Serpentine River and to Point Hibbs on the West Coast; and further north, from the Frenchman's Cap to Mt. Darwin and Macquarie Harbour. The latter traverse would enter the known mineral belt at the Darwin Range.

I am of opinion that this kind of traverse should, in future, form a permanent feature of the work of the Geological Survey. The best time for undertaking them is in the summer, when the weather is favourable for exploration in the highlands. I strongly advise that they be incorporated as an integral part of the functions with which the survey is charged. They will result in placing our knowledge of the structure of mining fields on a broad and sound basis, and are in essential harmony with the basic principle which underlies all geodetic

survey work, namely, to proceed from the whole to the part; not from the part to the whole. To confine operations to separated mining fields and to neglect the structure of the intervening country, is to reverse this important rule, and cloud our knowledge of the mining areas themselves with partial, empirical interpretations.

The methods here insisted upon are in unison with those officially adopted by the United States Geological Survey, an organisation which stands in the first rank as regards broad and enlightened practice. It may be permitted in this connection to quote a few pregnant sentences from the instructions which it places in the hands of its officers:—

"In field study of economic mineral deposits, the geologist should bear in mind that his results, to have their greatest value, must be based on a thorough knowledge of the geologic relations of the deposits. If he does not obtain this knowledge, his work will be a more or less complete failure, no matter how many facts he may ascertain regarding the deposits themselves. If time for the study of a deposit is limited, a considerable share should be devoted to the general geology of the district in which it occurs—to its geologic and physiographic history—although these matters may to the superficial observer appear to have little, if any, bearing on the subject under investigation."

Such exploratory traverse work might also be made of service to the cause of education by attaching to the party as cadet or assistant a university science student, who would be glad to join in the work, gaining experience for himself, and contributing to the final report in the form of maps or observations.

As an example of a traverse of this sort, I might instance one across the country between the Forth and Mt. Farrell. This would embrace an area, the geological structure of which is but little known. It would assist in the geologic interpretation of the country lying further north. It would pass across mineral-bearing strata, and it would connect the mining fields of Farrell and Middlesex. The impending investigation of the Mt. Balfour ore-deposits will also be incomplete without an examination of the hinterland to the immediate east of the mining field proper. It has been necessary to make these comments, because individuals have represented to me how improper it is that geological journeys should be taken into areas where mineral occurrences are not likely to be of importance. This objection is based principally on imperfect acquaintance with the principles of our investigations. Slight, and perhaps unusual, indications in any given district often assist greatly in interpreting normal deposits elsewhere; and observations of the outcrops and boundaries of geologic systems, wherever they may be found, are of guiding value in estimating the economic importance of the strata met with in the mining fields. Unless a fund of reliable data has been collected, from which conclusions can be drawn, the mere inspection of mine workings yields minimum results.

The exploration journey this year showed that below the Permo-Carboniferous mudstones and mudstone conglomerates which flank the Tyenna and Russell's Falls River valley lies

the Ordovician limestone, which has survived as far east as the Junece River. Exposures of this limestone were seen on the Humboldt Divide, in the Florentine Valley, and in the valley of Rasselas. Further west it was noticed in the valley of the Denison River. Approaching the summit of the above divide, it attains an elevation of 2000 feet above sea-level. In the valley of the Florentine its exposures are 1400 feet above sea-level; and in the valley of Rasselas, between 1500 and 1600 feet. As it is also met with in the Franklin River valley and along the Lower Gordon, extending also to near Point Hibbs, on the West Coast, it was evidently at one time continuous over the greater part of the area now occupied by the island. Limestone, apparently belonging to the same formation, occurs in the south, at the New River; and in the north, on the Sophia River, Blythe River, Leven River, at Gunn's Plains, Mole Creek, Chudleigh, Railton, Winkleigh, and Beaconsfield.

The fossil contents—*Actinoceras*, the coral *Tetradium* (*Dana*), *Raphistoma*, *Orthis lenticularis* (?)—have caused these strata to be referred to the Ordovician; and in Tasmania they are considered to be at the base of that system.

At Railton, in the north of the island, the limestone rests unconformably upon Cambrian sandstone, containing the characteristic Upper Cambrian trilobite, *Dikelocephalus*; and on the Humboldt Divide and on the flank of Tim Shea (Mt. Stephens) yellow sandstones with the same fossil form apparently underlie the same calcareous strata. Near the Humboldt Mine, at the foot of the Needles, cherty and chocolate-coloured silicified slate of presumably Cambrian age can be seen to pass below Tim Shea and the overlying limestone, heading in a north-west direction for the Florentine Valley.

In the valley of Rasselas the limestone which forms its floor is underlain by the pebbly sandstone quartzite and conglomerate beds which rise into the Thumbs, Mt. Wright, and the Denison Range, and which are interpreted as being of Cambrian age. The Gordon River crosses bars of this limestone, which here strikes N. 25° W., and dips north-east at an angle of about 70°. The strike of the underlying conglomerate series to the west is similar, and the dip is in the same direction; but the angle of the latter is only 50 degrees. To the same system belongs the limestone which at Beaconsfield overlies the sandstone and conglomerate beds traversed by gold quartz reefs in the Tasmania and other mines.

The limestone at the Upper Blythe River also reposes on the conglomerates and slate series which enclose the well-known copper and iron-ore deposits. The Gunn's Plains limestone, too, rests on the cupriferous breccia and slate series of the Dial Range. Its relations, therefore, seem to be fairly constant everywhere, making allowance for lithological differences in the conglomerates; and it consequently becomes highly important to fix its position in the geological record with certainty. The exploration journey has been of value in this respect, and in throwing light on the one hand on the relations between the Cambrian and the Ordovician, and on the other between the Cambrian and the Algonkian.

What is probably the Lower Cambrian is represented by the sandstone and conglomerate beds of which the Denison Range

is composed, beautifully exposed, and forming an easily recognisable belt between the Ordovician of the valley of Rasselas on the east, and the Pre-Cambrian schist region on the west.

As a result of these journeys, precise observations of the boundaries of a large part of the schist region have been made for the first time in the history of Tasmanian geology, and the true nature and age of the schists themselves ascertained.

Once the Denison Range was crossed, successive chains of the quartzite and sericitic schists continued with a dreary monotony as far west as the expedition penetrated, and it appears that they extend still further west to the coast itself, interrupted on the meridian of Pillinger and Darwin by the schistose rocks of Lyell, which are a younger series, and have an entirely different origin.

As regards the mineral resources of the country traversed, it is perhaps not safe to suggest the absence of mineral from parts of the country not absolutely on the route which was followed. Ore-deposits may possibly be discovered at isolated spots, provided that igneous rocks favourable to the deposition of ore are found to exist in the vicinity. I have been informed that serpentine occurs on the Boyes River, on the west fall of the Denison Range. Possibly some mineral veins may be found in that neighbourhood. Some gold-bearing schist was found at the Gell River by Mr. J. L. A. Moore, and a little work might very well be done at this spot with a view of ascertaining—firstly, whether the schist there is solid and undisturbed; and secondly, whether any formation can be found or signs of lode-action traced. The minute particles and streaks of gold observed were in the substance of samples of ordinary sericitic quartzite schist, such as forms miles of mountain ranges to the west.

Apart from the above, only unimportant occurrences of pyrites were met with in the schist area. The conclusion was irresistible that, failing the discovery of favourable igneous rock, the hope of any important mining field springing up on the line of route taken by the expedition is extremely slender. Moreover, the regularity of the contours of the mountain crests, and other surface outlines, indicated no change in the geology of the country further west and south within a considerable distance of the route. In the absence of the acid eruptions of the West Coast Range, or of such rocks as the great granite masses of Heemskirk, and the Meredith Range and other similar foci of ore-concentration, a sanguine forecast for this great schist area is not justifiable. The scattered occurrences of alluvial gold which have been reported from time to time from the Gordon, Franklin, and Jane rivers, while denoting that a little deposition has taken place, are not sufficient to shake the main conclusions arrived at. Once, however, the Lyell-Darwin meridian is reached, conditions are entirely changed, and a true mineral belt is entered. A good deal of limonite, or bog iron ore, was seen in the Florentine Valley, and these occurrences appear to have been trenced and otherwise prospected, in the hope that they would prove to be outcrops of mineral lodes. It is, however, for the most part an impure yellow hydrated oxide of iron,

mixed with ferruginous clay, and a wash of quartz and quartzite stones, without indications of any lode mineral.

At the eastern base of the Needles, however, the Cambrian slates and quartzites are traversed by copper and lead-bearing lodes. A copper-ore outcrop was discovered in 1891, and at different times some work has been done in connection with this lode. Three openings have been made on it at intervals over a vertical distance of about 150 feet. In the open cross-cut at the outcrop, the lode is 4 feet wide, and consists of a gangue of quartz, barites, and calcite enclosing narrow veins of copper pyrites, accompanied by a little galena and zinc blende. About 60 feet below this, a drive has been commenced on the lode, which is 9 to 10 inches wide, in a gangue of quartz and carbonate of iron, with spurs of quartz projecting into the country from an irregular ill-defined hanging-wall. At the entrance, a spur of quartzose veinstone appears to have yielded most of the copper ore which was obtained.

About 100 feet below this is the adit-level, which has been driven along a well-defined foot-wall. In the face, the lode is 2½ to 3 feet wide, consisting of barren quartz and spathic bands 6 to 9 inches in width, separated by lode slate. A cross course traverses the drive a few feet from the end, following the strike of the country strata N. 70° W. The country-rock is indurated chocolate-coloured slate and quartzite, dipping north-easterly, and evidently its prolongation westerly passes below Tim Shea and the Humboldt Divide. It must be referred to the Cambrian. A gossan outcrop was discovered by Mr. Clark north and east of the copper lode, and parallel with it. A shaft has been sunk on this, and a few trenches cut, without disclosing anything beyond the iron oxide. Southwards, and also parallel with the principal lode, a galena-copper lode has been found and trenched. The gossan outcrop above mentioned has shed boulders of limonite over the hillside, and it is almost certainly the upper part of a lode.

Whether these lodes are dominantly copper or galena lodes cannot be stated until more work is done on them. A wide gossan band occurs on the track between the mine and Tyenna, but no work has been done on it. This belt was the only zone in which I met with decided indications of ore-deposits, and there would seem to be some possibilities in it. A system of beds traversed by defined lodes carrying appreciable quantities of copper, &c., cannot well be passed over by the prospector. The country at the base of the Needles and Tim Shea is covered with timber, and the track to the mine from Tyenna is badly overgrown. Having in view the fact that undoubted ore occurrences exist, it is highly desirable that this track be kept open.

These journeys may prove of use to prospectors by indicating to them the routes which will best give access to the mountainous wilderness which they wish to explore, and by giving them some reliable notion of what they may expect to meet with. Tracks leading into the heart of the country have been staked out, and can be easily followed. It is scarcely necessary, and perhaps not possible, to keep all the tracks open. They have mostly been of an exploratory nature, made with a view of ascertaining whether the country would

warrant much expenditure on them. When it has been decided which routes will be the main lines of communication, those selected will have to be kept clear and open, and food depôts established at suitable central spots. The provision difficulty is the principal bar to the prospector. He cannot carry on his back all the requisite food; and, unless he can replenish his stock somewhere near his field of operation, he is not in a position to make any serious attempt to enter and tarry in the great desolate land.

It will be noticed that the exploration journeys, and the preparation of reports thereon, occupied the greater part of the first half of the year, reducing the time available for current examinations of mining districts. Under the circumstances, this was unavoidable.

Visit to Zeehan.—In my last, I accompanied you in a journey to Zeehan, which you made in response to a telegram of urgency received from that town asking for immediate remedial measures to cope with the situation created by the temporary suspension of the smelting works there.

The result of the journey was embodied in a joint report. Ministers had already decided in principle on the question of granting an advance to the smelters. When this was given effect to the critical situation was dissipated; however, information was gained on the spot which may be useful in the future.

Lisle and Cradle Creek Goldfields.—In July and September I examined this district, famous for having been the most important alluvial field ever worked in Tasmania. At one time it had a population of 2500. The Bessell Bros. discovered it in December, 1878, and there was an immediate rush of miners to it, and a consequent enormous output of alluvial gold. This feverish activity lasted for three or four years, and then the number of workers gradually decreased, until to-day there are not more than a couple of dozen. The total yield of the field to date, according to the most trustworthy accounts, approximates to a quarter of a million ounces; and this has been won from a fraction of a valley floor not more than a mile and a half square. The bed of the main creek and rich terraces of detritus on the eastern side of the valley have produced the bulk of the gold. A portion has also been won from creeks and terraces on the opposite side. As might be expected, the workings in the main creek have been the largest producers. The terraces, though they were exceedingly rich in places, have not yielded anything like the same amount, and the best gold in them was obtained from the few feet of clayey wash lying on the bottom, though it was present also in the upper part of the terrace, consisting of angular and sub-angular hill drift. The floor of the valley is granite, always soft granite in the workings, of the Golconda and Camden Plains type. This rock extends up the slopes of the surrounding hills for a height of 400 or 500 feet, and then junctions with slate and sandstone. The invasion of these sedimentary rocks by the granite has silicified them, and given birth to abundant secondary mica and incipient audalusite. The actual contact is concealed below a heavy overburden of clay and detritus, greatly impeding prospecting operations. Although

these sedimentary strata are traversed by some veins of quartz, from some of which perhaps gold is not entirely absent, specimens of gold-bearing quartz are practically absent from the alluvial workings. These would undoubtedly have been abundant if the gold won had been derived from ordinary quartz reefs. The inference, accordingly, appears to be a legitimate one—that the metal has come from soft seams of mica or kaolin in the granite, or from either soft formations or impregnations at or near the granite contact. It will not be easy to prospect these owing to the overburden, which uniformly hides the contact line and covers the hill sides, and, when found, the distribution of gold in them may turn out to be irregular. Nevertheless, the probability is that in places they will be found rich enough to work. Where so much gold has been shed in such a limited area, it does seem likely that large quantities of it have been left *in situ*. Two miles north-west of Lisle are the Cradle Creek and Tobacco Creek sections, on the latter of which gold was discovered 18 months before the discoveries at Lisle. The two creeks have returned about 2000 ounces of gold. Three or four years after work was started at the Lisle diggings a rush took place to these creeks, but the reefs or veins which shed the gold were not found. The natural features of the country indicate clearly that the gold which has been obtained from the two creeks was derived from quartz reefs or veins in the hill which separates them. The Ordovician country south of Lisle consists of ancient sandstone and slate strata, which are traversed here and there by dykes of hornblende granite, usually in an advanced stage of decomposition. These have probably some connection with the granite of Lisle to the north, and of Diddleum and Camden Plains to the south.

North-West Coast Mining Fields.—In October and November, I examined the mineral districts of Gunn's Plains and Alma, and at the same time visited some mineral occurrences at Stowport.

Some work has been carried on at Gunn's Plains, on Copper Creek (charted as Walloa Creek). An upper adit has intersected a copper ore lode 5 feet wide, with a siliceous brecciated slate gangue, bearing south-east. In a lower adit, what appears to be the same lode has been intersected, carrying a sprinkling of copper and iron pyrites in a calcite and slate matrix. Nothing has been done beyond cutting the lode at these points and trenching at surface, so that it remains now to prove the value of the lode by driving on its course and opening it up. A few other mineral indications exist in the district, but none of such definite character as the Copper Creek lodes. Most informative knowledge was gained on this journey of the geology of the country in which these ores occur. The Dial Range series of tuffs, breccias, and conglomerates have been recognised as occupying a well understood position in the geological record. The knowledge of their possibilities as foci of ore-distribution may be expected to contribute to important economic results in the exploration of other areas of similar structure.

Some of the peculiar breccias of the Dial have been recognised this year by the Assistant Geologist in the Dundas field, and as the porphyroids prevalent in the former district are

known to occur at Bell Mount, it is probable that they continue also to the Black Bluff and Stormount areas, and will be found there, too, to be associated with minerals worth looking for. It is the same geological complex which encloses the lodes of the copper ore mine at Alma, between the Forth and Wilmot Rivers. Exploratory work has lately been done there by the Alma Prospecting Syndicate, in the shape of sinking on a gossan outcrop, and driving to intersect its downward extension. A little surface-cutting has been carried out on an outcrop of barytes on this property.

A visit to Stowport, fortified by the observations made at the Dial and Alma, disclosed that, though the igneous breccias are absent there, the slate, conglomerate, and quartzite strata comprising the country near the Blythe River belong to the same geological system. At Stowport, however, they appear to be within the range of influence of the granite invasion, as the ordinary Devonian granite is exposed on their southern limit. The precise limits of the respective influences of the porphyroids and granite need further study before the genesis of many of our ore-deposits can be properly understood. It seems a pity that exploration work has been suspended at the Rutherford mine before it was really completed. All through these coastal shows the same unfinished state of things prevails. Prospecting or development work has not been pushed to a definite conclusion, and consequently it cannot be said whether the coast is likely or not to embrace mining districts of value. All that can be stated for the present is that there is a field for prospecting work, and that the indications encourage perseverance. The geological examination leads one to recognise a wide area in which the conditions for ore-deposition appear to have existed.

Oil Shales.—In pursuance of your instructions, I prepared, in December, an account of the oil shales occurring in Tasmania for the Commonwealth Statistician. This report embraced information respecting the Tasmanite shale of the Mersey district, the kerosene shale or cannel coal of Preolenna, and the cannel or pelionite of Barn Bluff. A copy is appended hereto.

Geology of Tasmania.—In accord with the practice which has been adopted of furnishing the Commonwealth Statistician with a succinct account of the geology of the island, brought up to date, at the end of each year, I compiled a revised sketch of the outlines of our geology, as far as has been worked out to the end of December. The enlarged area taken in by our recent exploration journeys and other field work has added to our knowledge, and in some points necessitated revision of some hitherto accepted parts of the stratigraphical record. As fresh knowledge is gained with successive years, such adjustments must be expected from time to time.

Office.

The correspondence this year embraced 2326 letters, reports, &c., in and out. The office library has been added to by bulletins, reports, and other publications received from the geological surveys and mines departments of other countries, and our reports have been duly transmitted to them in

exchange. Acknowledgment, with thanks, is tendered to the proprietors of the following papers:—"Daily Telegraph," "Daily Post," "Launceston Examiner," "Zeehan and Dundas Herald," "Australian Mining Standard," "Queensland Mining Journal," "New Zealand Mines Record," "New York Engineering and Mining Journal," "Mining Journal," (London), "Australian Mining and Engineering Review." The collection of ores prepared for Dr. E. Weinschenk, University of Munich, was completed and despatched. Special thanks are due to the Mount Lyell Mining and Railway Company the Mt. Bischoff Tin Mining Company, the Magnet Silver Mining Company, and the Anchor Mines, Limited, for their assistance in making this collection as representative as possible.

Every opportunity is taken in the field to gather material for such collections; but the demands are increasing, and it is becoming increasingly difficult to satisfy them, for many of the localities are visited but seldom. Care is being taken to restrict these donations to public institutions, or authors, who will make a *bona fide* use of the material.

Mr. F. S. Grove was, to the end of the year, still occupied with renewals to the Mt. Cameron Water-race. From the beginning of April, Mr. W. D. Reid acted as clerk and draftsman to my entire satisfaction.

The question of office-accommodation is still pressing, and can apparently only be disposed of by hastening the erection of the new technical school building, when the school staff and students will vacate their present quarters in the Public Buildings, and enable at least two additional rooms to be occupied by the Geological Survey. One room is required for the Assistant Government Geologist and for the drafting in connection with his maps and a workroom for depositing and testing ores and rocks. These rooms can be secured in the building quite adjacent to the present offices. It is hoped that this will become practicable without any great further postponement.

With our newly organised system, an increasing attention is being devoted to surveying and mapping, and this inevitably renders increased drafting assistance necessary. With a single draftsman it seems impossible to keep up with current work or to undertake the preparation of such further maps as the mining community and the public generally are entitled to expect. We have in view special maps, which it is intended to issue as soon as drafting facilities exist, such as maps showing the distribution of ores in the island, maps illustrating the distribution of igneous rocks, &c.; and there is the further important work of issuing a new map of the geology of Tasmania. This latter can only be thought of when we are able to keep a draftsman at work on an office chart, transferring the field results as they come in.

As large areas are continually coming under observation, with the result that the mapping becomes a very important part of our system of work, additional assistance in this respect appears to be imperative if any reasonable standard of efficiency is to be maintained. The further accommodation mentioned above in this report will, in any case, become more urgent than ever.

Geological Survey Collections.

The minerals, ores, and rocks collected from time to time in the field have of necessity accumulated to an extent which prevents their storage in the office, and most of them have had to be put away in boxes and bags in the Government Store, where they are difficult of access, and altogether hidden away from the public.

An opportunity now presents itself for their conservation and display in the Victoria Museum, Launceston, which has recently been enlarged (with Parliamentary funds) for the addition of a mineral gallery, which it is intended to arrange so as to represent the mineral resources of the State. The survey collections could undoubtedly be housed there, and be displayed with advantage to the State. The transfer would relieve the office from overcrowding with specimens, and would also turn to real use the collection at present lying idle in the store. It would also place representative ores and products in a position where they could always be seen by the public, and easily referred to by the Department.

The want of ability to refer quickly to any of the specimens stored is an inconvenience which is at present seriously felt by the geologists. I venture to suggest that, under proper conditions, the arrangement here proposed would prove of benefit to the public, the State generally, and the Department in particular. It would be necessary to devote a little time to the arrangement of collections, but perhaps not more time than is lost at present when reference is required to specimens which are packed up.

Analytical Work.

The absence of facilities for this continues to be felt, and I am afraid that the drawback will persist until definite arrangements are made with the Government Analyst. There is no difficulty in having our mine samples assayed, and I am not alluding to this branch of the work. I refer rather to systematic quantitative analyses of our minerals and rocks, such as are undertaken by Government laboratories elsewhere. Our weakness in this particular respect is unsatisfactory.

Conclusion.

Reviewing the work for the past year, the progress made in the examination of the structure and resources of large areas of the island has been considerable, and the additions made to our knowledge of the economic value of certain districts must inevitably prove of use and benefit to the State.

In the coming year the districts of Mt. Balfour, Mt. Claude and King Island will be the subjects of much-needed investigation.

I have, &c.,

W. H. TWELVETREES, Government Geologist.

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

REPORT OF THE ASSISTANT GOVERNMENT
GEOLOGIST.

Launceston, 1st June, 1909.

SIR,

I HAVE the honour to present the following report on the work upon which I have been engaged during the year ending 31st December, 1908:—

From 1st January until 18th February I was engaged upon the preparation of the bulletin dealing with the Mt. Farrell mining field. This has since been published as Bulletin No. 3 of the new series of publications of the geological survey.

At the conclusion of the work connected with the preparation of this bulletin, I proceeded to the West Coast in connection with the geological exploration of the route of the proposed Great Western Railway. That portion of the route which lies between Gormanston and the King William Range was examined by me during the period between 18th February and 9th April.

The preparation of my report, and the execution of the plans in connection with this work, occupied my time until 22nd June. The report and maps have been published in the report of the Department of Lands and Surveys for 1907-8.

On 22nd June, in accordance with instructions, I proceeded to North Dundas to undertake the geological survey of that tinfield. The field work in connection with this survey occupied the period from 22nd June to 14th October, and from that date I have been in Launceston engaged upon the preparation of the plans and geological report.

A summary of the principal results of my observations during the year is here appended.

Exploration of the Route of the Great Western Railway.

The rapid traverse of a considerable area to the east of Gormanston has enabled me to place upon record many of the salient geological features of this area. In some cases the stratigraphical relationships between some of the strata met with could not, in the time at my disposal, be determined; but, at least, the boundaries of these strata were ascertained and their lithological characters examined.

Special attention was paid to the economical aspects of the area as regards possible mineral contents, and a part of the time of the expedition was taken up with the systematic prospecting of the area. When regarded from this point of view, the country between Gormanston and the King William Range is certainly disappointing, for our prospecting operations met with negative results in all cases. This is the more remarkable on account of the immediate proximity of the well-marked zone of mineralization which follows a meridional course along the West Coast Range. Yet there was discovered no eastward extension of this metalliferous belt.

The principal ore-bodies of the Mt. Lyell district are located on the line of junction between the Mt. Lyell schists and the West Coast Range conglomerate.

The Mt. Lyell schists constitute the foliated mantle of a persistent belt of porphyritic igneous rocks which are known to traverse the western portion of the island from the north coast at Penguin to Birch's Inlet on Macquarie Harbour, and probably still further to the southward. I have described in detail a portion of this igneous belt in my report on the Mt. Farrell mining field.

The West Coast Range conglomerate forms the bulk of the capping of the several mountains which have been grouped together under the name of the West Coast Range. The formation is essentially a quartzose one; the component pebbles consisting of several varieties of quartz, quartzite, and quartzite-schist. Some further mention of this conglomerate is made below.

The relation of the conglomerates to the igneous schists has not yet been determined, and the question of this relationship is one of great importance. The view has been expressed that the siliceous sediments have been deposited upon the schists, but the recent work of the geological survey, in correlating the strata in various parts of Tasmania, shows that the view hitherto held is at least open to question.

The ore-bodies of Mt. Lyell are situated on, or in the immediate vicinity of, the contact, between these two formations. The reason is not that the metallic ores have been derived from either formation, but because the fissures (now filled with ore) have, in a manner the cause of which is thus far undetermined, followed very closely the line of junction of the two formations.

Detailed investigation of this region is necessary before any sound and scientific deductions can be made, which might lead to a confident statement regarding the possible extension of the ore-bodies beyond the limits thus far empirically delineated.

It may, however, be here stated that there appear to be no reasons, based on geological observations, why, under favourable conditions, ore-bodies should not be found within the boundaries of the conglomerate, which has hitherto been regarded by prospectors as quite unfavourable.

On passing eastwards, the geology is found to change abruptly at the King River. The sudden change from the rugged peaks and ridges of the West Coast Range conglomerates to the broad plains of the King River valley, worn down in dark slate, is striking. There seems to be some probability of the existence of a great fault-plane coinciding with the eastern border of the West Coast Range.

The relationship of the slate to the siliceous conglomerate was not determined. To the eastward of this belt of slate lies a narrow strip of river-borne alluvial, in which boulders of diabase are prominent. Beyond this alluvial deposit there is a marked difference between the country lying to the north and that to the south of the Nelson River. On the low hills to the northward, the country consists of sandstones and shales of Silurian age. These cannot, from their observed dip, be conformable with the slates of the King River valley. Moreover, from the absence of all signs of crushing in the members of this formation, the period of sedimentation which

is here represented followed after that of the crushing of the slate.

South of the Nelson River the Raglan Range rises abruptly and towers above the low hills of sandstone mentioned above. It is composed of rocks which, while showing variations in composition and structure from point to point, must yet be considered to constitute a geological unit. These rocks are, in the majority of cases, schistose; but some varieties have only a slaty cleavage, and others, again, are massive. In composition they are not complex, consisting, as they do, mainly of quartz and sericitic mica in varying proportions.

The quartzites are often remarkably free from all other ingredients than silica, and form dense non-schistose masses.

Closely allied to these massive white quartzites are the quartzite schists, in which a slaty cleavage or actual foliation is shown. These are due to the development of extremely tenuous films of sericite, which in some varieties are hardly visible. With the increase of the sericitic ingredient, these quartzites pass over into mica schists, which are distinctly foliated.

The age of these rocks could not be ascertained from the evidence obtainable in this area alone. The quartzitic and micaceous schists form the floor upon which the subsequent slates and Silurian sandstones have been deposited. These schists are covered by the Silurian sandstone as far to the eastward as the Collingwood River. Beyond this point they are exposed for miles north and south of the Linda track, and continue to the eastward as far as Mt. Arrowsmith, which forms the western escarpment of the central plateau.

No other rock-type is represented by any considerable outcrop throughout all this area. Some few intrusions of igneous material were detected, but these were of very small extent. Their presence is, however, significant.

Near the junction of the Collingwood and Cardigan rivers there were discovered some short lenticular veins of coarse pegmatite. These are only visible on the banks of the Collingwood River, but their presence is highly suggestive. The pegmatite seems to have undoubtedly been derived from a granitic magma, no other representation of which has thus far been found in this neighbourhood. Granite is known to outcrop at Granite Tor to the north, and at Cox's Bight to the south of this locality, and in both places it is stanniferous. It may be, therefore, that there is an axis of intrusion extending in the direction of these known outcrops, and that the pegmatite in the Collingwood River valley lies on that axis. And in confirmation of the supposition that a granitic mass is not far below, mention should be made of the fact that the mica schist in this place carries a number of small and irregularly formed veinlets of, either quartz alone, or quartz and tourmaline. The prospecting of this area gave only negative results. The other rocks to which an igneous origin is attached, and which penetrate the mica schists, are a few dykes of a garnetiferous zoisite-amphibolite. These rocks resemble closely those of Hamilton-on-Forth, and may be on an axis of intrusion which antedates that of the granite by several geological periods; for the zoisitic amphibolite is markedly schistose, and its schistosity appears to have been

superinduced contemporaneously with that of the mica schists alongside. The quartzitic schist of Mt. Arrowsmith is succeeded on the eastern slope of the mount by a softer mica schist. Upon this softer schist, to the north of the Linda track, there lies a small hill of reddish quartzite, which is identical in lithological characters with the quartzite, interlaminated with the West Coast Range conglomerate; and also with the quartzites which are associated with the Cambrian conglomerate of the Denison Range. All of these similar outcrops are, in my opinion, separated portions of one and the same formation. Hence the information gathered by Mr. Twelvetrees regarding the age of the formation (the evidence of the succession at the Denison Range) has proved of inestimable value in assigning an age to these rocks.

To the eastwards of the quartzite, the lower-level country consists of the typical Upper Mesozoic diabase. This diabase also caps the tops of the neighbouring mountains (Mt. Gell, Mt. Rufus, the Loddon Range, and King William Range). However, the two outcrops of diabase are not continuous on the surface between the King William Plains and the capping of the range; for, on ascending the mountain, a considerable thickness of Permo-Carboniferous sandstone was found lying about horizontally on the flanks of the mountain. The diabase seems, therefore, to form two sills, of which the upper one has a much greater westerly extension than the lower one. I was unable to effect a junction with Mr. Twelvetrees in the time at my disposal, and a small strip of country remains unexplored between the furthest points reached by us during the work of exploration.

The Geological Survey of the Tinfield of North Dundas.

The tinfield of North Dundas is situated between the Ring River and the Argent River, and therefore occupies a position intermediate between Zeehan, Rosebery, and Dundas. The nearest mining fields therefore are areas in which ores of silver and lead predominate. Yet there are exhibited signs of a genetic relationship between the tin ores of North Dundas and the ore-deposits of the neighbouring mining fields. These relationships will be fully discussed in the report now being prepared. With the nearest occurrences of tin, viz., at Zeehan, Heemskirk, Stanley River, and Granite Tor, the genetic relationship is still more fully expressed by the geological features of the North Dundas field. The geology of the area is fairly simple.

The oldest rocks on the field are the Dundas slates, to which, on recent evidence, a Cambro-Ordovician age has been assigned. These are intersected by, and interlaminated with, rocks of igneous origin. The interlaminated rocks are consolidated tuffs, similar to those observed by me at Mt. Farrell, and to those recently collected by Mr. Twelvetrees in the gorge of the Leven River, and on the coast at Penguin. They belong to the effusive phases of the eruption of quartz-porphyrries and felspar-porphyrries to which I have referred above in dealing with the origin of the Mt. Lyell schists. Some intrusive masses belonging to this period of igneous invasion were found at North Dundas, but they are of small extent, and unimportant. The second period of igneous invasion was that of

Devonian age, when there were introduced a complex series of basic rocks—gabbros, norites, pyroxenites, and peridotites.

With these basic rocks are associated later dykes of quartz-porphry in the central portion of the field. The relation between the acid and basic rocks is identical with that observed in other parts of Tasmania, viz., at Trial Harbour, and at Anderson's Creek, near Beaconsfield. It seems probable that in all these localities the juxtaposition of the acidic and basic groups is caused by the operation of some regular process or processes. There are several pieces of evidence which form a strong argument in favour of the view that the process known as magmatic differentiation has been the cause of the constantly recurring association of acidic with basic types. This argument will be presented in some detail in the forthcoming report.

At a still later period the field was again invaded by igneous material, of which the only remaining trace is a long dyke of diabase. The only other formations represented in the field are unconsolidated river deposits. One of these makes the wide plain of erosion of the older Pieman River, through which the present river has deeply corroded its way. The genesis of the ore-deposits of the field dates from the Devonian igneous intrusion. With the progress of solidification, the magma became increasingly more acidic in composition, until a quartz-tourmaline rock, sometimes carrying tin ore, was evolved. Between this differentiation product and a typical vein-stuff containing the same mineral, no line can be drawn. Besides these tin-bearing rocks having an obvious connection with the igneous reservoir, there are the stanniferous lodes which have been deposited in pre-existing fissures from solution. The most common vein-type in this field is a pyritic one, which at first sight does not resemble a typical tin ore. The principal metallic ingredient of the unoxidised ore is pyrrhotite, and, in smaller proportions, there occur pyrite, arsenopyrite, chalcopyrite, and a little galena and zinc blende. The most plentiful gangue mineral is quartz, and a little dolomite usually accompanies it. Besides these, fluorite, tourmaline, chlorite, and epidote are present. Still more remarkable is the structure of these pyritic-cassiterite lodes, for the ore seldom occurs as the filling of a simple fissure. The surface features appear to include the presence of more complex lode-systems, which show a great variety of form. The essential component parts of these systems are a series of vertical or steeply inclined ore-bodies, filling fractures which cut across the slate, and a number of more nearly horizontal ore-bodies which conform with the bedding-planes of the slate. The approximately vertical lodes may be termed "feeders," and those more nearly horizontal may be termed "floors." These complex lode-systems owe their structure to the character of the forces which caused the fracturing of the crust, and to the readiness with which the slate cleaves in the direction of the bedding-planes. There are two such lode-systems on the field, and these both have a general strike in a north-west-south-easterly direction.

The pyritic-cassiterite ore in these lodes has been largely altered by the progress of weathering, and two very distinct varieties of oxidised ore have resulted. On the one hand, the

"floors," where they closely conform to the present surface of the ground, have been partly oxidised. The surface portions of the ore-body have been almost totally deprived of the metallic minerals other than cassiterite. There has, in these cases, been no gossan formed, and the reason is that the organic acids resulting from the vegetation immediately above the ore have rendered soluble the iron compounds.

Almost the whole of the recent output of the field has been maintained by the working of these oxidised floors. The more vertical components of the lode-systems, and those floors which dip into the hill slopes have, with the progress of weathering, given rise to gossans of normal appearance. In some places the gossan ore carries a high percentage of tin, but none has yet been crushed.

In the neighbourhood of Pine Hill the pyritic-cassiterite type gives place to the more normal quartz-tourmaline-cassiterite type.

Little work has thus far been done on these veins, which traverse both the slate and granite-porphry. In the latter rock there is sometimes a complete network of veinlets, between which the porphyry has been considerably altered by the vein-forming solutions. A certain amount of cassiterite has thus been introduced into the wall-rock of the veins, and an attempt should be made to ascertain whether the proportion of tin ore is sufficiently high in some of these veins and zones of impregnation to render the working of them profitable.

Other minor occurrences of vein-matter will be duly described in the report, and their possibilities indicated.

The secondary ores on the tinfield are not of great consequence. Tin ore is very widely distributed in the alluvial deposit of the older Pieman River, but not in sufficient quantities to render this formation payable. Tin ore has recently been found in Dundas, and a beginning has been made to open up the deposits. A visit was paid to this locality, and a description will be given of the mode of occurrence of the tin ore there.

Practically no lode mining has been carried on up to the present time in this field. A few prospecting tunnels have been driven, and the work has been abandoned when pyritic ore was met with. The structure of the complex lode-systems has clearly not been understood.

The time has now come for the companies working on the detrital ore to start operations upon the unoxidised lode-matter. The detrital ore remaining on the surface, and the oxidised ore in the lodes, cannot last long, and until some systematic exploration of the lodes has been carried out no accurate idea can be formed of the future possibilities of the district. The Boulder Tin Mining Company has recently erected a small crushing plant and concentrating mill, and the Renison Bell Company is beginning to follow this example.

General Deductions drawn from the Observations made during during the past Year.

There are two main features of interest brought out by the work upon which I have been engaged during the past year, and both of them have an important economic significance.

The first of these is that connected with the correlation of the West Coast Range conglomerates and quartzites with the similar rocks of the Denison Range, and concerning which there is now definite evidence concerning age, which is held to be Cambrian. This is a matter of economic importance in that the great majority of the ore-deposits in Tasmania are genetically connected with the invasion of igneous material in Devonian time. It follows, then, that the Cambrian rocks may well serve as *loci* for ore-deposition, and should be prospected with care in the neighbourhood of the igneous intrusions.

The second important general deduction is that which concerns the essential unity of origin of the acidic and basic members of the igneous rocks, which attained their present position in Devonian time.

The occurrence of these rocks at North Dundas has been brought into correlation with other occurrences in Tasmania, and valuable inferences may be drawn. It will be pointed out in the forthcoming report on the North Dundas tinfield that the relation of the basic to the acidic rocks finds expression in the occurrence of a tin-bearing lode near the Dundas township, with no other adjacent igneous rocks than serpentine. Yet this seeming anomaly is satisfactorily explained by the known relationship between the serpentine and the granite.

This observed case of the association of tin ore with serpentine is closely allied to that of the limuritic vein-matter of the Colebrook Mine, with a similar rock; and both occurrences should be borne in mind in future prospecting.

The igneous complex of acidic and basic rocks referred to here is not separate and distinct from other occurrences in Tasmania. Precisely similar associations occur in several other places, and the general features of the North Dundas tinfield might profitably be kept in view by those who may be engaged upon the prospecting of geologically similar areas.

I have, &c.,

L. KEITH WARD, B.A., B.E.,
Assistant Government Geologist.

REPORT OF THE CHIEF INSPECTOR OF MINES.

Chief Inspector of Mines Office,
Launceston, 12th May, 1909.

SIR,

I HAVE the honour to present my report on the inspection of mines for the year ending 31st December, 1908. I append statistical tables and diagram showing the number and nature of accidents which have taken place in and about the mines and works in connection with mines during the year.

I also beg to attach the annual reports of the Inspectors of Mines, viz.:—Mr. M. J. Griffin, Inspector for the Northern and Southern, Eastern, and North-Eastern Divisions; Mr. Jas. Harrison, Inspector for the Western and North-Western Divisions; and Mr. C. H. Curtain, Inspector for the Lyell District.

The number of men engaged this year at the different mines and smelting works was 6464. The number of fatal accidents was 6; and of non-fatal serious injuries, 58. The death rate from accident was 0.928 per thousand, against 0.798 in 1907.

In the five fatal cases at Lyell, it is difficult to see that further or more effective protection could have been provided for the unfortunate victims. Two seem to have lost their balance, and fallen from the ore-bench at which they were working; one infringed the mine rules, and knocked the cage away prior to entering it, getting crushed by the moving cage in some unexplained way; the fourth lost his life from a fall of rock, which he appears to have known was unsound; and the fifth had his thigh broken by a slab of schist falling away from the side of a pass which he was timbering. He believed it to be safe, but a sudden bulge took place, and the slab fell. The sufferer became convalescent, but, after six weeks, suddenly died from a clot of blood in the lungs.

The sixth fatal accident was caused by a workman at the Tasmanian Smelters attempting to put a belt on without waiting for the machinery to slow down. It was the custom to await until the slowing down took place. The coroner's jury recommended the adoption of a more complete system of signalling, and that no belts should be replaced except when the engine is working at a minimum speed or is stationary; also, that such work should only be entrusted to an experienced person. The unfortunate youth was 17 years of age.

Health of Miners.—This continues to receive the inspectors' attention. Defective ventilation and insanitary conditions have to be closely watched and remedied. On the whole, the mines throughout the State are fairly ventilated, and sanitary conditions good.

Enquiry from the medical officers in various mining centres, as well as from Dr. Elkington, the Chief Health Officer, has shown that, so far, ankylostomiasis, or miner's worm disease, is happily unknown here. The latter informs me that he has made enquiries in the principal mining districts without eliciting anything which would lead him to suspect its existence. He also informs me that, in going through the statistics for a

number of years back, he found a case here and there reported as ankylostomiasis, but on enquiry these turned out to be due to other causes defectively described. Filth and moisture, combined with warm temperature, are the underground conditions in which the worm spreads and establishes this serious complaint. When the worm is thoroughly established in any mine in which it has found a home, it is rarely or never entirely eradicated. We have, however, an effectual preventive remedy in our hands, viz., insistence on strict attention to sanitary details underground, and to proper ventilation.

The lung disease, generally known as miner's phthisis, has occasionally been recorded by medical men; but how far it is prevalent and to what extent it was contracted in our mines are matters concerning which I have not been able to obtain definite information. It is stated that in the few cases which have been recorded the patients had worked previously in mines outside the State, or, if in the State, outside the district, and the origin of the complaint was consequently not under observation. Dr. Elkington states that, while there is undoubtedly some incidence in Tasmania, the disease is nothing like so prevalent as in some districts elsewhere in the Commonwealth. Until phthisis is proclaimed a notifiable infectious disease, it does not appear possible to obtain precise information of the occurrence of cases among the mining population. Men who are working rock-drills may be expected to be those who would show the most acute and unmistakable symptoms. The rock dust which they inhale is the primary and producing cause of the disease, and machine-drill men are undoubtedly more exposed to it than any other class of miners. Dry mines and dry holes are conditions favourable to the contraction of this distressing and disastrous complaint. Apart from the rules attached to "The Mining Act," the impulse of common humanity should inspire mine-owners to adopt every measure or appliance calculated to prevent the deadly inhalation of rock dust by those whom they employ underground. The inspectors have been enjoined to be especially on the alert in this matter. For the ordinary dust after firing, and in connection with work in dry stopes, much relief can always be given by adequate ventilation and avoiding the return of men until the dust caused by blasting has been dissipated.

The following is a list showing the number of persons killed and injured during the year 1908 under each branch of the mining industry:—

Gold mines	18
Silver-lead mines	16
Tin mines	8
Copper mines	22
	—
Total	64
	—

Legislation.—During the year an Act to amend "The Mining Act, 1905," was passed, in which several important changes were made.

New provisions for reporting accidents were introduced, and sections regulating mine labour on Sundays were embodied in the Act. Work, other than work of necessity or mercy, is pro-

hibited, and labour which may be considered as included in the latter category is set forth in full. Among the amended working rules is one relating to pent-houses in shafts. During shaft-sinking operations no work in any other place in the shaft, nor any hoisting to or from any other place in the shaft, is allowed, unless a pent-house is put in below these places, so as to protect men working in the bottom of the shaft. Adequate overhead protection, to the satisfaction of an inspector of mines, for men engaged in shaft-sinking, is always to be provided. Several other useful amendments of rules found to be necessary in practice were included in the Act. An Act to regulate the buying of gold was passed on the 14th December. The Act provides for licensing gold-buyers and gold-assayers, and prohibits the sale of gold, except by a bank, by any person who assays or smelts gold. Inspectors of mines are authorised to take proceedings against any licensee or other person for any contravention of the Act.

I have, &c.,

W. H. TWELVETREES,
Chief Inspector of Mines.

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

COMPARATIVE Table of Statistics of Accidents in and about the Mines of Tasmania from 1st July, 1892, to 31st December, 1908.

Period.	Number of Miners employed.	Number of Accidents.	Number of Persons.		Total killed and injured.	Average per 1000 killed and injured.	Average per 1000.	
			Killed.	Injured.			Killed.	Injured.
1 July, 1892, to 30 June, 1893	3295	28	4	25	29	8·8001	1·214	7·586
" 1893 " 1894	3403	25	7	20	27	7·934	2·057	5·877
" 1894 " 1895	3789	26	4	24	28	7·390	1·058	6·332
" 1895 " 1896	4160	22	7	16	23	5·529	1·682	3·847
" 1896 " 1897	4303	36	7	31	38	8·831	1·627	7·204
" 1897 " 1898	5530	36	13	33	46	8·318	2·351	5·967
" 1898 " 1899	6180	35	9	34	43	6·957	1·456	5·501
" 1899 " 1900	6834	19	7	16	23	3·365	1·024	2·341
" 1900 " 1901	7017	29	8	23	31	4·417	1·140	3·278
" 1901 " 1902	6438	38	7	35	42	6·524	1·088	5·437
" 1902 " 1903	6484	44	6	43	49	7·557	0·925	6·632
" 1903, to 31 Dec., 1903	5604	27	8	20	28	4·977	1·428	3·569
1 Jan., 1904 " 1904	6192	73	9	65	74	11·951	1·454	10·497
" 1905 " 19·5	6586	34	7	30	37	5·618	1·063	4·555
" 1906 " 1906	7004	65	4	61	65	9·280	0·571	8·709
" 1907 " 1907	7516	68	6	64	70	9·314	0·798	8·515
" 1908 " 1908	6464	60	6	58	64	9·900	0·928	8·972

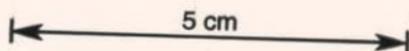


Diagram showing the ratio of fatal accidents
in mines in Tasmania.

Rate per 1000 men employed.

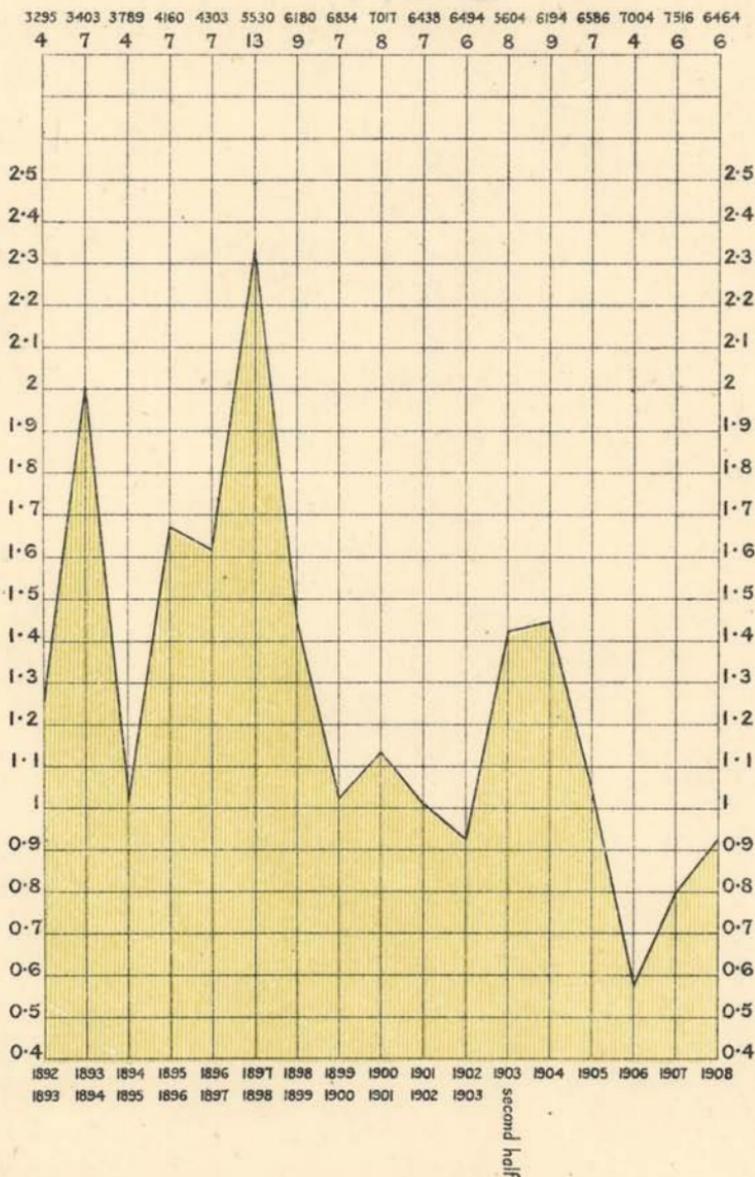


Photo Algraphed by John Vail Government Printer Hobart Tasmania.

TABLE showing Rate per Thousand Killed and Injured in the different Divisions for the Year 1908.

Division.	Average Number of Men employed.	Number of Accidents.	Number of Persons.		Total number Killed & Injured.	Average per 1000 Killed and Injured.	Average per 1000.	
			Killed.	Injured.			Killed.	Injured.
Northern and Southern	803	16	Nil	16	16	19·925	Nil	19·925
North-Eastern	760	5	Nil	5	5	6·578	Nil	6·578
Eastern	583	4	Nil	4	4	6·861	Nil	6·861
North-Western	517	2	Nil	2	2	3·868	Nil	3·868
Western	3801	33	6	31	37	9·734	1·578	8·155
	6464	60	6	58	64	...	...	...

ANALYSIS of Statistics for the Western Division.

Division.	Average Number of Men employed.	Number of Accidents.	Number of Persons.		Total Number Killed & Injured.	Average per 1000 Killed and Injured.	Average per 1000.	
			Killed.	Injured.			Killed.	Injured.
Mount Lyell	2073	19	5	16	21	10·130	2·411	7·718
Zeehan, &c.	1728	14	1	15	16	9·259	0·578	8·680
	3801	33	6	31	37	9·734	1·578	8·155

TABLE showing the Number of Persons Killed and Injured in and about the Mines of Tasmania during the Year 1908.

PLACE OR CAUSE OF ACCIDENT.	INSPECTION DISTRICTS.												TOTAL.	
	Northern and Southern Division.		North-Eastern Division.		Eastern Division.		North-Western Division.		Western Division.					
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Zeehan and other Dist. &c.		Lyell District.		Killed.	Injured.
UNDERGROUND—														
Falls of Ground .....	...	4	...	...	...	...	...	...	...	2	2	2	2	8
Shaft Accidents—														
Things falling down shafts	...	...	...	...	...	1	...	...	...	...	...	...	...	1
Haulage .....	...	1	...	...	...	...	...	1	...	1	1	...	1	3
Falling down passes and shafts .....	...	...	...	...	...	...	...	...	...	...	...	2	...	2
Total .....	...	1	...	...	...	1	...	1	...	1	1	2	1	6
Miscellaneous (underground).														
Haulage—														
Trams, &c. ....	...	2	...	...	...	...	...	...	...	2	...	1	...	9
Sundry accidents .....	...	4	...	...	...	2	...	...	...	3	...	2	...	5
Explosives .....	...	...	...	...	...	...	...	...	...	5	...	3	...	16
Total .....	...	6	...	...	...	2	...	...	...	8	...	7	...	30
Total Underground . . .	...	11	...	...	...	3	...	1	...	8	...	3	...	30
ON SURFACE—														
Smelting-works .....	...	...	...	1	...	...	...	...	1	4	...	1	1	5
Machinery .....	...	...	...	...	...	...	...	...	...	1	...	1	...	2
Falls of stone .....	...	...	...	...	...	1	...	...	...	...	...	1	...	1
Tramways .....	...	1	...	2	...	...	...	...	...	...	2	4	2	8
Falls of persons .....	...	2	...	2	...	...	...	...	...	...	...	...	...	2
Falls of timber .....	...	1	...	1	...	...	...	1	...	2	...	2	...	7
Miscellaneous—	...	1	...	1	...	...	...	...	...	7	2	9	3	28
Total Surface	5	...	5	...	1	...	1	...	7	2	9	3	28
GROSS TOTAL, 1908.....	...	16	...	5	...	4	...	2	1	15	5	16	6	58
Total during 1907.....	1	16	3	2	...	3	...	7	2	14	1	22	6	64

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RETURN showing the Number of Men Killed and Injured in Mining Accidents during the Year 1908.

	Killed.	Injured.	Total.
Europeans	6	58	64
Chinese .....	..	..	..
	6	58	64

REPORTS OF INSPECTORS OF MINES.

MR. INSPECTOR GRIFFIN (Launceston) reports:—

I have the honour to submit my annual report as Inspector for the Northern and Southern, North-Eastern, and Eastern Divisions of the State for the year ending 31st December, 1908.

Accidents.—I am pleased to be able to state that no fatal accidents have occurred in the mines of the above divisions during the year. Twenty-five accidents of a nature serious enough to be recorded have been reported; of these, 11 were on the surface, and 14 underground. Although some of these accidents were of a very painful nature, causing the sufferer to be off work for several weeks, yet none of them were of a nature from which fatal results or permanent injury might be anticipated. No accident from the use of explosives occurred. In the majority of cases the injuries were cuts on head, jammed fingers, or a bruised foot, caused generally by small pieces of stone falling in stopes, trucks leaving the line, &c. Four-fifths of the whole number were what might be called purely accidental; some carelessness was perhaps in evidence, but nothing of a gross nature. Of the remaining five, two occurred in stopes, caused by timber giving away, for which both management and men were to blame—the men, who were contractors, for not setting up and securing the timber properly, and the management for not insisting on more care being taken by these men, who, if employed on wages instead of contract, would be more careful. One of these stope accidents might easily have been attended with fatal results. The man injured in it had a most miraculous escape from death, being for a time buried up to the waist beneath a tangle of timber and mullock. Shock and a few cuts about the head were, however, the only injuries he sustained.

Airey, an engine-driver, got his fingers jammed off through carelessly placing his hand on the bed-plate near the crank-disc while the engine was in motion. Baker, a wood-stacker, was struck on the head and badly injured through going from under cover when firewood was being sent down a shoot. Maumill, engaged attending to pumps, got into a compartment where he had no right to go, and was jammed, but not seriously injured, by the inspection cage.

Machinery and other Accidents reported:—At the Tasmania Gold Mine a double-cage with two trucks of mullock on was being lowered at rate of 1500 feet per minute. Something went wrong, probably the door of one truck got unfastened, and swinging out caught the frame timber of shaft. Both trucks were thrown out of the cage, and striking timbers below the 600-foot level on each side of the shaft. One truck went through roof of cage and jammed in shaft; the other was upside down, and balanced on the crossbar of cage. The safety-grips worked, smashed their chains, and turned right round, the squeeze reducing the 8-inch Oregon skid to 4 inches at place where they first struck. The only sign in the engine-

house was a slight shake of the rope, as when shutting off steam with unbalanced cages. It was only when the cage reached the bottom, 1000-foot level, that it became known that anything unusual had happened. The softwood skids allowed the grippers to turn right round, thus rendering them useless. It is, however, extremely doubtful if any safety appliances known or in use in this State would have arrested a heavily-loaded cage descending at such a high rate of speed. New grippers, with a projecting lug to prevent them from turning completely round, are now being fitted to the cages.

At the Tasmanian Consols an over-wind took place, and the cage went to the poppet-head. The detaching-hook acted well, and no damage was done.

At the Arba Tin Mine an accident to one of the tanks on the haulage line happened, owing to the slipping of clips on the rope-cupping splice. The tank descended with great force beneath the sand-beds, but no great damage was done, as there was a good buffer of tree-ferns and sand-pack for it to strike.

On December 30 the western cage of Hart's Shaft, Tasmania Mine, when about 150 feet from the surface, caught a loose studdle, which jammed it; in consequence, the two $\frac{1}{2}$ -inch bridle-chains carried away, and the rope was released. The cage was held up by the safety-grippers. When the cage was brought to the surface it was thoroughly examined, but found in good order. One link in hauling-chain was found defective. The rope was pulled into the shoe to the extent of 5 inches, and had to be reshod.

Complaints from Miners.—Written complaints were made by miners, and in each case received prompt attention. In two cases out of three reported there was just cause for complaint; these were from two of the small gold mines. In one case the mine manager, who was also engine-driver on one shift, was accused of carelessness when in charge of the engine, inasmuch as he allowed the cage, with three men on, to descend into the well, which, fortunately, had only a few feet of water in it, otherwise serious consequences might have followed. As it was, two of the men got a fright and a bit of a ducking. The third man stepped out on to the plat as the cage slowed down before it went into the well. There was some little excuse for this mistake, as the indicator-chain in the engine-house had stretched a bit. Other mistakes made, such as allowing the cage after ascending (with men on) some distance to run back, also over-winding on one occasion, were inexcusable. It was, however, not considered necessary to take any proceedings against the offender, a reprimand and caution being sufficient. The second complaint was with reference to the unsafe method of working at another mine, where a tunnel was being driven through running ground. There was sufficient ground for this complaint, and the methods of working had to be improved upon. The third complaint made was in connection with what was alleged to be the very unsafe state of the workings of one of the small coal mines. A long journey had to be made to investigate this, and it was found that there were absolutely no grounds for the complaint.

Ventilation of Mines.—On the whole the ventilation of the metalliferous mines has been fairly good. In most cases natural ventilation is sufficient. Some few, however, have to

employ mechanical means, not regularly, but as a stand-by when natural means fail through atmospheric influences. At Beaconsfield, which is probably the worst district for gases, especially carbon dioxide, which is contained in large quantities in the rock strata penetrated, exhaust-fans are employed when natural ventilation fails through a change in the weather. High temperatures accompanied by a north wind are always a source of trouble, and the fan must be set going. At the big mine (Tasmania) natural ventilation, except at the north section, is found adequate, excepting at times when there is a sudden increase of water, which brings with it volumes of gas. This often occurs when the bottom levels are being driven, and a round of shots fired liberates both gas and water. The face must be then allowed to drain for several days. At the north section, where only a few men are employed, prospecting, a powerful fan is employed; but even this, with a good return air-course and brattice divisions right up to the face, is at times insufficient, and the men have to be called out and put to other work for a time. At the Bonanza Gold Mine the shaft-sinking was carried out to a depth of 1180 feet without encountering any difficulty in the way of gases. Now, however, that crosscutting and driving in the bottom carbonaceous strata has been started, the use of the blower is frequently needed.

Magazines.—The magazines at the different mines are well kept and in good order. A few pounds of gelignite which was badly stored and kept overlong had in one instance to be condemned. Apart from this, the explosives used were in good order.

Equipment.—The ropes, chains, shackles, and safety appliances in use are generally in good order and efficient, especially so at the big mines, where weekly all-round inspection, changing, or renewing is the order. With regard to the efficiency of safety-cage appliances, the two cage accidents at the Tasmania Mine already referred to under heading of machinery accidents, afford an object-lesson. In the one case the cage, loaded with two trucks of mullock and descending at the rate of 1500 feet per minute, was partly arrested through one of the trucks slipping out and striking the shaft timbers. This was sufficient to allow a slackening of the hauling-rope. The grippers acted, but so great was the force of the descending weight that they compressed the softwood skids, 8 by 4 Oregon, to half their size, turned completely round, and having passed their greatest eccentric radius were, of course, useless, and the cage was not stopped. In the other case the cage was ascending, when it was caught by the bottom end of a studdle swinging out an inch or two; the bridle-chains carried away, releasing the rope, but the cage was prevented from falling by the safety-grippers, which acted promptly as soon as the rope-connection was severed. The studdle did not jam the cage in any way, but striking as it did, end on, tended to force it downwards. The deduction to be drawn is that, as in the first case, the safety appliances cannot be depended on to arrest a loaded cage descending at a high rate of speed; even if the skids were of hardwood and no squeezing took place, something would be bound to give away and disable the grippers under the influence of such force. The winding-speed was, of course,

much higher, nearly three times as great as that allowed with men on, but still there must be some doubt as to the safety and usefulness of these grippers on a descending cage although they may be thoroughly relied on when the cage is moving upwards, as shown in the case of No. 2 accident.

Coal Mines.—The two principal collieries, Cornwall and Mt. Nicholas, maintained their usual outputs, although both have had to encounter difficulties of a serious nature through the faulting of the seams being worked.

Mt. Nicholas.—At this colliery the system of working is long-wall. The 4-foot seam worked for many years past gave out, or had to be abandoned, a year ago, owing to frequent faulting, that rendered working on long-wall, or indeed on any other system, difficult and unprofitable. Faulting of the seams in the Mt. Nicholas Range had to be counted with throughout the whole period of their working existence. Main faults, some times a down-throw of from 6 to 11 feet, and again jumps of a similar nature, but not so frequent as the down-throws, were in evidence from the first; these, however, only occurred at long intervals, and a good scope on even floor was worked between. It was not until the workings were pushed beneath the hill for a distance of three-quarters of a mile or so from the outcrop of the coal that serious difficulties were encountered. Minor faults appeared, and the floor became very uneven. The continuity of the long-wall face could not be maintained in unbroken line, and ventilation was a good deal interrupted. At last a jump-up fault occurred, cut off the seam completely, and beyond hope of being recovered again from the old working level. A rise was put up to a height of 32 feet, but the top was not reached. The break is in steps of from 10 to 12 feet each. The 4-foot seam is tilted up, but feathered, and disappears at the top of the first rise of 10 feet. A 5-foot seam of inferior coal above the 4-foot is also tilted up, but not lost sight of at the top of the rise. The line of fault is roughly north and south. No sign of the eruptive diabase rock was observed, nor was there any deterioration in the quality of the coal that would indicate its immediate proximity. A year's work in the 4-foot seam still remained in coming back south and east along the main line of faulting. In the meantime the 6-foot seam, on which some work was done a few years back, was reopened for a long-wall working. It had previously been worked on the pillar and bord, and now at the close of 1908 the whole of the coal output is being obtained from this seam. Difficulties had to be overcome. The thickness (6 feet) of the seam necessitated extra precautions in stowing, and large quantities of timber had to be used in packs on chocks, as well as in props and lids, to guard against a too sudden subsidence of the roof. Despite all this, a general crush took place in June last, and the colliery was idle for several days before work could be resumed. The area affected extended over 3 to 4 acres of worked-out seam. On resuming work it was thought advisable to work only the bottom portion, 4 feet 6 inches, of the seam, leaving 18 inches of coal and bands at the top, that makes an excellent roof. The subsidence, although causing a good deal of work in the way of reopening roads, &c., had its value in easing the strain on the roof, and work is now proceeding in

a satisfactory manner. A continuous line of long-wall face is opened up, ventilation is good, and from an inspector's point of view the colliery was never in better nor safer working order than at present.

Cornwall Colliery.—The system of working in this colliery was, until the latter end of 1907, pillar and bord, when it was changed to long-wall. Why it was not worked from the first on the long-wall system is not easy to understand. The seam is 4 feet. Faulting, which at the commencement gave some trouble, had almost totally disappeared by the time the long-wall face was opened up, and for nearly a year everything went well under this system of working. The output of coal was increased, until it reached 10,483 tons for the quarter ending 30th September. The long-wall workings had opened out well, but faulting of the seam was soon encountered, and within a month this portion of the 4-foot seam had to be abandoned altogether, a network of faults having completely broken up the coal. The distance from the entrance of the tunnel to the point where work ceased is a little over three-quarters of a mile. A new pit was opened on a 5-foot seam 25 feet or so below the level of the abandoned 4-foot. The work was carried on for a month or two prior to the end of the year. During the Christmas holidays and when the mine had been idle for nine or 10 days a collapse of the roof took place in most of the working places, as well as in the back roads and main heading. So serious was the break that no attempt at reopening was made. The coal in this seam is of inferior quality. It could not be worked under the long-wall system, as the roof is bad, and as pillar and bord working is a more expensive method, there was no great incentive for reopening. Work is now in the old pit, recovering the coal pillars left from the first working on the pillar and bord system. There is also a good portion of the unbroken seam coming back towards the outcrop that can be worked. A small electric fan was installed during the year, and by this means ventilation was improved.

Wallsend Colliery (late Sandfly).—This colliery was reopened by a new company about the middle of the year. Mr. R. H. Stokes, late of Stockton Colliery, Newcastle, N.S.W., was appointed as mine manager. Extensive alterations and improvements have been made, and the mine is now being opened up in a thorough and systematic way for long-wall working. Mr. Stokes is a thoroughly experienced coalminer and the holder of a first-class certificate for mine management from New South Wales. It is safe to assume that if the Sandfly seam can be made to pay for working, he will make a success of it.

Mt. Cygnet Colliery.—No alteration to note in the working of this mine. Only two or three men employed, and the output seldom exceeds 300 tons per quarter. Berry's, Woodbridge, seam has been idle for some time past. Nothing doing at the Catamaran coal seam at Recherche Bay. It seems a pity that this coal never got a fair trial, as the seam is of good thickness, and the quality of the coal is quite equal, if not superior, to any coal worked in the State.

York Plains Coal Mine is still being worked in a small way. There is not much demand for this coal, which is only used by brewers and maltsters.

Mersey Coal.—Only Mr. Allison's Spreyton Mine working in the locality now. A new seam, or new workings, have been opened up about 1½ mile east of the old colliery, and close to the Tarleton railway-station. The seam is probably the same as that worked at the old pit. No work is being done at the latter place now. Bound's Illamatha Coal Mine is idle. At Dulverton nothing in the way of coal-mining has been done for the past year or two.

Gold Mining.—Beaconsfield.—The Bonanza Company's shaft has been sunk to a total depth of 1180 feet. The bottom plat is cut at 1170 feet, from which level a short crosscut reached the continuation of the Tasmania Company's lode into Bonanza ground. Unfortunately for the Bonanza Company, the lode is not payable where cut. This bottom level in the Bonanza corresponds to the 1000-foot level in the Tasmania Mine. No great distance need be driven to connect the two mines.

Tasmania Gold Mine.—During the year the 1100-foot and also the 1250-foot levels have been connected with Hart's shaft, so that the lode can now be reached at these bottom levels from either Hart's or Grubb's shafts. Extra water was cut in driving west at the 100-foot level. At end of last year work was discontinued in that direction. A couple of months later, January, 1908, heavy water was cut in the 1100-foot level west, completely draining the 1000-foot level, and it was not considered advisable to continue driving until a connection was made between the 1250-foot level and Hart's shaft, as any excess of water could not be dealt with till this was done. Grubb's shaft was sunk a further distance of 76 feet, making a total depth of 1353 feet. Hart's shaft has not been sunk during the year, owing to the heavy flow of water. It will now be connected by rising from the bottom level. The sinking of Grubb's shaft towards the 1500-foot level will also be proceeded with. The pumps have easily controlled the water, the heaviest flow on any one day being 4,894,700 gallons. The mine is well equipped with regard to safety of working, and good ventilation is generally maintained.

Lefroy Field.—Blue Jacket.—This got another trial during the year, but the result was not satisfactory, and operations ceased.

The New Pinatore Company has done a good deal of prospecting. Nothing worth mentioning was discovered. Other parties have been at work, and on the whole a good deal of prospecting has been done.

Mathinna.—New Golden Gate Mine.—In the early part of the year the east lode at the 1800-foot level was driven on north and south from the crosscut. Going south stone giving fair prospects of gold was met with at one place, but the shoot was very short. A winze sunk 102 feet at this place lost the shoot further on, and before the main slide was reached the lode split up. A crosscut was driven east at this place for some little distance, but no good results followed. At the west lode some good payable stone was cut in driving north from the crosscut, but, as in the case of the eastern lode, the gold shoot was very short. A winze was sunk to a depth of 90 feet, but the gold did not live down. The mine has been tested to a total depth of 1902 feet. The bottom levels are now abandoned altogether. At the old upper levels, 500, 600, and

800 feet, short sections of stone are being worked by tribute parties, and good payable stone is obtained. The company is testing a lode on the old East Gate section. A shaft 12 feet by 4 feet was sunk to a depth of 200 feet, and the lode is being driven on.

Tasmanian Consols.—Work during the first part of the year was at the 1300, 1400, and 1500 feet levels. At the bottom (1600-foot) level the diamond-drill was employed, to test the western lode at greater depth. By arrangement the company was enabled to further test the west lode below the 1600-foot, by driving from the crosscut on the same lode in New Golden Gate Mine at the 1800-foot level. The distance to the boundary is about 200 feet. The drive was extended another 100 feet or so into the Consols' ground, but the lode so far tested was not payable. The last of the payable stone at the working levels was taken out, and the mine finally shut down about September.

Miner's Dream.—The Tasmanian Consols Company prospecting this mine under option to purchase. A small winding plant was installed, and the underlay shaft going down on the lode deepened, making a total depth on the underlay of nearly 200 feet. The section of stone, when tested, on both sides of the shaft at bottom level was found to be short. Work had ceased before the end of the year, as the company declined to purchase under the terms of the option. The original owners, Stephenson and Dick, having become possessed of the winding plant under the terms of the option, will probably now work the mine themselves.

Eldorado Prospecting Syndicate made an attempt to reopen the old mine. A vertical boiler and small steam winch of the type used for pile-driving was put in use, and the old shaft (9 feet 8 inches by 3 feet 8 inches), which is 171 feet in depth, was unwatered. Some further work was done in the way of cleaning out the old crosscut, but operations soon came to an end.

Scott and Pickett Company.—This mine closed down during the year.

Golden Horseshoe Company.—At this mine there is a small crushing-plant driven by water-power. Stone was obtained by stoping from two windlass shafts, of depths from 80 to 100 feet. The equipment was not good. Altogether it was a sort of struggle for existence affair. It is understood that an effort to get more capital into this show will be made.

The Long Struggle Mine was under option to the Tasmanian Consols Company, but nothing has come of this.

Golconda.—The New Wyengatta.—The shaft has been sunk to a further depth, and is now down 257 feet from the surface. The lode at the bottom level is small and difficult to follow, owing to the hard nature of the country. The prospects of this mine were not very good at the close of the year.

Golden Pyramid Mine.—Several vain attempts have been made to reach a lode supposed to exist somewhere about the contact of the granite and sandstone, west of Panama Creek, by means of tunnelling. A shaft equipped with a small sinking-pump could have been put down to prove the existence or otherwise of the lode at much less cost than all this driving has run into.

New Panama Gold Mine.—This mine is still working and getting out stone. The ore is, however, of a complex nature, containing gold, galena, and silver. The Government expended a sum of money in extending the road from Golconda railway-station on to this mine. The whole distance is only $1\frac{1}{2}$ mile. The company has now a fairly good road to its mine, but no ore has, so far, been sent out, excepting a few tons to the Pinafore battery at Lefroy.

Liste Alluvial Gold.—About 20 men are at work on this old field; some few are prospecting and fossicking, the remainder working in open-cut on the terraces and in the old creek and flat workings. Most of these people have been on the field ever since it was discovered and worked so successfully 30 years ago. There is no impoverished look about place or people, and the conclusion one arrives at is that the small community is doing fairly well; in fact, much better than it cares to admit. The Tasmanian Consols (Mathinna) had some boring done on the flat with a view to working by bucket-dredge, but the results it is understood, were not satisfactory.

Tin Mines.—Every mine on the East and North-East Coast has suffered more or less from the effects of an exceptionally dry year—no rainfall worth mentioning. Many of the small claims, especially those depending on storm-water for their supply, suffered severely. In the Mt. Cameron district miners who were accustomed to get sufficient storm-water to keep their sluices going for from six to seven months in each year, did not get as many weeks during the past year. The big mines, too, had to slow down. The Briseis, with its various sources of supply and extensive service channels, went short for a time, and had to discontinue the work of removing the overburden at its northern section for awhile. The Arba Tin Mine was practically idle for a long time. The Briseis Extended Company gets its supply by gravitation from the river close by. The breaking down water is pumped into the face from the barge, on which the centrifugal gravel-pump is at work. Its supply did not therefore diminish much. The Purdue Tin Mine, near Gladstone, is perhaps the only tin mine that can claim to have worked full time throughout the year. Its steam-pumping plant, 3-stage centrifugal with Allen engines, is up to date, and gives a highly efficient service, pumping under a head pressure of 300 feet. The power-station is 30 feet above river-level the water being brought on to the pump-well by open race from the river. This plan insures immunity from interference by floods, and also affords a means of getting rid of a great proportion of the tailing sand before the water reaches the pump.

Pioneer Tin Mine.—Shortage of water interfered a good deal with the progress of this mine towards the close of the year. The hydro-electric scheme now fast approaching completion will not only cheapen and otherwise facilitate the use of mechanical power required for running the gravel-pump, but also ensure a more constant supply of water for sluicing purposes. Through the courtesy of the general manager, Mr. C. G. Ryan, I am enabled to furnish the following outline of the new scheme:—

The primary object was to augment the water-supply by the construction of a dam on the Frome River that would enable

enough water to be stored to run the sluicing plants continuously during the summer months. As the elevation of the dam above the mine workings was sufficient to give the necessary power for generating electricity for driving two large barges, it was decided to put in a generating station at a convenient point, and substitute motors for driving the sand-pump in the place of steam-engines. The water therefore serves the dual purpose of providing water-power for the pumps, and water for sluicing. The dam is 625 feet in length and 54 feet in depth, and is constructed of loose rock with a concrete facing, and has a capacity, to the 51-foot level, of 420,000,000 gallons. The water is drawn off in a concrete tunnel through the base of the dam, and passes into a race $1\frac{1}{2}$ mile in length, which conveys it to the head of the power-pipe line of wrought-iron, 36 inches in diameter and 1200 feet in length, from the end of which it issues to the nozzles, driving the turbines under a head of 440 feet. Three generating sets are installed of Voith turbines, coupled direct to 375 K.W. Allgemeine. Three-phase generators, generating at 6500 volts, which is transmitted 4 miles to the mine, direct on to the motors driving the sand-bumps. From the turbines the water passes into a race 3 miles long, which conveys it to the head of the pressure-column on the mine, from which it issues from the sluicing-nozzles under a head of 250 feet. The transmission line is carried to the edge of the workings, where it branches in two, each branch consisting of armoured cable, which is carried on to the two barges, each of which has a 400 B.H.P. motor driving a 16-inch sand-pump. The priming gear, consisting of an Edwards air-pump, is directly connected to a 5 B.H.P. motor. The speed variation on the motor is obtained by a liquid controller, and also by different sized split-pulleys on the motor shaft. The whole outfit combines the most modern European practice, and is fitted with carriage-switch gear and automatic voltage regulation, as well as lightning arrestors and other safety devices. It is anticipated that the plant will be in operation before the end of April, 1909.

The Anchor Tin Mine ceased operations for a time towards the end of the year. Want of a sufficient supply of water was mainly the cause of this, as it is only by treating large quantities that the mine has any chance of living at all.

The Mt. Rex Company commenced again, this time on a big lode formation to the south-east of the old mine. Several hundred tons were put through, but the lode-stuff could not be made to yield marketable tin, owing to the presence of large quantities of wolfram.

The Shepherd and Murphy Mine at Bell Mount.—Middlesex is working steadily, and with a fair measure of success. Scarcity of water here, as elsewhere, retarded operations a good deal. The mill and concentrating plant is operated by Pelton wheels. A crosscut, which is a continuation of the battery level tunnel tapping No. 6 lode is now being driven south. The intention is to cut all the lodes hitherto worked from the higher level tunnels, and do away with the necessity for using the aerial tram.

Silver Mines.—The Round Hill Silver and Lead Mining Company had almost completed its ore-concentrating plant at the close of the year. No mining work had been done during the last quarter, but everything is in readiness for the breaking

of large quantities of ore, once the plant for treating it is set going. The facilities for mining by means of tunnelling are excellent, and with plenty of ore in sight good results might reasonably be expected.

Devon Silver Mine.—Work was resumed after the winter months were over, and about 50 tons of high-grade ore obtained from the old adit level. A winze commenced at the end of the year is going down on good ore, the lode improving in width as sinking proceeds. Only a few men, seven in all, are employed. The means of transit of the ore from this mine to Devonport has been made easier by the opening of the new road from South Staverton *via* the Round Hill Silver and Lead Mine to Lorinna on the River Forth, a distance of 10 miles. The ore has still to be packed from the mine to Lorinna, about 5 miles. The new route is shorter by about 5 miles than the old road *via* the Shepherd and Murphy Mine and Wilmot.

Copper.—**Burnie Copper Mine.**—The old company ceased operations altogether in September, and sold its leases, and plant to a small syndicate formed at Burnie, which has taken out a considerable quantity of ore left in the different levels. This work will soon come to an end, and it is not likely that any attempt will be made, by the present owners at all events, to prove the lode to a greater depth. The total depth worked to is 258 feet. The shoot of ore shortened going south at the bottom level, and the lode pinched somewhat under foot.

Copper Creek Syndicate.—**Gunn's Plains.**—No work at this mine since February, 1908.

Bucket-dredging for Tin.—The Gladstone Development Company's dredge has been idle for several months past. All the payable ground in "Weir's" paddock being worked out, it will be necessary to remove the dredge to a flat about half a mile further down the river. This can only be accomplished in time of flood, or by constructing a temporary dam to raise the water. The Dorset and Ringarooma dredges are working with varied success. There is now a chance of improvement under new management.

Annexed are tables showing the number and nature of accidents for the year.

LIST of Accidents in Inspector Griffin's Districts for Year 1908.

Fatal, 0; non-fatal, 25; total, 25.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1908. 23 Jan.	Tasmania Gold Mining Co., Ltd.	Beacons- field	Piece slip- ping from chuck of lathe	Archer, Edward	Married	Right forearm badly lacerated	Was preparing to turn up match- ing piece in lathe of fitting shop; piece fell out of chuck, when machine started; caught his arm on tool rest.
24 Jan.	South Mount Cameron Tin Mining Co.	South Mt. Cameron	Inadver- tently placing on hand on bed plate of engine, caught by crank disc	Airey, Joseph	Single	Points of first and second fingers of right hand cut off	Was employed as engine-driver; inadvertently placed his hand on bed plate, was caught by disc crank of engine and had his finger tops cut off.
25 Jan.	Tasmania Gold Mining Co., Ltd.	Beacons- field	Truck jumping tram rails	Oakley, Henry	Ditto	Flesh torn from knuckles and palm of hand	Was trucking at 1100-ft. level; truck jumped rails, and jam- med his hand against a leg, tearing the flesh from knuckles and palm.
30 Jan.	Ditto	Ditto	Ground fal- ling from hanging wall	Foley, James	Married	Cut on head	While shovelling quartz in stope of Block 152, loosened baulked ground in hanging wall, portion came away, striking him on the head, and inflicting a wound 2½ inches long.
18 Feb.	Purdue Tin Mining Co.	Gladstone	Axle slipping	Arnold, Arthur	Ditto	Severe cut on foot	Was carpentering, axe slipped, cutting his foot badly; was off work 20 days as result of accident.

LIST of Accidents in Inspector Griffin's District for Year 1908—continued.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1908. 2 Mar.	Shepherd & Murphy Mining Syndicate	Middlesex	Slipped off lath into pass, fell 10 or 12 feet	Johnstone, Arthur	Married	Slight cut on head and severe injury to leg below knee	Was sending mullock down pass from surface, slipped on lath, and fell down pass, some 10 or 12 feet, sustaining cut on head and severe injury to leg.
9 Mar.	New Golden Gate G.M. Co.	Mathinna	Stage giving way	Summers, Thos.	Ditto	Bruised side; appeared to have a rib broken	Had, with his mate, John Long, fixed up a stage in a stope to beat off a brow; the stage gave way, and Summers fell 7 feet; got his side rather badly bruised.
25 Mar.	Anchor Tin Mine	Lottah	Knocked down by rake of trucks	Steel, Ray F.	Ditto	Foot badly crushed	Was fixing something at battery hopper, and standing close to rails of tram, did not hear warning whistle from rake of trucks coming in; was knocked down, one truck passing over his foot, and crushing it.
25 April	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Screen blown against him	Hutchins, Wm.	Ditto	Severe shock	Was dismantling hydraulic filter, wind blew a screen against him causing him to fall about 8 feet; he was insensible for a few minutes, suffered from shock, and was off work for 7 weeks.
4 May	Ditto	Ditto	Timber he was handling falling on his foot	Garrett, James	Ditto	Big toe badly bruised and lacerated	Was handling a piece of timber for main shaft; it slipped, and falling, caught his foot, bruising and lacerating the great toe badly.

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5 May	Ditto	Ditto	Strained by overlifting truck on to line	Crawford, Peter	Married	Sinews of back strained	While attempting to lift a loaded truck on to the rails at the 1250 ft. level, strained the sinews of his back; was 9 weeks off work as a result of this accident.
5 June	Ditto	Ditto	Cap slipping from footwall hitch	Campbell, Alexander	Ditto	Cuts on face and severe shaking	While stoping in No. 7 Block, stepped on cap which carried away from footwall hitch; he fell 15 feet, and sustained several cuts on face, also very severe shaking.
1 Aug.	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Caught by descending cage	Maumill, E. A.	Ditto	Squeezed about hips, left foot a little strained	Was attending to pet corks of plungers, was caught by inspection cage which was being lowered slowly, got a good squeeze across the buttocks and hips, also injury to left foot which was strained.
26 Aug.	Briesis Tin Mines, Ltd.	Derby	Reaching for piece of board and over-balanced	Chick, Arthur John	Ditto	Shoulder dislocated	Was reaching over dump race at open cut face, lost his balance, and fell 6 feet, dislocating his shoulder joint; was off work 5 weeks as a result of this accident.
26 Aug.	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Run into by a truck being wheeled by another man	Lock, Henry	Ditto	Bruised on ribs under right arm	Was cleaning road underground, when his mate coming along with a truck jammed him against the wall; he received a bruise on the ribs under the right arm; was off work 3 weeks as a result of accident.
24 Sept.	Briesis Tin Mines, Ltd.	Derby	Fall from stage	Wilkins, Arthur Henry	Ditto	Blow on head, causing unconsciousness for a short time	While working on a stage 7 feet high, he got his file fast in a hole being drilled through galvanized iron, and in endeavouring to free it, lost his balance, and fell to the floor, striking his head.

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LIST of Accidents in Inspector Griffin's District for Year 1908—continued.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1908 22 Sept.	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Jumping off rake of trucks while in motion.	Herron, George	Married	Leg badly bruised, no bones broken	While jumping off a rake of trucks slipped and fell, one truck running over his leg before horse could be stopped; fortunately no bones were broken.
1 Oct.	New Golden Gate G.M. Co.	Mathinna	Windlass handle slipped	Moses, F.	Widower	Deep gash in forehead	Was hoisting a full bucket of dirt out of winze; windlass handle slipped from his hands, and striking him on the forehead inflicted a deep gash.
8 Oct.	Pioneer Tin Mining Co.	Bradshaw's Creek	Carelessly going too near fire-wood chute	Barker, Walter	Married	Severe scalp wound	Was engaged stacking engine-wood, carelessly went from under cover when wood was sliding down chute, was struck on the head by a piece, and temporarily rendered unconscious.
14 Oct.	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Piece of stone falling from hanging wall	Brown, J. W.	Ditto	Cut on head severing an artery	While working in stope, No. 9 Block, a piece of stone fell from hanging wall, striking him on the head and cutting an artery; he was off work 3 weeks.
3 Nov.	Ditto	Ditto	Stone rolling down rill	Foley, William	Single	Cut on head	While working in Block 201 was struck on the head by a piece of stone that rolled down rill; injury not very serious; he was off work 3 weeks.

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2 Dec.	Ditto	Ditto	Foot slipping into hole of staging	Herbert, Joseph	Married	Broken leg	While working at 1000 feet level his foot slipped into a hole in a platform, he fell over, breaking his leg; not a bad fracture.
10 Dec.	Ditto	Ditto	Ground falling from hanging wall	Ashman, James	Ditto	Jammed fingers	A piece of ground fell out of hanging wall and jammed his fingers against a set of timber, breaking end joint of one.
16 Dec.	Ditto	Ditto	Timbers in stope giving way	Brown, William	Ditto	Severe shock and cut on head	One of a contract party working in Block 103, footwall hitch gave way letting down several sets of timber, Brown was buried up to his waist, and had a narrow escape of being killed; his injuries, however, were not serious.
19 Dec.	New Golden Gate G.M. Co.	Mathinna	Pipe falling down shaft	Rushton, E.	Ditto	Foot badly bruised on it step, no bones broken	Was engaged as platman; sent some pipes to surface in cage, securely lashed; one dropped down shaft when braceman was removing them, and struck Rushton on the foot; braceman did not see pipe slip.

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Mr. Inspector Harrison (Zeehan) reports:—

Accidents.—In submitting my annual report for 1908, I beg to state that the number of mining accidents has been 13, and at the Tasmanian Smelters five, one of which proved fatal.

Ropes and Cages.—Ropes and cages have been tested, as required; several of the former have been replaced by new ones.

Ventilation.—The ventilation of the mines has been in most instances all that could be desired, and there have been no complaints.

Prospects of the Field.—Notwithstanding the depressed state of the metal market and the temporary closing down of the Tasmanian Smelters, the output from the field has been fairly well maintained. Smelters are in course of erection for the treatment of the large quantities of stannite ore that has been opened up in the Oonah Mine.

The construction of tracks and bridges is enabling the inspectors to extend their exertions further afield, and encouraging reports are coming in.

Magazines.—Magazines are 31 in number in this district, requiring supervision. They are kept in good order.

Legal Proceedings.—There have not been any during the year.

LIST of Accidents in Inspector Harrison's District for Year 1908.

Fatal, 1; non-fatal, 17; total, 18.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1908. 28 Feb.	Magnet Silver Mine	Magnet	Cage being moved without signal.	Cooper, Walter	Single	Cut heel	—
14 Mar.	Spray Mine	Zeehan	Fall of rock	Wyatt, George	Married	Injury to spine	While cutting hitch for log
17 Mar.	Hercules Mine	Mt. Read	Barring down	Monks, John	Ditto	Broken leg	While working down. Result of a shot
18 Mar.	No. 2 Magnet Mine	Zeehan	Explosion	M'Villy, Henry	Ditto	Burns and cuts on hands and body	In boring struck bottom of hole in which there was some unexploded gelignite
18 Mar.	Ditto	Ditto	Ditto	Evans, Thomas	Ditto	Ditto	
23 Mar.	Colebrook Mine	Dundas	Revolving of winch handle	Gannon, Patrick	Ditto	Fractured arm	Struck on arm by winch handle
11 Apr.	Tasmanian Smelters	Zeehan	Putting belt on wheel	Eberle, Daniel	Ditto	Broken Arm	Putting belt on wheel while in motion
25 May	N. Mt. Farrell Mine	Mt. Farrell	Explosion	Parsons, Robert	Single	Cut eye	Parsons was notified about a fire, but thought it was in another place
30 July	Oonah Mine	Zeehan	Loading trucks	Dakin, George	Married	Broken leg	Loading ore in trucks

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1908. 6 Aug.	Tasmanian Smelters North Mt. Farrell	Zeehan	Putting belt on wheel	Sherrin, Horace	Single	Mangled arm	Putting belt on wheel while in motion
20 Aug.	Ditto	Mt. Farrell	Fall of ground and timber	Curtin, Frank	Ditto	Crushed	In driving home laths, knocked the cap pieces off the legs
20 Aug.	Ditto	Ditto	Ditto	Jones, Robert	Ditto	Shock	
15 Sep.	Victoria-Zeehan Mine	Zeehan	Lowering of cage	Davis, Charles	Married	Shock	Engine driver lowered cage on him
28 Oct.	Tasmanian Smelters Cleveland T.M. Coy.	Ditto	Caught in harness Trucking	Hines, William	Ditto	Broken arm	Horse driven on slag pot while cleaning tuyer of furnace
9 Nov.	Cleveland T.M. Coy.	Heazlewood	Trucking	Sims, William	Single	Ditto	Sims was trucking at the time
12 Nov.	Tasmanian Smelters New Mt. Zeehan	Zeehan	Explosion	Timothy, J.	Married	Burns on face	Explosion of gas
20 Nov.	New Mt. Zeehan	Ditto	Putting belt on wheel	Gamble, Frank	Ditto	Broken arm	Putting on belt while wheel in motion
1 Dec.	Tasmanian Smelters	Ditto	Fall of slag	M'Phillips, J.	Single	Both legs broken	While working in slag dump a fall of slag occurred

MR. INSPECTOR CURTAIN (Queenstown) reports :—

Of the 21 casualties recorded, five were accompanied or followed by death. This, unfortunately, is the highest percentage on this field since it became a separate district.

1. Maher's thigh was broken by a fall of side rock while he, with his mate, was timbering a pass. In due time (six weeks) his convalescence was well assured, when a lung complication, arising from a clot of blood, whose origin was attributed to the mine injury, unexpectedly set in, and from which, briefly after its first symptom was observed, he expired. He was a capable man, and a statement supplied by him shortly after the occurrence pointed to the fact that it was purely accidental.

2 and 3. Atkinson and Cusick, with others, were late in the evening working overtime in one of the overburden benches of the open-cuts, in order to make it safe for the next morning-shift, when from some unaccountable cause both fell off the bench and lost their lives. At the coroner's enquiry it was surmised that Cusick, while barring down a piece of spoil, lost his balance, and Atkinson, realising his mate's danger, attempted to save him, but failed, and, instead, went with him. Subsequently it became generally stated that Atkinson suffered from dizziness or some other head trouble, and being evidently seized with an attack at the time, fell forward, and striking Cusick, who was a light man, occasioned the trouble.

4. Archie Frank Best, a platman at the North Lyell Mine, lost his life by being crushed by the cage against the shaft timbers. A mate was travelling with him, but beyond stating (1) that the deceased knocked the cage away prior to entering it (which was contrary to the mine's regulation), and (2) that ample time elapsed for Best to enter before the enginedriver moved it away after receiving Best's signal, he could give no tangible reason how the accident happened. Best's duties gave him control of the cage, and how he got entangled is a mystery.

5. David Young, a head contractor in the substopes of the 700 feet level at the North Lyell Mine, lost his life by a fall of face rock. From the statement of his mate it was quite evident both were aware of the "drummy nature" of the ground, but to "build" a pass directly alongside this same ground, "chanced it," with the result that such procedure added another victim to the many who have lost their lives from a similar cause.

Next in order to these fatal accidents may be taken that of Willows Farrows, who, following the pernicious practice of priming fuse by biting the caps on, had one explode in his mouth, which, in addition to shattering his jaws, burst an unsightly hole through his cheek, and otherwise severely injured his throat and tongue. For some time he remained in the local hospital, but to secure special treatment was removed to Melbourne, where, it is stated, he fared indifferently. His last address was with his relatives at Tunnack, but locally his state of health is unknown.

McNab, a slag wheeler at the Reduction Works, was severely burned by backing into a pot of molten metal, but fortunately he has made a remarkable recovery, and is again pursuing his ordinary labours at the works.

Cox, a machine hand, in broad daylight walked into a mullock pass at the Iron Blow open-cut workings, and was, with a broken shoulder and severe head wounds, unconscious for a week.

These, with Fisher, a carpenter, who fell off the roof at the Converters while making some alterations there, may be rated as the more serious injuries that have taken place during the year, the remainder being of a minor and non-apprehensive character, compare favourably with other States, when the number and occupations of the men are taken into consideration.

Of those not enumerated, a case of "gassing" took place on the eastern crosscut of the North Lyell Mines' 1000-foot level, where a man was overcome and seriously affected for some days afterwards. Here, again, unnecessary liberties were taken, redeemed only by the fact that the man's mate, though somewhat oppressed, stuck by his unconscious comrade and carried him outside the influence of the fumes, where, after raising the alarm, he practically collapsed himself.

Chiefly based on medical information, it is pleasing to state that, bar casuals from other places, the health generally of the men is good. This, however, should be expected, for, as a body, they are still in their prime, many really barely out of their teens. Hence, while fully recognising this fact, it was with no desire to harass those in charge that exception had to be taken to the quality of the air prevailing in certain ends, rises, and close stopes; together with dust from rock drills, and smoke from blasting; but to remedy these evils, in pursuance of the Mining Regulations, so that the evils arising from such causes, and so notoriously known in older fields, should not get a footing here.

Ropes and Cages.—These in use receive periodical inspection, and within the stipulated intervals are tested and minuted by the company's officers, whereby a departmental repetition is unnecessary. The ropes on the new electrical hoist at the North Lyell Mine are furnished with the maker's certificate, which states their quality and breaking strains as 30 tons.

Explosives and their Magazines.—These are satisfactory, taking into consideration the large quantities of chemical and mechanical compounds that pass into use in this district, the Mt. Lyell Company's consumption alone exceeding 60 tons.

LIST of Accidents in Inspector Curtain's District for the Year 1908.
Fatal, 5; non-fatal, 16; total, 21.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1908. 23 Jan.	Mt. Lyell M. and R. Co., Limited	Queens- town	Pot of mol- ten slag left in thorough- fare	Geo. McNabb	Single	Severe burn to back, buttocks, and left arm	McNabb was slag-wheeler at No. 2 plant of the reduction works, and while attempting to place an empty pot under the spout of No. 9, backed unconsciously into another pot of molten slag that had just been withdrawn and left in the roadway by a fellow-wheeler. The injured man is again at work.
7 Feb.	Ditto	North Lyell	Fall of rock	James Maher	Married	Left thigh broken above knee	Maher was treated for sometime in the casualty ward at Gormanston, and subsequently left there for his home, where he continued to improve, but on the morning of the 23 d March he took suddenly ill and died, the cause being pulmonary embolism, attributable to relics of the accident.
7 Feb.	Ditto	Ditto	Ditto	Patrick Reilly	Single	Severely bruised on left side of face, shoulder, and leg	Reilly was Maher's mate, and observing the side coming away pushed him from under it, but was caught himself and pinned under the fall until assistance arrived and released him. He made a complete recovery.

LIST of Accidents in Inspector Curtain's District for the Year 1908—continued.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1908. 11 Feb.	Mt. Lyell M. and R. Co., Ltd.	Gormanston	Fall over, and from No. 1 overburden bench	William Atkinson	Married, aged 47 years	Concussion of brain, severe scalp wounds, ribs and right arm broken	Atkinson, with others, was working overtime, and from some unaccountable cause fell over the bench, a distance of some 120 feet, and was killed.
11 Feb.	Ditto	Ditto	Ditto	William Cusick	Single, aged 28 years	Fractured skull and lacerated brain	Cusick was mate with Atkinson, both men being working together. It is believed Cusick fell first, but from what cause there was no evidence to show how it happened. Death ensued three days later.
18 Mar.	Ditto	Ditto	Fall down a surface mullock-pass	Robt. J. Cox	Single, aged 24 years	Concussion of brain and right collar-bone fractured	Cox, when returning from crib, in broad daylight, walked into the pass and fell about 40 feet. He was unconscious for some time, but he has made a good recovery.
31 Mar.	Ditto	North Lyell	Fell 40 feet through a timber-chute off a chain sling	John Thompson	Married, aged 33 years	Severe shaking and bruised body, but no bones broken	Thompson was assisting to land timber on the 5th floor of No. 14 stope workings, and while being hoisted to the next floor fell or slipped through the sling. He recovered and is working again.
2 April	Ditto	Ditto	Fall of rock in No. 15 winze	Benj. Krull	Married, aged 48 years	Severe bruises on back, loins, and side	Krull, with his mate, was engaged timbering when the piece came away. He recovered, and has resumed work.
13 April	Ditto	Ditto	Premature explosion of dynamite cap	William Cotter	Single, aged 22 years	Right hand shattered, necessitating amputation of thumb and fingers	Cotter states that at the time he was preparing charges, and while inserting the fuse into detonator it exploded. He has resumed work.
23 May	Ditto	Ditto	Jammed by a rising cage against the 850ft. level's plat-timbers	Archie Frank Best	Single, aged 31 years	Severely crushed about the head and shoulders	Best was platman, and, contrary to instructions, attempted to enter the cage after having signalled it away, with the result that he was caught and crushed to death.
2 June	Ditto	Gormanston	Slip back on aerial rope-way	Frederick H. Wright	Single, aged 32 years	Crushed left hand that necessitated amputation	Wright, as a coupler, while waiting at the mine-bins to despatch the next bucket, sustained the injuries stated, through the grip of the preceding bucket becoming disengaged from the baul or running rope. His condition and whereabouts are unknown.
9 June	Ditto	North Lyell	Premature explosion of dynamite cap while being bit on to fuse	Willows Farrow	Single, aged 29 years	Top and bottom jaws of left cheek fractured, with lacerated tongue, throat, and roof of mouth	Farrow was preparing a "round of charges," and to prime the fuses adopted the general but dangerous practice of biting the cap on to the fuse, with the foregoing stated result. He left the local hospital for treatment in Victoria, but his present condition and whereabouts are unknown.
12 June	Ditto	Gormanston	Jammed by a mullock-wagon against No. 1 bench-wall	Clyde Langdon	Single, aged 20 years	Bruised about groin, back, and abdomen	Langdon, after obtaining a place of safety, thoughtlessly left it, and sustained the injuries stated. They were not serious, and he early resumed work.

LIST of Accidents in Inspector Curtain's District for Year 1908—continued.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1908. 13 June	Mt. Lyell M. and R. Co., Ltd.	Queens-town	While emptying a barrow fell over an embankment	Percy J. Butler	Single, aged 14 years	Right leg broken above ankle	Butler was employed as a "nipper" at the converting works, and while emptying a barrow it overbalanced, and he going with it, fell about 20 feet, and sustained the injuries herein stated. He is again working.
23 July	Ditto	North Lyell	Fall of ground from working face of substope at the 700-ft. level	David Young	Married, aged 31 years	Severely crushed across abdomen	Young was the leader of a large contracting party, and while engaged timbering an ore-chute a slab of schist that was known to himself to be "drummy" fell away, and killed him.
15 Aug.	Ditto	Queens-town	Fall from roof of converter's shed	James Fisher	Married, aged 45 years	Lacerated left eyebrow, bruises, and shock	Fisher, a carpenter, and others were engaged on the roof making some alterations when, stepping on the galvanised iron that had been rendered slippery by a heavy frost, he lost his balance and fell about 20 feet. He is again working.
4 Sept.	Ditto	Gormans-ton	Fell from II. to II.A. bench, a distance of 33 feet	William Garwood	Married, aged 28 years	Fractured olecranon or "funny bone" of elbow	Garwood was raising the end of a sleeper with his "beater," and the latter slipping caused him to overbalance and fall as described. He left the district for further medical advice and has not returned.

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19 Sept.	Ditto	North Lyell	Fell 20 feet down an unlighted and uncovered pass	Charles George Mason	Single, aged 20 years	Sprained or ricked knee, accompanied by a general shaking	Mason was a trucker, and while proceeding to his work on the afternoon shift inadvertently took the wrong turning or direction and fell down the manway leading to No. 14 stope. He returned to work on the 15th October.
21 Sept.	Ditto	Gormans-ton	While barring down a piece of pyritic ore, fell on crowbar man was using	John Quayle	Married, aged 28 years	Nose broken over bridge	Quayle, a member of an emergency gang, was retained after hours in order to make the workings safe, and while doing so, in a most peculiar manner, met with the accident as here described.
29 Sept.	Ditto	North Lyell	Fell down a mullock chute manway	William Joseph O'Brien	Single, aged 23 years	Dislocated left shoulder	O'Brien's duties necessitated his keeping the required mullock-chutes open, and while so engaged he fell off the timbers and sustained the injuries that incapacitated him for four weeks.
10 Oct.	Ditto	Gormans-ton	Struck by a piece of ore that came away from an upturned wagon	William Bushell	Single, aged 30 years	Shoulder and back bruised, that necessitated his removal to casualty ward	Bushell's chief duty was that of powder-monkey on bench IVc., but while performing other services a piece of ore that was shot out of a derailed or overturned truck from the bench above struck him. Pneumonia supervened, which made his case serious. He recovered and resumed work.

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REPORT ON SHALE DEPOSITS IN TASMANIA.

1. *Tasmanite Shale*.—The oil shale of the Mersey district, which was formerly called dysodile, occurs associated with coal-measure sandstones in the Latrobe area in the basin of the River Mersey. It seems to have been recorded first in 1852, when it was reported to the Royal Society of Tasmania. The first analysis of it was made by Professor Penny, of Glasgow, who reported as follows:—

Resinous matter	26.04
Sand and clay	69.83
Pyrites	2.76
Water	1.37
	100.00

He also stated a proximate analysis as follows:—

Volatile matter	20.41
Fixed carbon	5.50
Ash	71.20
Sulphur	0.73
Water	2.16
	100.00

In 1861, Mr. Charles Gould reported officially that, the coal measure beds are permeated by the resinous particles of the substance, and he referred to this as dysodile; but Professor A. H. Church, in 1864, gave the shale the name of tasmanite.

In 1876, Mr. E. T. Newton proposed the name tasmanite for the shale, and *Tasmanites punctatus* for the spores (or plants to which they belong). The size and form of the seed-like bodies or sacs were considered by him to indicate that they are more nearly allied to Lycopodiaceous macrospores than to anything else.

E. A. Newell Arber (Catalogue of the Fossil Plants of the *Glossopteris flora*, Brit. Museum, p. 176) in 1905 regarded it as hardly necessary to retain the name *Tasmanites punctatus*. He says there is no doubt that they are of the nature of spores, although of what particular type of plant there is no evidence to show. They can, however, hardly be of Lycopodean origin, since lycopods are unknown at present from Australasia in association with the *Glossopteris* fauna.

The layers of shale wear the aspect of a light-brown or yellowish brown sandstone, charged with minute resinous-looking flattened discs, Marine Permo-Carboniferous fossils (*Spirifera*, *Productus*, *Aviculopecten*, *Cardiamorpha*, *Pachydomus*, *Platyschima*, *Pleuretommia*, *Pteronites*) are recorded from the beds. They are just below the Tasmanian upper marine Permo-Carboniferous beds, and correspond approximately with the Mersey coal measures, though their precise relations with the

known coal seams in this basin have not yet been settled. The neighbouring coal seams probably lie beneath them.

The known shale area comprises a strip of country about 6 miles long by 2 miles wide, lying to the east of the railway-line, between Railton and Latrobe. One thousand three hundred and five acres of this are held at present for shale-mining, and 931 acres formerly held are at present vacant. About a square mile has been proved by shafts. At the southern end of the field, north of Railton, 899 acres are held in the name of F. E. Hedditch, where, apart from two small upper seams of inferior quality, a 4-ft. seam of good quality has been proved at a depth of 28 feet from the surface. At the northern end of the area, about a couple of miles south of Latrobe, 406 acres are held, in the name of G. T. Bastard.

The Mersey River has intersected the shale area, and at one place a bed shows in the bank for a thickness of 6 or 7 feet. An outcrop has also been noticed up to 9 feet in thickness. Several of the exposures are at different levels, and are considered to belong to more than one seam. At many points the beds can be worked by open-cut; and where underground mining is necessary, drainage will be easy, as the beds are higher than the river. It is probable that the area in which the shale beds occur is more extensive than is at present known. It is intended to have a departmental examination of the district made shortly.

In 1902 the Tasmanian Shale and Oil Syndicate, originating in South Australia, caused some exhaustive experiments to be made by Dr. J. G. A. Black, M.A., and Mr. T. Esdaile. The sulphur and refractory bitumens contained in the shale were removed in the experiments without difficulty, and were declared as forming no obstacle to the successful extraction of the oil. Dr. Black reported results from various outcrops as from 44 to 65 gallons of crude oil per ton. Mr. Esdaile says that the tests indicate an average richness of 60.2 gallons of oil per ton of shale, sp. gr. 0.931. He states that the specific gravity of the crude oil is about .932, as against .892 of the parallel oil of the Scotch shales.

The following tabular statement of oil products obtained by testing 144 ozs. (troy) of crude oil, equal to about 39½ lbs. of good shale, by Esdaile's No. 2 method has been published, and will show the nature of the oils which can be extracted from the Mersey shale:—

Product.	Weight in troy, ozs. grs.	Fraction of gallon of product.	Temperature of steam distillation.	Specific gravity at 20 deg. Cent.	Flashing tem- perature, degrees Fahr.	Firing tempera- ture, degrees Fahr.	Gallons per ton of 2240 lbs.
Gasoline or heavy benzine ..	12.390	.1128	up to 115C.	.779	Fires at once	Ordinary tem- perature	6.429
Light burning oil (photogene)	12.270	.1115	up to 140C.	.834	88° F.	120° F.	6.365
Heavy burning or lighthouse oil	6.600	.0496	140 to 160C	.846	140° F.	161° F.	2.827
No. 1 light lubricating oil ..	8.700	.0642	160 to 180C	.870	180° F.	225° F.	3.659
No. 2 ditto ditto ..	11.360	.0882	180 to 200C.	.914	250° F.	272° F.	5.027
No. 3 ditto ditto ..	3.310	.0230	200 to 220C.	.901	260° F.	283° F.	1.311
No. 1 medium lubricating oil	11.250	.0855	220 to 240C.	.924	272° F.	290° F.	4.873
No. 2 ditto ditto ..	6.000	.0433	240 to 270C.	.947	310° F.	351° F.	2.468
No. 3 ditto ditto ..	6.000	.0429	300C.	.966	371° F.	398° F.	2.445
	79.270	.6210					35.394

The analyses which were made in the Black and Esdaile experiments show 64 per cent. lubricating oil, 25 per cent. lighting oil, and 11 per cent. benzine and benzoline. The richness of the shale (1 ton of it yielding as much crude oil in these experiments as 2½ tons of Scotch shale), combined with the low mining costs (1s. 6d. to 2s. per ton of shale, equal to 6s. to 10s. per ton of crude oil) and proximity to port, indicate conditions favourable to a successful enterprise, provided that an extraction method involving moderate working costs can be applied.

2. *Kerosene Shale or Cannel Coal.*—About 16 miles south of Wynyard, an outcrop line of coal seams stretches for about 2 miles north-east and south-west, between the Jessie and Flowerdale rivers, in the Parish of Preolenna. The seams are in a series of sandstones and clays, approximately 250 feet thick, which are known as the lower coal measures of the Permo-Carboniferous system in Tasmania. One of these seams is 20 inches in thickness, and is made up of kerosene shale 6 inches, bright coal 9 inches, splint (?) coal 5 inches. The shale is black; has a pitchy lustre, conchoidal fracture, and is characteristically tough and sextile. Samples assayed in the Tasmanian Government laboratories yielded the following results:—

	Fixed Carbon.	Gases, &c.	Ash.	Moisture.
No. 1	21.0	76.2	2.3	0.5
No. 2	23.2	71.6	4.1	1.1

Samples have also been assayed in the New South Wales Government laboratory, and yielded results as under:—

No. 3	28.51	67.32	2.92	1.25
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The Launceston Gas Company tested the illuminating power of the gas yielded by the Preolenna shale, which proved to be about double that of Greta coal. The result extended beyond the limit of the photometer scale used, and was estimated as approximately 40 candle-power per gas referee's burner. The extent over which this seam exists has not been proved by boring or mining work. The shale is only known at two points, but the coalfield has an approximate area of 2 miles by 1 mile. The distance from the nearest port (Wynyard) is too great to allow these seams to be worked profitably until the transport question is settled by the construction of a tramway-line from the coast. Parliamentary sanction has been given for a survey of a line from Burnie to Flowerdale, and, when further facilities exist in this direction a working programme will be brought within the range of profitable discussion. The substance, strictly speaking, appears to be neither shale nor cannel, but is rather intermediate between the shale-cannel group and bituminous coal, and would probably produce benzenes rather than oils.

Barn Bluff.—A somewhat similar coal to the preceding exists in fragments near Barn Bluff, 45 miles from the north coast. The seam from which the pieces have been derived has not been located, but it doubtless exists somewhere in the vicinity. Mr. W. A. Dixon, of the Technical College Labora-

tory, Sydney, considered that it would yield far more tar than oils, which would be difficult to purify. He says, "It is not a cannel from which oils are not made, and not a shale from which they are."

The proximate analyses which have been made of this coal at different times are the following:—

	1	2	3	4	5
Analyst	J. Sharpe, Ballarat.	W. F. Ward, Hobart.	J. C. Newbery, Melbourne.	W. A. Dixon, Sydney.	Average analysis.
Water	0.30	0.4	trace	none	0.2
Ash	2.80	4.2	6.05	4.12	4.3
Volatile Hydro- carbons	55.00	51.1	54.20	50.86	52.8
Fixed Carbon ...	41.90	44.3	39.75	43.69	42.4
Sulphur	trace	0.8	not determined	1.33	0.7

In Petterd's Catalogue of the Minerals of Tasmania, the name "Pelionite" is suggested for this variety.

Mr. W. F. Ward, the Government Analyst, obtained 92 gallons of crude oil and tar per ton by very slow distillation; but no investigation has yet been made in the direction of establishing the commercial value of the substance as an oil producer.

W. H. TWELVETREES, Government Geologist.

OUTLINES OF THE GEOLOGY OF TASMANIA.

By W. H. TWELVETREES, Government Geologist.

TASMANIA is the separated southern terminal of the Australian Continent. The western half of the island consists of folded Pre-Cambrian and early Palæozoic strata, moulded by denudation into high ranges with crests between 3000 and 5000 feet in height. The central tableland and eastern borders are composed of more or less horizontal beds of late Palæozoic marine strata and Mesozoic sediments, relics of the vanished Gondwana Land. Denudation has exposed huge sills of diabase in these, now crowning the high plateaux and mountains in that part of the island. The plateaux are known by the name of "tiers," and sink by successive faults to sea-level on the east coast. Tertiary fluvial, lacustrine, or estuarine drifts occupy the floors of the broader valleys, and fill old stream-channels which are now concealed by flows of basaltic lava.

The great movements of igneous material leaving their mark upon the present configuration of the land have been acid and sub-acid irruptions in Cambrian times, the consolidation of gabbro and granite in the Devonian, the intrusion of widespread diabase sills at the close of the Mesozoic, and the effusion of basalt lavas in Mid-Tertiary.

In Pre-Cambrian times Tasmania appears to have been beneath the Algonkian ocean, which received its sediments from continental land to the west. The surface of the deformed Algonkians was subsequently exposed, and furnished material for the Cambrian sediments, which in their turn were eroded and redeposited in the Ordovician and Silurian seas under which most of the present area of the island lay. In the Devonian, land surfaces must have prevailed, as no marine strata of that age are recognisable, and in the Permo-Carboniferous and during the Mesozoic a partial land connection with Australia continued, with shallow waters of a retreating sea. During the Cretaceous, Tasmania was still connected with a part of the adjoining continent, but after the close of that period a separation occurred. Subsequently the land connection was restored, to be again broken, since which time insular conditions have continued. The last land bridge across the straits is supposed to have

been between Wilson's Promontory in Victoria, and Cape Portland in Tasmania, *via* Flinders Island, and the Kent Group. It is estimated that an elevation of 300 feet would lay dry a strip of the present sea-bottom between Victoria and Tasmania.

The difficult features and inaccessibility of the uninhabited mountainous parts of the island have greatly impeded geologic research. It has, however, been possible to settle the stratigraphy of a large portion, though the lower Palæozoic strata and the Pre-Cambrian schists still require further study. The following systems or groups of systems are recognised:—

- I. Pre-Cambrian.
- II. Cambrian.
- III. Ordovician.
- IV. Silurian.
- V. Devonian.
- VI. Permo-Carboniferous.
- VII. Mesozoic.
- VIII. Tertiary.
- IX. Quaternary.

I.—PRE-CAMBRIAN.

Strata belonging to this group of systems come to view in the western, north-western, and south-western parts of the island. Whatever horizons may be established for the great breaks in this group, the known Pre-Cambrian rocks developed in Tasmania belong to the upper divisions, called Algonkian by the United States Geological Survey, and comprising dominantly rocks of sedimentary origin (Proterozoic of Chamberlin and Salisbury). The Archæan or lower series, consisting of granitoid rocks and igneous schists, has not been identified in the island. A solitary boulder occurs at the 29-mile peg on Innes' track from Liena to Barn Bluff, having a distinctly Archæan facies, and it may be that the Archæan rocks will be found in the neighbourhood. Up to the present no discovery has been made.

The Algonkian is extensively developed. It forms the platform on which the Cambrian strata have been laid down, and wherever its upper boundary is exposed, rocks of the Cambrian system are in unconformable juxtaposition. Its lower limit has not been seen, but naturally the basal beds must ultimately rest upon rocks belonging to the Archæan complex. No organic remains have been found in them. In some parts the metamorphism is suffi-

ciently intense to obliterate all traces of any life forms, while elsewhere the deformation and alteration have been slight and the rocks have the aspect of merely indurated or crystalline sandstones. In general the Algonkians consist of schistose quartzites, quartzitic, sericitic, and occasionally argillaceous schists.

The possibility of subdivision of the Algonkian is rendered likely by the discovery of what seems to be an upper horizon, indicated by bedded quartzites lying nearly horizontally upon the normal strongly-folded quartzitic schists prevalent in the valleys of the Franklin and its tributaries near the Raglan Range and Frenchman's Cap.

Denison Zone.—The largest continuous development is in the west and south of the island. Lofty schist ranges in parallel north-and-south lines traverse the country west of the King William and Denison Ranges and Mt. Wedge and the area in the south-west between the New River and Port Davey. These schists form the Raglan and Collingwood Ranges, the Frenchman's Cap, the greater part of Mt. Arrowsmith, the lower slopes of Mt. Gell, and the Loddon Range. From below the conglomerates of which the Denison Range is composed, and which strike N. 20° W., quartzitic schists rise with a north-easterly strike, and the same general bearing (with numerous local variations) prevails throughout the whole of the schist country further west. The eastern boundary of the schists is prolonged south of the River Gordon, west of the Wedge River, and then in a direction east of south to the south coast west of New River. The mica schists of the Collingwood River valley are intersected by dykes of garnet-zoisite-amphibolite. Three occurrences of this rock lie between the intersections of the Balaclava and Cardigan rivers with the Collingwood.

South of the Gordon the dominant strike of the schist is between N. 5° and 30° W., and this is also the case in the Port Davey district.

Cox's Bight and Port Davey.—Schistose quartzites and micaceous schists are pierced by tin-bearing granite at Cox's Bight, at the southern end of the Bathurst Range. The bight is 6 miles across, and is divided into two bays by a small promontory called Point Eric, which rises to a peak 160 feet above sea-level. This headland consists of alternate layers of micaceous sandstone and saccharoidal quartzite, contorted and dipping at low angles to the south-west. The strike of these is north-north-west to north-west, and this is the general strike of all the schists and quartzites in

the locality, excepting in the range of dark schists in the eastern bay, where the strike is about north and south. The junction with granite is observable at the neck of the Point Eric promontory, and the igneous rock then forms a spur with rocky knobs rising north from sea-level to 600 feet, where it again junctions with quartzite, which continues to the summit of the Bathurst Range, 2800 feet above sea-level. Cox's Bluff Range is a high headland (about 1000 feet), forming the western horn of the bight, and consisting of dense white quartzite, like many of the bluffs which jut out on this part of the coast, with bare snow-white crests visible for many miles. The white quartzite of Port Davey has long been assumed to be of Pre-Cambrian age. This series of schists and quartzites continues westwards to South-West Cape, and eastwards to the high land west of the New River.

Barn Bluff and Dove River.—The country round Barn Bluff consists principally of foliated quartz schists with a general east-and-west strike, or slightly north of west and south of east. Micaceous and argillaceous schists are also present. This Pre-Cambrian country continues as far north as the Dove River.

Ulverstone and Forth.—At the mouth of the River Leven, quartzitic and sericitic schists and schistose conglomerates, with beautifully stretched quartz pebbles, are well exposed along the beach eastwards as far as Button's Rivulet, where they are covered by basalt of Tertiary age, with a general strike of N. 10° E.; and westwards past Picnic Point to halfway across Barkworth's Bay, west of Goat Island, where their junction with the overlying Dundas and Leven Cambrians is hidden by a flow of lava. The striped slates and breccia a little further west appear with a strike of from N. 15° to 25° W., showing their strongly unconformable position on the Algonkian schists. The schistose conglomerates at Goat Island furnish classical examples of dynamically deformed pebble beds, the quartz pebbles being stretched into lentils and long narrow strips without fracture. The strike of the schists west of Goat Island ranges from N. 12° to 30° E., with a north-westerly dip.

At Hamilton-on-Forth a picturesque river gorge exposes the ancient rocks beneath a thin covering of Tertiary basalt, which occasionally assumes a felsparless or limburgitic facies. To the north-west of the township crags of saccharoidal white quartzite overlook the river. This

is bounded on the west by the basalt. Further south along the road there emerges from below the basaltic sheet a small exposure of serpentine about a chain wide. The next body of rock westerly is micaceous quartz schist striking N. 10° W., and dipping south-west. South-east of this, and on the same strike, is a belt of garnet-zoisite-amphibolite with a north-westerly bearing. This is succeeded on the west by mica schist and micaceous quartzite with strike of from N. 10° to 30° W., and a south-westerly dip. The schist is sometimes graphitic. Further south intrusions of porphyroid occur, and the Algonkian platform sinks below the Cambrian slate and breccia series.

Rocky Cape.—A series of quartzites and quartz schists is exposed along the north-west coast of Tasmania from Jacob's Boat Harbour west of Wynyard to Rocky Cape, which forms a promontory on the east side of the bay extending to Circular Head.

The Rocky Hills form a high range of massively bedded quartzite, which trends south or a little east of south from the coast to about a mile south of the main road, when it sinks rather abruptly, and subsides in the country which extends south across the Arthur River towards the Heazlewood and Long Plains. Immediately west of the Cape are contorted quartz schists, which are a part of the complex of schists and quartzites which succeed one another on this part of the coast. The strike of the quartzite at Rocky Cape port is north of east, and of the curled schist west of same N. 80° E. The quartzite here is coarsely bedded and not schistose.

The same series extends eastwards to Jacob's Boat Harbour, where the strike is north-west, with a north-easterly dip.

Rocky River Schists.—This formation is met with on the Waratah-Corinna-road, at 26 miles from Waratah, and continued to 31½ miles with a strike of about N. 10° W. and a north-easterly dip. The observed width of the belt is about 1½ mile. On the east it is bounded by the Long Plains series of quartzitic, sericitic, and graphitic schists. The country to the west has not been closely examined, but slate and quartz schist occur in it. The Rocky River schists continue north-west for 10 miles to the Savage River, and perhaps 3 or 4 miles further north. For this distance they maintain their lithological characteristics, and at intervals expose their characteristic ore outcrops. These comprise large lenses of magnetite and hematite, with a variety of associated minerals—gold, silver, copper,

pyrrhotite, pyrite, barytes, arsenide and antimonial sulpharsenide of nickel, cobalt molybdate, asbestos, siderite, dolomite, calcite, arsenopyrite, &c. On each side of the ore-bodies, and separated from them only by bands of more siliceous schist, are the amphibolitic schists of this zone, which are sometimes gneissoid and fissile, sometimes typically foliated, or compact, or granular with irregular fracture. Smooth talc-like schists are frequent. The elements forming the amphibolite are a rather fresh-looking acid plagioclase in large plates, a green amphibole, sometimes decidedly bluish-green in thin section, with the extinction angles of common hornblende; apatite in large formless crystals; quartz; and much epidote. The rock obviously belongs to the amphibolitic crystalline schists, and possibly was once gabbro, the pyroxene of which has been replaced by hornblende and the basic feldspar transformed into more acid feldspar and quartz. The presence of nickel ore and the frequent development of serpentine in the joint planes of the rock harmonise with this supposition.

At the junction of the Whyte River with the Nine-Mile Creek, where some copper ore mining has been carried on, this zone contains actinolite schists.

Long Plain Schists.—The rocks on the Long Plains between Waratah and Corinna may be placed in the Pre-Cambrian. They comprise sericitic, graphitic, and quartz schists striking a little east of north. A good deal of loose gold has been obtained from the creeks north of the plain (in nuggets up to 5 ozs. in weight), as well as from the angular hill detritus. Gold in ragged, spongy, and crystalline forms has been obtained from softened zones in the schist.

Asbestos Range.—This is a majestic linear range 5 or 6 miles west of Beaconsfield, terminating northwards in promontories at Badger Head in Bass Straits. No asbestos has been found in it. The range has been so named from its lying immediately to the west of the Anderson's Creek belt of serpentine, in which veins of chrysotile or serpentine asbestos exist. The serpentine intrusion obscures the junction of the schists of this range with the Cambrian grits and sandstones of the Beaconsfield district. The rocks of which the range is composed are micaceous schists, slates, and grits, striking N. 10° to 20° W.

Ore-deposits in Pre-Cambrian Rocks.—Ores of copper, antimony, and lead occur in the schists at Port Davey, copper and nickel ores (with gold and silver) in the Rocky

River belt, gold in the Long Plain schists, and disseminations of copper ore in dykes traversing the quartzite at Rocky Cape and Jacob's Boat Harbour. Gold has been found in sericitic quartzite at the Gell River, 19 miles north of the Great Bend of the Gordon, and has been reported from several points in the schist area. Copper ore occurs in the Asbestos Range schists, and in quartzite and actinolite rock at Barn Bluff.

II.—CAMBRIAN.

The base of the system, where observed, rests unconformably upon the upper Pre-Cambrian rocks, which were subjected to foliation and erosion before the overlying Cambrian strata were deposited. Recent information has shown that the clay slates and breccias which in early literature were called Cambro-Silurian, and more lately Cambro-Ordovician, may be regarded as belonging to the Cambrians. The West Coast conglomerates, the schistose porphyries of the West Coast Range, and the felspathic schists of Mt. Lyell, about which uncertainty has been felt for a long time, may be almost certainly placed in the same system.

The grouping of the beds in the Cambrian is somewhat provisional at present, as investigation is still proceeding, but the following groups have been recognised:—

- (4) Dikelocephalus sandstone at Caroline Creek and the Florentine.
- (3) Discoidal sandstone in the Loddon River valley and at Caroline Creek near Dulverton.
- (2) Tubicolar sandstone at Middlesex, Five-mile Rise, Mt. Claude, Lemonthyme Hill, Black Bluff, Zeehan, Loddon River Valley.
- (1) Conglomerates, pebbly sandstone, and quartzite on the West Coast Range, Mt. Zeehan, the Thumbs, Denison Range, Railton, &c.

Incertae Sedis.

- (a) The Dundas slates and breccias, the Dial Range, and Leven slates, breccias, tuffs, and porphyroids; the felspathic porphyries of Mts. Lyell, Jukes, and the West Coast Range generally.
- (b) Slate and sandstone at the Needles and in the neighbourhood of Mts. Mueller and Wedge.

(1) *Conglomerates.*

The great Denison Range flanks the valley of Rasselas to the west as one proceeds north of the Gordon Bend. First comes its southern offshoot (Mt. Wright), which forms a high wall on the west for about 5 miles, and then the main ridge of the Denison in continuation of the Thumbs and the mountain north of Clear Hill comes to the front and rises above the plain in lofty peaks. The western face of this range is composed of crystalline and pebbly sandstone, weathering into a visible conglomerate, the small pebbles of quartz showing on the weathered surfaces. These beds are succeeded to the west by strong bands of medium-grained and coarse conglomerate, which, with beds of sandstone, continue to the summit of the range. Behind these are quartzites, dipping conformably below them. Still further west are similar alternations. The whole forms the basal formation of the Cambrian system, striking N. 30° W., and dipping 45° to 50° north-easterly. The beds plunge below the Ordovician limestone on the east, and transgress the Algonkian strata on the west. The latter strike east of north. At the junction of the systems is a basal breccia bed composed of large angular stones of quartz and quartz schist. This is the lowest bed which has as yet been noticed in the Cambrian system.

No essential distinction can be made between these conglomerates and those of the West Coast Range. The series extends as far south as the head of the Florentine River. The general colour of the conglomerate is white or pink (reddish where fine-grained), and the pebbles are of quartz and quartzitic schist. Such conglomerate appears on nearly all the mountains of the West Coast Range, and on many in the north of the island, such as Valentine's Peak, Mt. Roland, &c. It exists near Railton behind the Cambrian beds. It underlies tubicolar sandstone at Mt. Zeehan, and is associated with similar sandstone at Black Bluff. It forms the footwall of the felspathic schists at the Mt. Lyell Mine. It underlies Ordovician limestone at the Upper Blythe. The steadily growing evidence seems to require its inclusion in the Cambrian system, though it has hitherto been considered as being of much younger age.

The beds of quartz grit, conglomerate, and sandstone, which form the Cabbage Tree Hill at Beaconsfield, pass below the Ordovician limestone in the eastern part of the township at an angle of 45° to 50° to the north-east.

The strike of the beds is north-westerly. A fault exists at the junction of the two systems here.

Some casts of orthis have been found in the whitish sandstone of the Cabbage Tree Hill; and on the surfaces of light grey slate from the Tasmania and Salisbury Mines undetermined markings and tubular forms have been found and referred to planolites and fucoids.* The term planolites covers various obscure cylindrical impressions supposed to be casts of the tracks of worms travelling over the surface of sand or mud.

(2) *Tubicolar Sandstone.*

This is a white crystalline sandstone seen in the Middlesex and Mt. Claude districts, at Zeehan, and in the Loddon River valley. It is known locally as "pipe-stem rock," from its abundant fossil forms, taken to resemble the stem of an ordinary clay pipe. These are sometimes straight, sometimes slightly curved. Sometimes they lie parallel with the bedding, sometimes vertical. Their forms project from or lie in relief on the weathered surfaces of the rock or stones, but their substance is wholly made up of quartz grains, and no signs of structure can be detected even by microscopic examination. Any name given to them must be entirely conjectural. They may be worm tracks, or possibly the fillings of dwelling tubes constructed by some tubicolar annelid. For the present, the rock carries the non-committal name of tubicolar sandstone. It plainly forms such an excellent stratigraphical horizon that its relations with its associated beds are important for Tasmanian geology.

Silurian fossils have been collected from the Bell Mount and Five-mile Rise districts, but the stratigraphy of these areas has not been worked out closely, and for a long time the tubicolar rock has been believed to be of Silurian age: but recent investigations lead to the conclusion that it must be Cambrian. It directly overlies the basal Cambrian conglomerate at Mt. Zeehan. These tubicolar forms have been found in the Cambrian conglomerate of Mt. Lyell Peaks. The rock is associated with Cambrian conglomerate at Black Bluff; it underlies Ordovician limestone on the eastern side of the Forth River near Lorinna.

(3) *Discoidal Sandstone.*

In the valley of the South Loddon the tubicolar rock is overlaid conformably by a whitish sandstone, which is

* By Mr. R. Etheridge, Jr.

charged with impressions of a peculiar discoid form, in appearance somewhat resembling encrinital stem segments. Similar forms, though much smaller, occur in a thin bed in the Upper Cambrian sandstone on the railway-line at Caroline Creek. It may be added that in the valley of the South Loddon River, the tubicolar sandstone overlies unconformably the Algonkian schists.

(4) *Dikelocephalus Sandstone.*

Yellow friable sandstones, grits, and claystones, with the *Dikelocephalus* fauna, underlie Ordovician limestone at the Railton lime quarry; and the same series of beds crosses the railway-line at the Caroline Creek, 2 miles north-west of Dulverton Siding. The following organic remains have been obtained from these beds:—*Dikelocephalus tasmanicus* (Eth.), *Asaphus* sp., *Ophileta* sp., *Ptychoparia stephensi* (Eth.).* A univalve, referred by Mr. Etheridge to *Raphistoma*, has been found in the Cambrian beds behind the quarry. All these beds strike north-west and dip south-west. In the south of the island on the west flank of Mt. Stephens (Tim Shea locally) in the Florentine Valley, belts of yellow claystone and soft sandstone have yielded another form belonging to the same genus of trilobites, viz., *Dikelocephalus florentinensis*.

(a) *Dundas and Leven Slates and Breccias, &c.*

Green and purple slates, breccias, and brecciated conglomerates prevail in the North Dundas district, intruded by porphyroids or dynamically altered quartz and felspar porphyries, and interbedded with the tuffs of these (clastoporphyroids). Some of the latter have the appearance of indurated sediments, and lithologically resemble European greywackés, but their origin is probably attributable to volcanic action, and in all likelihood they were submarine tuffs. Slate on the North-East Dundas railway has yielded indistinct graptolite markings, interpreted as belonging to the *Dendroidea*, and probably to the genus *Callograptus*. At 12½ miles from Zeehan, on this railway-line, some slate was collected, showing monopronidial graptolite thecae.†

The central and western portions of the Zeehan field comprise a series of slates, tuffs, and breccias, which are lithologically identical with those of the Dundas and Leven series. They form a clearly marked horizon in a great

* Formerly *Conocephalites stephensi*. † Determined by Mr. T. S. Hall, M.A.

sedimentary series, which consists for the most part of dark grey slate and white sandstones and grits.

Interbedded with these latter are beds of tuffs and isolated areas of vesicular lava sheets and dykes. Petrologically these effusive rocks at some points resemble the spilite or amygdaloidal diabase of German authors; at others, they display clearly marked porphyroidal affinities. The majority of the Zeehan lodes are enclosed within these rocks.

Lithologically similar breccias, tuffs, and slates occur in the Leven Gorge, at Gunn's Plains, where they underlie the Ordovician limestone with an unconformable angle of dip. Intrusive porphyroids are associated with them here also. On the North-West Coast, in Barkworth's Bay, west of Goat Island, this breccia series rests unconformably upon the Algonkian schists and schistose conglomerates. The series is exposed all along the beach from Lodder's Point to the Penguin township, and on the Dial Range.

This series may be distinguished from the conglomerate on the West Coast ranges by the abundant breccias, the cherty nature of the fragments, and general absence of quartz pebbles.

The varied massive and schistose porphyries intimately associated with them correspond with similar developments of igneous rock at Mt. Lyell, Mt. Farrell, and on the West Coast Range generally, for which a like age must be accepted as probable. These are the dynamically affected quartz and felspar porphyries, to which the convenient descriptive term "porphyroid" has been applied. They are associated with granites and syenites, which are generally more basic than the Devonian granite, and they constitute a complex group of acid and sub-acid porphyries and porphyrites, with some, as yet, imperfectly understood basic varieties.

The Leven porphyries extend as far south as Bell Mount, where they may be seen in the road cutting round that hill; and in the axial line of the West Coast Range they stretch from Bass Strait to Birch's Inlet, on Macquarie Harbour. Fragments of this kind of porphyry enter into the composition of the Permo-Carboniferous conglomerates in regions drained by the Gordon and Derwent Rivers and their tributaries, and when released from the matrix have frequently misled the searcher for granite exposures.

No intrusion of porphyroids has been observed in Ordovician strata, and from the evidence accumulated in various portions of the island the period of eruption must have

terminated before the close of the Cambrian. It is still difficult to precisely define the exact horizon occupied by the slates and porphyroids, but stratigraphical evidence appears to indicate that these rocks belong to the Upper Cambrian.

(b) *Slate and Sandstone at the Needles, &c.*

At the eastern base of the Needles, between Mt. Stephens (Tim Shea) and Mt. Mueller, a belt of reddish and purple slate and quartzite strikes north-west with a north-easterly dip. It underlies Ordovician limestone on Wherret's Look-out, and forms the country rock at the Humboldt Copper Mine.

Clay slates and quartzites of Cambrian age are also seen west of Mt. Mueller and all round the base of Mt. Wedge, but it is uncertain what horizon they occupy in the system.

III.—ORDOVICIAN.

The actual sequence of Ordovician strata in Tasmania has not yet been ascertained. The Gordon River limestone, however, has been observed succeeding Upper Cambrian beds at Railton, and it is taken as being the base of the system. Accordingly, the Ordovicians are divided as follows:—

- (2) Slate and sandstone in the goldfields of Lefroy, Mt. Victoria, Mathinna, Mangana, &c.
- (1) Limestone on the Gordon, Florentine, and other rivers, at Railton, Mole Creek, Beaconsfield, &c.

(1) *Gordon River Limestone.*

This is exposed at various places throughout a great portion of the island from north to south and from west to centre. It appears at Point Hibbs, in the Lower Gordon, in the Franklin, Denison, and Jane Rivers, in the Valley of Rasselas, in the Florentine Valley, on Mt. Humboldt, Mt. Müller, at the Junee Caves, on New River, at Mt. Farrell, Upper Blythe, Gunn's Plains, the Don River, Railton, Chudleigh, Mole Creek, Winkleigh, Beaconsfield, &c.

The limestone at Railton strikes N.W.-S.E., with a dip to the south-west. It rests with a slight unconformability on the *Dikelocephalus*-bearing sandstones of the Caroline

Creek series. It has yielded numerous specimens of *Actinoceras*.

The organic remains determined from the occurrences along the Gordon River include *Favosites*, *Halysites*, *Syringopora*, *Stenopora*, *Orthoceras*, *Phragmoceras*, *Lituites*, *Orthis*, *Rhynchonella*, *Raphistoma*, *Euomphalus*, *Murchisonia*, and the following species established by Mr. Johnston:—*Straparollus tasmanicus*, *Scalites salteri*, *Scalites gouldii*, *Trochonema etheridgei*, *Tellinomya jonesii*, *Modiolopsis gordonensis*.

The Gordon River from the entrance to the Gorge eastwards at the Great Bend shows numerous bars of this limestone crossing its bed, forming a limestone belt about $1\frac{1}{2}$ mile wide. The rock here is dark grey, regularly bedded and somewhat argillaceous. On the hills near the Gorge it contains some impressions of *Orthis*. Its strike is N. 25° W., and its dip north-easterly, at about 70°. It is evidently the bedrock of the Gordon Plains and the Rasselas Valley. It is underlaid on the west by the crystalline pebbly sandstone, conglomerate, and quartzite, which form the front wall of the Thumbs and Mt. Wright, and which there is reason to believe are Lower Cambrian.

Similar limestone is met with a few hundred feet west of the Florentine River, and again east of the river, striking N. 10° E., and dipping north-westerly. It is also exposed east of the Little Florentine River, with about the same strike and dip. It reappears on the shoulder of Mt. Field West, and again at the Junee River, striking north-west and dipping north-easterly. Impressions of fossil shells resembling *Orthis lenticularis* are met with in this limestone at the Junee River and in the Valley of Rasselas.

Further south the limestone occurs at the head of the Styx River, and between that place and the Upper Florentine Valley. At the junction of the Gordon and Port Davey tracks it is faulted against the Cambrian conglomerate of Junction Hill. In the extreme south of the island it exists on the New River.

At Copper Creek, on Gunn's Plains, the same rock lies unconformably on the Dial Range breccias and conglomerates, and the same relations obtain at the Upper Blythe. At Beaconsfield it is faulted against the Cambrian grits and conglomerates of the Cabbage Tree Hill.

Its occurrence at Mt. Farrell is in the bed of the Macintosh River, a short distance above the junction of the latter with the Sophia River, where it is fossiliferous.

(2) *Auriferous Slate and Sandstone Series.*

This series is assumed to be of Ordovician age, partly from its analogies with Victorian strata, partly from the absence of Silurian fossils. It is, however, strange that no grapholites have been discovered. The strata form a well-recognised belt of clay slate, arenaceous slate, sandstone, and quartzite, extending from Fingal and Mangana through Mathinna to Mt. Victoria and Warrentina. To the north-west the zone widens so as to embrace Lisle and Lefroy. The general strike of the strata throughout the belt is N. 20° to 30° W., with varying dips due to anticlinal folds. From St. Patrick's River to Back Creek the dip is north-easterly, but changes to the south-west a few miles from Lefroy. As a north-easterly dip prevails on the west side of the Tamar, the river is either in a synclinal valley or masks a fault.

The gold quartz reefs which run through the belt apparently began to form after the close of the Silurian, and are a constant feature of the entire belt.

IV.—SILURIAN.

This system is represented by the following subdivisions:—

- (2) Eldon Valley clay slates.
 (1) Fossiliferous limestone, sandstone, and slate at Zeehan, Heazlewood, Queen, and Nelson Rivers, Lorinna, &c.

(1) The Silurian strata at Zeehan, believed, on the evidence of their contained fossils, to be of Middle Silurian age, comprise slates, limestone, and sandstones. These beds occupy a position to the eastward of the Cambrian sandstones, slates, and breccias, save where by faulting, the isolation of small Silurian areas within Cambrian boundaries has occurred.

Lithologically there is a very close resemblance between the Silurian and the Cambrian sediments on the Zeehan field, a fact which has been responsible for the massing of the two groups in previous geological literature. There are, however, marked differences between the assemblages of organic remains preserved in the rocks of the two systems.

The general strike of the Silurian sediments in the Zeehan field is between 45° and 80° west of north. Post-Silurian faulting has disturbed the beds, and minor varia-

tions of strike are frequent. The limestones appear to be the basal members of the system.

Mr. Etheridge has determined the following organic remains:—

From the Despatch Limestone—

- Asaphus, sp. ind.
 Hausmannia meridianus (Eth. fil. and Mit.).
 Hausmannia, sp. ind.
 Illaenus johnstoni (Eth. fil.).
 Amphion? brevispinus (Eth. fil.).
 Leptodomus? nuciformis (Eth. fil.).
 Eunema montgomeryi (Eth. fil.).
 Orthoceras, sp. ind.

From blue-grey Slate at Zeehan—

- Cornulites tasmanicus (Eth. fil.).
 Cromus murchisoni (De Kon.?).
 Rhynchonella borealis (Schlotheim?).
 Rhynchonella cuneata (Dalman).
 Strophodonta, sp. ind.
 Tentaculites, sp. ind.

From white Quartzite at Zeehan—

- Lophospira, sp. ind.
 Murchisonia, sp. ind.
 Raphistoma, sp. ind.

The Silurian beds are penetrated by dykes of granite-porphry, which have suffered faulting and crushing by later earth movements.

To the west of the Zeehan field is a large development of gabbro and serpentine, forming the aureole of the granite mass of Mt. Heemskirk.

Numerous silver-lead veins intersect the field in all directions, and at least one valuable lode of stannite exists.

At the Heazlewood, in the vicinity of the Whyte River, are limestone and sandstone strata of the same age as the Zeehan series, striking N. 40° W., and dipping generally to the north-east.

Mr. Etheridge has determined the following forms from these beds:—

- Cornulites tasmanicus (Eth. fil.).
 Cromus murchisoni (De Kon.).
 Rhynchonella decimplicata (J. de C. Sow.).

^a NOTE.—For much of the palæontology of this paper the works of R. M. Johnston, A. C. Seward, E. A. Newell Arber, R. Etheridge, Jr., J. Shirley, Dennant and Kitson, V. Ellingshausen, Feistmantel and others have been consulted and used. Mr. R. Etheridge and Mr. F. Chapman have freely given assistance in several determinations.

Rhynchonella capax (Conrad).
Tentaculites, sp. ind.

Silurian sandstone with abundant casts of *Rhynchonella* occurs near Lorinna, on the Five-mile Rise.

Grey, white, and yellowish gritty sandstones, plentifully charged with impressions of brachiopods, are found in the valleys of the Queen and Nelson Rivers, and west of Queenstown on an old track leading to Howard's Plains. Some brachiopod-bearing sandstone occurs at the Mt. Lyell Mine in close proximity westwards to the large clay course, which runs in a northerly direction through the Reward claims. Rock met with underground in the Lyell Blocks Mine has yielded specimens of a *Rhynchonella*, which, *vide* Mr. Etheridge, is, in all probability, *R. Capax* (Conrad). Similar specimens occur behind the township of Gormanston. Fragments of similar rock have been found on the Gordon track, 5 miles from Tyenna.

Trilobite-bearing Silurian rocks exist also near the Wilson River, north of the Pieman. On the north-west face of Mt. Arrowsmith Silurian sandstone dips west at a low angle.

In the Eldon Valley are clay slates and mudstones, with undetermined forms of *Calymene*, *Orthis*, *Cardiola*, &c., which have been placed provisionally at the base of the Silurian.

At the White Hawk, north of Mt. Farrell, a bed of limestone occurs between a sandstone on the west and pebbly sandstone on the east, the whole dipping westward. The sandstone below the limestone contains impressions of *Rhynchonella borealis*, and that above has many impressions of *Rhynchonella capax*. (Conrad), var. *meridionalis* (Etheridge).

V.—DEVONIAN.

The gap between the Silurian and Permo-Carboniferous is not bridged by any record of sedimentation. Doubtful beds occur near Fingal and in the Eldon Valley, but they are too insufficiently known to admit of classification.

This period, however, was marked by the intratelluric consolidation of a great mass of igneous rock, subsequently exposed and appearing in various parts of the island in the form of granite and serpentine. The serpentine is generally a peripheral mantle of serpentised gabbroid and ultra-basic rocks surrounding the granite masses on the West Coast. Occasionally between the granite and serpentine is an aureole of actinolitic rock. On the East

Coast, however, serpentine has not been met with. The localities where serpentine is known to occur are as follows:—Trial Harbour, Comstock, Dundas, Parson's Hood, Heazlewood, Hamilton-on-Forth, Styx River, Upper Florentine River, Boyes River. Aplitic and other granitoid veins have been noticed to invade serpentine at the Heazlewood and Anderson's Creek; gabbro, in the North Dundas tinfield, is also traversed by granite-porphry dykes. There is a junction of granite with serpentine on the beach at Trial Harbour. At the contact the serpentine is highly altered, and is penetrated by small dykes of porphyry, which proceed from the granite mass. These facts indicate the prior consolidation of the basic rock.

Granite occurs in a meridional line down the East Coast, extending from Flinders Island to Maria Island. It forms Mt. Cameron, Mt. Stronach, the Blue Tier, Freycinet's Peninsula, and is exposed at Ben Lomond, Lyell, Golconda, and at the base of Mts. Arthur and Barrow. Exposures are also seen at Middlesex, Granite Tor, Upper Blythe, Hampshire Hills, Heazlewood, &c. The Meredith Range and Mt. Heemskirk are huge granite massifs. The most southerly occurrence is at Cox's Bight.

Granite or acidic vein-matter penetrates all rocks of earlier date than Permo-Carboniferous; but granite itself has not been seen intrusive in strata of the latter age.

An important feature by which the Devonian granite is lithologically distinguishable from the older granitic and syenitic rocks of the porphyroid group is its uncrushed character. It has not been subjected to the dynamic stresses which the Cambrian granites and syenites have undergone.

The normal rock is a biotite granite. In the tin-mining districts a development of muscovite or lithia-bearing mica takes place, and greisen formations frequently occur, accompanied by patches and veins of pegmatite. Where granite exists on the goldfields of the North-East (round Mts. Barrow and Arthur) hornblende enters into its composition. Tin-bearing lodes occur in the granite at Ben Lomond and Mt. Heemskirk, while on the Blue Tier floors or stocks of altered granite form large tin-ore bodies of low grade. Quartz or granite-porphry dykes at Mt. Bischoff have shed the vast accumulation of tin ore which has been mined there for the last 36 years with wonderful success.

The quartz-porphry and granite-porphry dykes in the Dundas district, the tourmaline-gold-copper lodes at Mt.

Black, the axinite veins at the Colebrook, and the stannite lodes and quartz-porphry dykes at Zeehan, all denote a granitic reservoir below the mineral fields of the West Coast; and the gold quartz reefs of the eastern part of the island may be similarly interpreted. Serpentinised rocks at the Heazlewood, Dundas, and Trial Harbour carry lodes of silver-lead, copper, and nickel ores. Osmiridium (iridosmine) is a constituent of sands in the neighbourhood of serpentine masses (always associated with gold). An extraordinary feature is the occurrence of tin ore with serpentine at Dundas.

VI.—PERMO-CARBONIFEROUS.

This system in Tasmania represents a time interval which is too late in the geological record to be called exclusively Carboniferous, and as a whole too early to be exclusively Permian. It shows no traces of the Carboniferous Lepidodendroid flora and Calamites. Cooler, or even frigid, climatic conditions were ushering in the Glossopteris flora, which had already appeared in the Australian Carboniferous. Such characteristic forms as *Productus semireticulatus*, *Spirifera striata*, and the *Phillipsia trilobite*, which lived in Australian Carboniferous waters, are unknown in Tasmania, though many other Carboniferous species still lingered. On the other hand, *Stenopora*, *Strophalosia*, &c., give a Permian facies to the marina fauna. Generally an impoverishment of marine forms of life was in progress.

During this time a continued process of withdrawal of the sea took place, finally leaving the surfaces of the older, folded strata, covered with comparatively shallow sheets of water, forming probably chains of lakes and arms of the sea. Oscillations of the strand level were inconsiderable. The sedimentation would seem to have been largely in enclosed or partially enclosed seas, or at most, on an epicontinental sea-floor. The base of the system rests upon the ancient rocks (Cambrian, Ordovician, or Silurian); sometimes upon the Devonian granite, which was then in places already exposed by denudation.

Glacial conditions prevailed at the time of the deposition of the basal conglomerates. Similar conditions are known to have existed in Australia, India, and Southern Africa during this period. The similarity of the Permo-Carboniferous and Mesozoic flora in these three continents (including Tasmania) is suggestive of a mutual land connection—that of the hypothetical Gondwana Land.

The Permo-Carboniferous strata in Tasmania are usually horizontal or gently inclined. They have not been deformed by folding, but have been greatly depressed or raised by faulting. The sills of diabase, which have penetrated them on an enormous scale, do not seem to have tilted them to high angles. Innumerable displacements, however, have been caused by faults.

The thickness of the maximum development of the beds belonging to this system is estimated at about 2000 feet.

The strata comprise conglomerates, grits, limestones, sandstones, and mudstones, with shales and thin coal seams, all indicative of shallow-water conditions. They appear at the surface over a large area, being exposed in nearly all parts of the island.

The subdivisions are as follow:—

Upper—

- (6) Elæolite and alkali syenites with various alkaline porphyries at Port Cygnet and along D'Entrecasteaux Channel. Precise age unsettled.
- (5) Southport sandstones and shales.
- (4) Mt. Cygnet and Adventure Bay sandstones and shales.
- (3) Upper Marine mudstones overlying Mersey coal; Porter Hill shales and sandstones, Sandy Bay.
- (2) Lower coal measures (= Greta horizon, N.S.W.), Mersey Basin, Preolenna, Henty River; Tasmanite beds.

Lower—

- (1) Conglomerates, grits, limestones, and lower marine mudstones throughout South-East, North-East North-West, and Midlands. Glacial conglomerates, grits, micaceous sandstones, and slaty flagstones in thick beds form the base of the system.
- (1) The base sometimes consists of marine gritty conglomerates, as on Bruni Island, with erratic boulders; sometimes of limestone and conglomerate with a calcareous cement, also carrying erratics; or of glacial till, conglomerates, and sandstones with erratics, as at Wynyard, or of marine mudstone with boulders, as on the banks of the Derwent. The glacial beds at Wynyard, where a full development of them occurs, have been estimated by Prof.

David to represent a thickness of 1200 feet. The basal beds are well represented on Bruni and Maria Islands.

On Maria Island, north-east of Darlington, are coastal cliff sections, below Mt. Maria (with its twin peaks, the Bishop and Clerk), showing nearly 600 feet of limestone and mudstone, the lower 10 or 12 feet of which consist of boulder limestone and conglomerate, with large erratic blocks of granite, slate, and sandstone. The series as here developed has been divided by Mr. R. M. Johnston into palæontological zones as follows (in descending order):—

- (v) Crinoid zone.
- (iv) Productus zone.
- (iii) Fenestella zone.
- (ii) Pachydomus zone.
- (i) Erratic zone.

(i) Some of the erratics in this zone weigh over a ton. The matrix between the boulders is impure limestone.

(ii) This zone, in which Pachydomus predominates, is 80 feet in thickness, and comprises beds of limestone and calcareous shale. One bed, 40 feet thick, is almost entirely composed of shells of Pachydomus. The following are characteristic fossils of this zone:—Pachydomus globosus (J. de C. Sowerby), P. de konincki (Johnston), P. hobartensis (Johnston), P. gigas (McCoy), P. carinatus (Morris), Eurydesma cordata (Morris), Notomya gouldii (Johnston), N. trigonalis (Johnston), N. beddomeii (Johnston), Deltopecten limæformis (Morris sp.)*, D. fittoni (Morris sp.), Aviculopecten squamuliferus (Morris), Platyschisma ocula (J. de Sow), Conularia tasmanica (Johnston), Stenopora tasmaniensis (Lonsdale), S. informis (Lonsdale), S. ovata (Lons.).

(iii) This zone consists of mudstones 124 feet thick, replete with crushed specimens of Fenestella internata (Lons.), F. plebeia (McCoy), Protoretrepora ampla (Sow.). With these are Spirifera tasmaniensis (Morris), S. darwinii (Morris), S. glabra (Morris), S. duodecimcostata (McCoy), Productus brachythærus (G. Sow.), Strophalosia clarkei (Eth. fil), Pleurotomaria morrisi (McCoy).

(iv) This zone includes a group of blue hydraulic limestones worked at one time for Portland cement. Beds of

* = Aviculopecten limæformis (Johnston). Deltopecten is a genus formed by Etheridge fil in 1892, occupying an intermediate position between Aviculopecten and Pecten proper. Vide Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales, by R. Etheridge, Jr., and W. S. Dun, 1906, p. 22.

calcareous shale and mudstone separate the limestone bands. The limestones contain Stenopora, Fenestella, Crinoids, Spirifera, Strophalosia, Productus, Deltopecten, Pachydomus.

(v) The Crinoid zone embraces limestones which are composed principally of Crinoid remains, and is about 30 feet in thickness.

The dip of the entire group of beds is to the south-east.

The lower division of the Permo-Carboniferous is also developed on Bruni Island, in D'Entrecasteaux Channel. The eastern shore of this island abounds in cliff escarpments, the stratified rocks dipping south of west. The core of the island is diabase. A narrow strip of sandy beach, 6 or 7 miles long, connects North with South Bruni. The marine Permo-Carboniferous beds flank the diabasic backbone of the island up to a height of 300 or 400 feet. The basal beds here are marine gritty conglomerates, with Spirifera strzelecki, S. darwinii, Pterinea macropteris, and trunks of conifers. At One-tree Point, North Bruni, the lower beds are grits, conglomerates, limestone, and white and yellow arenaceous mudstones. Stones of granite, porphyry, slate, &c., are common in the conglomerate. Some of the boulders are of huge size, and their transport is ascribed to the agency of ice. Overlying the conglomerate is a bed of limestone 4 feet thick, composed nearly entirely of large specimens of Stenopora ovata (Lons.). Large conifer trunks are embedded in both the limestone and conglomerate.

At Variety Bay, a little north of Cape Frederick Henry, the fossiliferous mudstones are well exposed. Mr. R. M. Johnston gives the following descending section.

	Feet.
6. Fenestella Zone.—Finely laminated mudstone, with abundant Fenestella fossula and Protoretrepora ampla	70
5. Spirifer Zone.—Siliceous limestone, with casts of Spirifera convoluta, S. strzelecki, Dielasma (Terebratula) sacculus, Deltopecten limæformis, Deltopecten fittoni, &c.	12
4. Pleurotomaria Zone.—Hard, dense, siliceous rock replete with thin layers almost wholly composed of the casts of Pleurotomaria morrisiana	4
3. Siliceous limestone and mudstone, with occasional casts of Pleurotomaria morrisiana.....	10
2. Hard conglomerates and grits without fossils	4
1. Diabase.	

These beds have a westerly dip of from 15° to 20° . For 5 miles along the sea coast east and west of Wynyard the basal glacial beds of the Permo-Carboniferous system are exposed at water-level, dipping north-westerly at low angles. They consist of glacial till, conglomerates, with ice-scratched boulders, sandstone, and clay shale, and rest upon dark Ordovician slate containing *Phyllograptus*, *Diplograptus*, various *Phyllocarids* and brachiopods allied to *Obolella*.

The Lower Marine mudstones are exposed all along the Derwent Valley, near Hobart, at Glenorchy, Bridgewater, New Norfolk, on the Styx River, near Tyenna, &c. They rise by a succession of faults to a height of 2000 feet on the slopes of Mt. Wellington. The Huon-road, as it rises from the city of Hobart, shows good sections of these beds. The main subdivisions are—

3. *Fenestella* mudstones, at Cascade, Grange, Porter Hill, &c.
2. *Spirifera* and *Strophalosia* mudstones, Huon-road.
1. *Pachydomus* limestones and sandstones, Cascades, Bridgewater.

Pachydomus Zone.

Pachydomus konincki
 " globosus
 " hobartensis
Eurydesma cordata
Spirifera convoluta
 " stokesii
Productus brachytherus
Aviculopecten (*Deltopecten*) *limaeformis*
 " *fittoni*
Pleurotomaria morrisiana
Pterinea macroptera
Conularia derwentensis
 " *tenuistriata*
Lithodomus gouldii

Spirifera Zone.

Spirifera darwini
 " duodecimcostata
 " convoluta
 " strzeleckii
 " glabra
 " tasmaniensis
 " oviformis
 " lata
 " vespertilio
 " stokesii
 " *Orthotetes crenistria*
Terebratula (*Dielasma*) *sacculus*
Deltopecten *limaeformis*
 " *fittoni*
 " *Aviculopecten squamuliterus*
Chaenomya (*Sanguinolites*) *etheridgii*
Stenopora tasmaniensis
 " *crinita*
Platyschisma ocula

Fenestella Zone.

Fenestella internata
 " *pk-beia*
Protoretopora ampla
 with organisms of the other two zones

The principal organisms found in the above are as follows:—

At Eaglehawk Neck the lower beds occur. The coarse grits and conglomerates form a level floor on the sea beach, with rectangular joints filled with oxide of iron. This is known as the Tessellated Pavement. The jointing is possibly due to the vicinity of a concealed body of intrusive diabase. At the Blow Hole, near the above, Mr. R. M. Johnston gives the following section:—

	Feet.
3. Yellow or white chalky mudstones with <i>Spirifera glabra</i> , <i>Dielasma sacculus</i> , &c....	about 150
2. Mudstone and calcareous sandstone, with <i>Fenestella</i> , <i>Productus</i> , <i>Spirifera</i> , <i>Pachydomus</i> , <i>Platyschisma</i> , <i>Deltopecten</i> , <i>Pleurotomaria</i> —	about 60
1. Basal grits. Thickness not known.	

At the Middle Arm of the Tamar is a small development of the Lower Marine limestone resting upon the older Palæozoic rocks. The upper part represents characteristically the *Fenestella* zone, while the lower part contains *Eurydesma* in abundance.

On the Meander, near Cheshunt, the mudstones contain *Spirifera*, *Productus*, *Dielasma*, *Pachydomus*, *Eurydesma*, *Pterinea*, *Deltopecten*, *Aviculopecten*, *Platyschisma*, and *Pleurotomaria*.

Limestones occur in the Fingal Valley, at Marlborough, Eastern Marshes, and with the mudstones and conglomerates all round the borders of the Western and Central Tiers.

In the north-eastern part of the island, on the right bank of the River Piper, not very far from Lilydale, foraminiferal limestone—with *Nubecularia stephensi* (Howchin) and *Spiroloculina*—of this system has been found. The Lower Marine mudstones are exposed for a thickness of about 400 feet on the Jessie River, Preolenna, south of Wynyard. Below the coal of the Mersey (= Greta) horizon there fossiliferous mudstones come in for about 150 feet, containing *Fenestella*, *Spirifera*, *Aviculopecten*, *Pachydomus*, &c. These overlie non-fossiliferous mudstone, which extends down to the Jessie River, 200 feet or more.

In the neighbourhood of the Eldon Valley mudstones occur, with dwarfed varieties of *Spirifera* and *Rhynchonella*.

Round the base of East Pelion and Mt. Pelion are mudstone and limestone, with *Fenestella*, *Spirifera*, *Productus*, *Aviculopecten*, &c. Similar beds underlie the coal measures

on the Henty River, West Tasmania, yielding the following:—*Spirifera tasmaniensis*, *Spirifera avicula*, *Spirifera convoluta*, *Chænomya*, *Fenestella internata*, *F. plebeia*, *Protoretetpora ampla*, *Stenopora tasmaniensis*.

At Port Cygnet the succession is:—(3) *Fenestella* zone; (2) *Spirifera* zone; (1) shaly mudstone. The fossiliferous sandstones occur all round Lovett and Lymington.

The Lower Marine beds in the Mersey basin have been disclosed by boring at Tarleton, where 105 feet of pebbly sandstone and conglomerate containing Permo-Carboniferous marine fossils rest upon Ordovician limestone. The organic forms are *Stenopora tasmaniensis*, *Spirifera tasmaniensis*, *Fenestella plebeia*, *Dielasma sacculus*, and *Pleurotomaria morrisiana*.

(2) The lowest beds of the upper division of the Permo-Carboniferous are the sandstones and shales which enclose the coal seams of the Mersey horizon. These correspond with the Greta series of New South Wales, and, like those measures, separate the Upper Marine series from the Lower Marine.

The Mersey coal measures consist of grits, sandstones, and marls, with seams of coal generally not exceeding 2 feet in thickness. The analyses of the coal from different collieries in the district are as follows:—

	Fixed Carbon.	Gases, &c.	Ash.	Moisture.
(1)	36.5	46.6	4.0	12.9
(2)	36.6	41.2	9.8	12.4
(3)	40.5	44.4	5.8	9.3
(4)	41.7	48.0	2.4	7.9

Remains of the vertebral column and ribs of a small amphibian(?) were found on the spoil heap from a shaft sunk near Railton in these measures.

The plant remains are the forms characteristic of the Permo-Carboniferous, viz.:—

- Glossopteris browniana* (Brongn.)
- " *ampla* (Dana)
- " *indica* (Schimper)
- Gangamopteris angustifolia* (McCoy)
- " *cyclopteroides* (Feistmantel)
- Noeggerathiopsis hislopi* (Bunbury)
- Phyllothea australis* (Brongn.)
- Cardiocarpus* sp.

In this basin, near the Great Bend of the River Mersey, near Latrobe, are beds of Tasmanite shale, consisting of sand and mud charged with oil-bearing vegetable spores,

and considered to be of value for the manufacture of lubricating and illuminating oils. The precise local relation which they bear to the coal seams is not known, but geologically they are on the same horizon. The fossils contained in these beds are as follows:—*Spirifera tasmaniensis* (Morris), *Cardiomorpha gryphoides* (de Kon.), *Pachydomus hobartensis* (?) (R. M. Johnston), *Pleurotomaria morrisiana* (McCoy), *Pteronites latus* (de Kon.), *Aviculopecten* sp.

At Preolenna, south of Wynyard, between the Flowerdale and Jessie Rivers, yellow sandstone and clays with seams of coal (with *Glossopteris*) attain a thickness of 250 feet. The proximate analysis of the coal, from seams varying from 20 inches to 3½ feet in thickness, ranges from 44 per cent. to 52 per cent. fixed carbon, 41 to 50 per cent. volatile matter, and 5 to 9 per cent. ash. Portions of these seams consist of kerosene shale or cannel coal, containing 76 per cent. gas and 21 per cent. fixed carbon. The coal-bearing beds are covered by fossiliferous mudstone, and rest on similar strata.

The beds of the coal measures series are developed on Mt. Pelion, Mt. Ossa, Mt. Oakley, at the north end of the Du Cane Range and on the Eldon Range. A seam of coal is known at Coal Hill, west of Lake St. Clair. The coal measure basin appears to deepen going south.

Near Barn Bluff is a seam of coal in a band of black micaceous shale, containing remains of *Glossopteris* and *Noeggerathiopsis*. The coal bed there rests upon conglomerate, and is overlaid by Permo-Carboniferous marine strata. A cannel coal similar to that at Preolenna has been found near Barn Bluff in loose blocks, supposed to be remnants of a wasted seam. Ice-action has been invoked to account for the breaking up of this seam.

On the north side of the Henty River, between the Henty and Badger, the lower coal measures are hard dark-grey shales, which contain *Glossopteris browniana* (Bngt.), *Glossopteris ampla* (Dana), *Gangamopteris cyclopteroides* (Feistm.), and *Noeggerathiopsis hislopi* (Bunbury).

At Harefield, in the Fingal coal basin, 97 feet of conglomerate, sandstone, and shale, with coal stains and impressions of a plant resembling *Schizoneura*, have been shown by boring to underlie beds belonging to the Upper Marine series.

(3) *The Upper Marine Series.*—In this are included the fossiliferous mudstones which overlie the Mersey coal

measures. Many of the organic remains in these are identical with those in the Lower Marine; some of the latter, however, have disappeared. The genera *Fenestella*, *Spirifera*, *Dielasma* (*Terebratula*), *Pleurotomaria*, *Pachydomus*, *Aviculopecten*, *Cardiomorpha*, *Pterina*, &c., have been recorded.

The upper zones of sandstone and shale at Porter's Hill, Hobart, correspond with the Upper Marine beds of the Mersey. Two hundred feet of these are exposed along the Derwent, containing, besides fragments of the plant *Gangamopteris*, the following forms:—*Cythere tasmanicus* (Johnston), *Spirifera tasmaniensis*, *S. darwinii*, *S. duodecimcostata*, *Dielasma sacculus*, *Avicula*, *Arca*, *Aviculopecten*, *Eurydesma*, *Edmondia*, *Inoceramus*, *Pachydomus*, *Pleurotomaria*, *Conularia*, &c.

At Harefield, in the Mt. Nicholas Valley, a bore revealed 313 feet of Upper Marine beds below the Mesozoic coal measures. These consist of sandstone, shale, conglomerate, and limestone, containing remains of *Fenestella* and other forms.

(4) The Mt. Cygnet and Adventure Bay coal measures may be taken as corresponding with the Newcastle series of New South Wales.

At Mt. Cygnet the measures rest on the *Fenestella* beds, and the coal seam, 3 to 4 feet in thickness, is enclosed in sandstone, which is occasionally pebbly. The proximate analysis of the coal is: fixed carbon, 63.9 per cent.; volatile matter, 13.2 per cent.; ash, 22 per cent. The shale of this seam contains impressions of *Vertebraria australis* and *Gangamopteris spathulata*.

At Adventure Bay, on Bruni Island, coal measure seams and shales lie conformably on the Lower Marine mudstones, &c. They contain dwarfed forms of *Glossopteris browniana* var. *præcursor* (Brgt.), *Gangamopteris spathulata* (McCoy), *Gangamopteris obliqua* (McCoy).*

(5) At Southport sandstones and shales rest upon conglomerate and pebbly sandstone, with marine shells. A diamond-drill bore reached the basal conglomerate beds at a depth of 500 feet. The recorded plant remains from the shales are *Vertebraria australis* and *Pecopteris lunensis* (Johnston).

(6) The alkaline rocks which form a N.E.-S.W. belt running from the Huon River through Port Cygnet to

* These forms of *Gangamopteris* are referred by Arber to *G. cyclopteroides* (Feistmantel). Vide "The *Glossopteris* Flora," by E. A. Newell Arber, 1905, pp. 104-5.

Woodbridge and Kettering are referred provisionally to the close of this period. It is definitely known that they are intrusive in the Lower Marine sandstones and mudstones, and they appear to be cut through by the diabase, which is considered to date from the close of the Mesozoic.

The belt comprises the following rock varieties:—

<i>Alkali Syenites.</i>	<i>Elaeolite Syenites.</i>	<i>Esserite.</i>
Quartz-augite syenite	Pyroxene foyaite	Esserite
Aegirine-augite syenite	Mica foyaite	
Alkali-syenite porphyry	Jacupirangite	
	Amphibole foyaite porphyry	
	Sölvbergite porphyry	
	Mica sölvbergite	
	Tinguaité porphyry	
	Monchiquitic nephelinite	

Auriferous quartz and pyrites have been developed near the line of contact of these igneous rocks with the Permo-Carboniferous sediments, and a good deal of alluvial gold has been recovered from the creeks and flats.

VII.—MESOZOIC.

In Tasmania no essentially marine sediments are known to have accumulated in Mesozoic times. The process of retreat of the oceanic waters evidently persisted. Land plants, fish, and amphibian remains point to sub-aerial, fluvial, and lacustrine conditions. The poverty of the fauna and the aridity of climate indicated by saliferous beds tend to confirm this view.

The lowest beds of this era rest conformably upon the Upper Permo-Carboniferous. The total thickness of the Mesozoic strata is tentatively estimated at about 1200 feet.

The intrusive sills of diabase which penetrated the Permo-Carboniferous strata forced their way also between the beds of this era, and as the upper coal-bearing beds have been affected in this way, it is evident that the diabase invasion took place at the close of the Mesozoic or in the early Tertiary.

Modern geological theory postulates a general shrinkage of the earth's mass upon its centre, and, as a consequence, the dominant movements are downward, not upward.

There has been, however, a greater relative sinking of the ocean floors (which are believed to have a higher specific gravity than that of the land areas). This subsidence is supposed to have been attended by a compression, and incidentally a raising of the continental segments. The

elevated land tracts subsequently proceeded to settle down to the level of isostatic equilibrium.

Possibly some diastrophic action of a minor character, and certainly the processes of base levelling, would also lower the surface of the land and bring about transgressions of the epicontinental seas. Finally, stresses would be developed, causing fracturing and faulting down the epicontinental platforms and margins of the land, and originating generally broad physical features identical with those which we see in our late Palæozoic and Mesozoic areas.

If this interpretation is correct, the huge step faults marked by the eastern escarpments of the diabase-capped central and eastern tiers can be explained. The successive tiers between the centre of the island and the eastern coast may be considered as successive steps leading down from the central "horst" to the coastal plains.*

The Mesozoic strata in Tasmania cannot as yet be broken up with any certainty into divisions corresponding with those of Europe, owing to the absence of stratigraphic breaks and adequate palæontological evidence. The utmost that appears possible for the present is to divide both stratified and igneous rocks into Lower and Upper Mesozoic, with a ternary subdivision of the lower group. Thus:—

- (2) Upper Mesozoic—
 - (iv) Diabase in intrusive masses, sills, or dykes.
- (1) Lower Mesozoic—
 - (iii) Fingal series or upper coal measures.
 - (ii) Ida Bay series.—Sandstones and slates with coal at Ida Bay.
 - (i) Knocklofty series—Variegated sandstones with *Vertebraria indica* (Royle),† remains of heterocercal fish and amphibians.
 - (i) *Knocklofty Series*.—The sandstones at Knocklofty, the Domain, Tinderbox Bay, Sandy Bay, and probably at Ross, belong to this horizon. From the Cascades to Knocklofty are about 1000 feet of sandstone, from which the

* "In considering the coasts of Australia we must leave out of account the east coasts of Australia and Tasmania, which appear for many reasons to be a fractured margin of recent age, presenting no indications of negative movement"—The Face of the Earth: E. Suess, 1906 (Sollas' transl. Vol. II., p. 521).

† Arber has united *Vertebraria australis* (McJoy) with *V. indica* (Royle), "since there do not appear to be any good characters which clearly separate them" (*Glossopteris Flora*, 1905, p. 99).

remains of the fish *Acrolepis hamiltoni* (Johnston and Morton) have been recorded. These authors give the ascending section of the beds as follows:—

	Feet.
1. Yellow fissile sandstone	20
2. Flaggy sandstone with fish remains	5
3. Mottled shales with plants	60
4. Thick sandstone beds, quarried for building	715
	800

Sandstone near Tinderbox Bay is on the same horizon as the Knocklofty beds, and has yielded remains of a fish described by Messrs. Johnston and Morton under the name of *Acrolepis tasmanicus*. This sandstone overlies conformably the uppermost beds of the Permo-Carboniferous mudstones, as developed at Tinderbox Bay, Huon-road, and Waterworks Valley near Hobart.

This series of sandstones and shales contains the plant remains *Vertebraria indica* (Royle) [= *V. australis*, McCoy]. *Vertebraria* was discovered by Zeiller in 1896 to be the rhizome of the fern-like plant *Glossopteris*. In Tasmania it is restricted to the above series, and to the Southport beds.

Mr. Johnston considers the Lower Sandy Bay mudstones exposed 3 miles from Hobart on the Brown's River-road to be the base of the system. They contain obscure plant impressions.

The building stone at Ross probably belongs to this series of beds; as also possibly the saliferous sandstone of the midlands. Several salt pans occur on the estates of Mona Vale, Ballochmyle, Lower Park, and Ellenthorpe, in a chain extending for 7 miles N.W.-S.E. The individual lagoon beds or pans are from 1 to 100 acres in area. In dry seasons hundreds of tons of salt have been taken from them, and used for farm and domestic purposes. They were prized by the aboriginals, and were often the cause of tribal conflicts. Saliferous sandstone exists also near Richmond, on the Coal River 3 miles east of Colebrook, and reappears south of the town. Early settlers used to collect salt for household use from the caverns in this rock all along the line of the Richmond hills. Whether these saliferous sandstones belong to the Lower or Upper Mesozoic is a matter which needs investigating.

(ii) *Ida Bay Series*.—This comprises coal-bearing shale and sandstone at Ida Bay. About a mile south-west of the bay and 150 feet above sea-level are the coal-bearing beds. In the shales above the coal are impressions of *Zeugophyllites** and *Pecopteris lunensis* (Johnston).

The beds of these two subdivisions of the Mesozoic are regarded as being on the horizon of the Narrabeen-Hawkesbury series of New South Wales (Trias.).

(iii) *Fingal Series or Upper Coal Measures*.—The upper coal measures of Tasmania are, from the affinities of their plant remains, considered to be on the Hawkesbury-Wianamatta horizon of New South Wales (Rhaetic?). The critical species for the Clarence measures, *Tæniopteris daintreei* (*T. spathulata*), has not been found in them. The only two forms of this genus hitherto discovered are *T. tasmanica* (Johnston) and *T. morrisiana* (Johnston). The most abundant plant impressions in these measures are those of *Thinnfeldia odontopteroides*, *Alethopteris australis*, and *Zeugophyllites elongatus*. The equisetel genus *Phyllothea* is also common.

The Mesozoic coal measures of Eastern Australia have recently been transferred from the Trias-Jura to the Jura. Mr. W. S. Dun remarks†:—"It would appear advisable to (1) discontinue the use of the term Trias-Jura usually applied to this formation by Australian geologists; and (2) consider the Eastern Australian Mesozoic coal measures—characterised by the relatively great abundance of *Tæniopteris daintreei* (= *spathulata*), *Alethopteris australis* (= *Cladophlebis denticulata*), and numerous types of conifers and *Thinnfeldia*, together with the Lake Eyre beds, as Jurassic."

In accordance with this the Ipswich formation in Queensland, the Clarence measures and Talbragar fish beds in New South Wales, and the South Gippsland and Otway coal measures in Victoria, all of which contain *Tæniopteris daintreei*, are now assigned to the Jurassic system.

The Wianamatta, Hawkesbury, and Narrabeen beds have not yielded this plant, nor have the Tasmanian Mesozoic measures. The evidence certainly is negative, and consequently inconclusive. For the present, however, the

* *Zeugophyllites elongatus* (Morris) has been transferred by A. C. Seward to the genus *Phoenicopsis* of Heer. See Arber: *Gloss. Flora*, p. 183. On the other hand Dr. F. Kurtz includes it under *Podozamites elongatus* (Morris), Feistm. *Q. J. Geol. Soc.* 1903, p. 25.

† *Geol. and Min. Resources of the Western Coalfield*, by J. E. Carne, *Mem. Geol. Sur. New South Wales*, 1908, p. 42.

whole of the Mesozoic groups of strata in Tasmania are regarded simply as Lower Mesozoic. The Knocklofty beds appear to correspond lithologically with the Hawkesbury sandstones. The upper coal measures have been looked upon by English authors as Rhaetic.

The strata occupy discontinuous areas, which are separated from one another by intrusive masses of diabase. Much faulting occurs. They occupy positions varying from sea-level to nearly 3000 feet above the sea. Their vertical thickness, as observed, is not less than 1200 feet, and probably exceeds this. They lie horizontally or at low angles, usually not exceeding 10° or 20° . Lithologically they are yellow, brown, greenish, and bluish-grey sandstones, frequently markedly felspathic, alternating with grey or bluish-grey shales.

The coalfields probably at one time belonged to one basin, but as they are now disconnected, it is convenient for purposes of reference to class them geographically in separate divisions. The following division embraces the different fields:—

Northern—

- (1) Longford basin.

Southern—

- (2) Colebrook (Jerusalem) and York Plains basin.
 (3) Ouse basin.
 (4) Derwent and Richmond basin.
 (5) Huon basin.
 (6) Recherche basin.

South-Eastern—

- (7) Schouten and Spring Bay basin.
 (8) Tasman Peninsula Basin.

Eastern—

- (9) Fingal basin.
 (10) Llandaff and Douglas River basin.

(1) *Longford Basin.*

The upper coal measures crop out near Norwich from below the sediments of the Launceston Tertiary area, and apparently succeed the fringe of Permo-Carboniferous marine strata which skirt the northern face of the Western Tiers. The coal seams have a thickness of 3 to 4 feet.

(2) *Colebrook (Jerusalem) and York Plains Basin.*

The Mesozoic strata fringe everywhere diabase-crowned hills. At York Plains sub-anthracitic seams of coal up to 4 feet in thickness occur in these beds. The coal assays 60 to 67 per cent. fixed carbon, 13 to 14 per cent. gas, and 16 to 23 per cent. ash. At Colebrook bluish-grey sandstone overlies a seam of coal 2 feet thick; and other seams up to 3 feet have been met with.

At Green Ponds horizontal beds of these sandstones have been preserved. At Mike Howe's Marsh, 17 miles north-west of Oatlands, soft yellow sandstones dip north-westerly, and contain coal assaying 62 per cent. fixed carbon, 18 per cent. gas, and 10 to 11 per cent. ash.

(3) *Ouse Basin.*

The strata of this coalfield comprise soft yellowish-brown felspathic sandstones and grey shales with characteristic fern impressions. The general dip is to the west, at an angle of about 3° . Fragments of silicified wood are frequent. Seams of coal from 2 to 5 feet thick exist at this horizon. Analyses show from 53 to 63 per cent. fixed carbon, and 21 to 25 per cent. volatile matter. Below the coal-bearing sandstones are a series of siliceous or quartzose sandstones, corresponding with the freestones quarried at Knocklofty, Ross, &c. The coalfield is nearly encircled by igneous rocks—by basalt to the north-west and diabase on the north-east, east, and south.

(4) *Derwent and Richmond Basin.*

Mesozoic sandstones and shales flank the ranges round Mts. Wellington, Direction, and Dromedary, along the valley of the Derwent between Hobart and Bridgewater, and again between Bridgewater and Richmond.

Coal-bearing beds of shale and sandstone are met with round New Town, where they repose on the grey and yellow building stone, the beds of which belong to the Knocklofty series. The coal shales contain plant impressions characteristic of the upper coal measures, the most abundant forms being *Alethopteris australis* (Morris), *Thinnfeldia odontopteroides* (Morris), and *Neuropteris tasmaniensis* (Johnston). *Zeugophyllites elongatus* (Morris) and the common species of *Phyllothea* also occur.

North of Mt. Direction sandstones of this division carrying coal dip gently towards the west. The associated shales

contain impressions of *Thinnfeldia*, *Phyllothea*, and *Zeugophyllites*.

(5) *Huon Basin.*

Felspathic sandstones and shales occur on the divide between the Huon and North-West Bay River basins. They contain several coal seams from 1 to 6 feet in thickness, and have a general dip to the north-west at angles varying from 5° to 10°. These seams are known as the Sandfly group. The assays range from 50 to 56 per cent. fixed carbon, 25 to 30 per cent. volatile matter, and 15 to 17 per cent. ash. An anthracitic seam also occurs, assaying 80·8 per cent. fixed carbon, 8 per cent. volatile matter, and 9 per cent. ash. The crowns of the hill ridges consist of diabase.

(6) *Recherche Basin.*

The Upper Coal Measures occur in a belt of country flanking Recherche Bay, and continuing across Catamaran River to South Cape Bay.

At the head of Recherche Bay is the settlement of Leprena, and south of this the coal measures form the coastal range, which rises to 900 feet and dip in a north-westerly direction. They extend also to the east side of the bay. The outcrops of the coal on the range are about 200 feet above sea-level. The coal contains, by assay, 54 per cent. fixed carbon and 26 per cent. volatile matter.

North of the Catamaran River the coal-bearing sandstones and shales contain *Thinnfeldia odontopteroides*, var. *obtusifolia*, *Zeugophyllites elongatus*, and *Phyllothea australis*, and continue across the river to the south, where some coal has been found overlaid by shale and white sandstone. The shale carries impressions of *Thinnfeldia odontopteroides*.

The Catamaran coal assays 67 per cent. fixed carbon and 25 to 27 per cent. volatile matter, and under 4 per cent. ash.

The same beds crop out along the coast-line between South and South-East Capes, containing identical plant remains and trunks of silicified conifers.

(7) *Schouten and Spring Bay Basin.*

The Prosser's Plains and Spring Bay strata consist of white or yellow freestone, of good building quality and the usual greenish-grey or yellowish felspathic sandstone. The freestone seems to overlie the felspathic variety, which, in

its turn, overlies the coal, at any rate round Spring Bay. Much false bedding prevails, but a main gentle northerly dip of one or two degrees exists. Coal seams up to 5 feet in thickness occur at Triabunna. At Prosser's Plains are seams of coal dipping to the south-west, at high angles (40°).

On the north shore of Schouten Island a seam of coal was worked at one time by the Imperial Government. This is associated with fireclay enclosed in soft carbonaceous sandstones and shales.

(8) *Tasman Peninsula Basin.*

The Mesozoic rocks, yellow and white sandstone and blue and grey shales, with coal seams, flank the diabase-capped ridges of the northern part of the peninsula, and form low cliffs on the coast-line. Some of the coal seams were at one time worked extensively by the Imperial Government. The north-easterly extension of these shales at Dunalley has yielded numerous plant remains, which have been determined by R. M. Johnston as follows:—

- Pecopteris buftoni* (Johnston).
- Pecopteris caudata* (Johnston).
- Thinnfeldia buftoni* (Johnston).
- Thinnfeldia polymorpha* (Johnston).
- Macrotaeniopteris wianamattae?* (Feistm.).
- Gleichenia dubia* (Feistm.).
- Trichomanides spinifolium* (T. Woods).
- Neuropteris tasmaniensis?* (Johnston).
- Ptilophyllum oligoneurum* (T. Woods).
- Pterophyllum*, sp.

(9) *Fingal Basin.*

At one time this plainly embraced all the measures between Ben Lomond and Mt. Nicholas in the north, and Llandaff in the south, though continuity has since been interrupted by diabase intrusions. The limits of the field are quite arbitrary, as continuity southwards can be established indefinitely. The Mt. Nicholas Range rises to a height at the trigonometrical station of 2800 feet above sea-level, and consists of about 1000 feet of coal measure sandstone crowned by columnar diabase. This descends below the valley-floor for over 200 feet, and rests upon the Upper Marine beds of the Permo-Carboniferous system, giving about 1200 feet of vertical thickness for the Upper Coal Measures here.

Strong coal seams are being worked on the south flank of the range. A section of the range at the Cornwall Mine would give approximately the following succession in descending order:—

	Feet.
Diabase—about	300
Coal	6
Sandstone	200
Coal	4
Sandstone	250
Coal	20
Sandstone	70
Coal	6
Clay	4
Coal	8
Sandstone	15
Clay	7
Coal	9
Coal measures sandstone to floor of valley...	480

Recent assays of the coal worked at the large Cornwall and Mt. Nicholas collieries are as follows:—

	Moisture.	Hydro-Carbons.	Fixed Carbons.	Ash.
(1)	6.50	26.30	57.70	9.50
(2)	7.48	26.14	58.36	8.02
(3)	8.72	23.10	58.88	9.30
(4)	8.60	18.20	61.40	11.80
(5)	6.66	21.48	56.76	15.10

Several unworked seams occur at different horizons all round the mountain. The Mesozoic strata continue westwards to Fingal, and thence along the valley of the South Esk to St. Pauls, Ben Lomond, Mt. Rex, and Avoca. Southwards from Mt. Nicholas they extend south in a coastal belt down the eastern shore-line. Mt. Logie (Elephant) south of St. Marys forms a north and south ridge a mile long, capped with diabase and fringed with Mesozoic sandstone and Permo-Carboniferous sandstone. Beyond this to the east granite stretches away to the coast-line. Further south are coal seams near Thompson's Marshes, in the usual soft greenish-grey felspathic sandstones.

Avoca township is on Tertiary basalt, below which are Tertiary sediments resting upon Mesozoic sandstone and Permo-Carboniferous limestone. At Mt. Rex and on the

Bona Vista estate are strong seams of coal 6 to 12 feet in thickness. The coal analyses of the Mt. Rex seams are:—

Moisture.	Hydro-carbons.	Fixed Carbons.	Ash.	Sulphur.
1.2	35.0	54.5	8.5	0.8
1.7	28.2	55.0	15.1	—
—	38.2	52.9	8.9	—

(10) *Llandaff and Douglas River Basin.*

Strictly speaking, this is a continuation of the Fingal area, but is so far south as to justify geographical separation. The diabase-capped mountain range parallel with the coast near Bicheno and Seymour is flanked by Mesozoic sandstones up to 800 or 900 feet above sea-level, and above this diabase ascends for about 300 feet further. These sandstones have been shown by sinking and boring to descend to a depth of at least 350 feet below sea-level. The horizons are, however, affected by faults, so as to render an estimate of thickness difficult. The coal-bearing beds consist of yellowish-green felspathic sandstone and shales, with fossil imprints of *Thinnfeldia odontopteroides* (Morris). They have a gentle inclination to north-west and south-west. The seams of coal vary in thickness from 2 to 12 feet, and the quality is also variable. The good qualities range from 50 to 57 per cent. fixed carbon and 27 to 34 per cent. volatile matter.

The following is R. M. Johnston's list of Tasmanian Mesozoic plants:—

	Upper Coal Measures.	Ida Bay.	Lower Sandstones.	Remarks.
<i>Ferns.</i>				
<i>Alethopteris australis</i> (Morris) .	1	...	...	= <i>Cladophlebis denticulata</i> (Brongn.) var. <i>australis</i> (Morris)
" <i>serratifolia</i> (Johnston)	1			
<i>Cardiopteris tasmanica</i> (Johnston)	1			
<i>Cyclopteris</i> (or <i>Salisburia</i>) <i>australis</i> (Johnston)	1			
<i>Gleichenia dubia</i> (Feistm.)	1			

	Upper Coal Measures.	Ida Bay.	Lower Sandstones.	Remarks.
Glossopteris moribunda (Johnston)	1	...	...	Lord's Hill, New Town
Macrotaeniopteris wianamattae (Feistm.)	1			
Neuropteris antipoda (Johnston)	1			
" tasmaniensis (Johnston)	1			
Odontopteris crispata (Johnston)	1			
Pecopteris buftoni (Johnston)...	1			
" caudata (Johnston)...	1			
" lunensis (Johnston)...	...	1		
" odontopteroides (Morris)	1			
Rhacophyllum coriaceum (Johnston)	1			
Sagenopteris tasmanica (Feistm.)	1			
Sphenopteris morrisiana (Johnston)	1	...	...	} Considered by Arber as = S. lobitolia
" flexuosa (McCoy) ..	1	...	...
" germana (McCoy) ..	1	...	...
" hastata (McCoy) ...	1	...	...
" lobifolia (Morris) ...	1	...	...
" plumosa (McCoy) ..	1	...	...
" alata (Brongn.) ...	1	...	...
" elongata (Carruthers)	1			
" tasmanica (Johnston)	1			
Strzeleckia gangamopteroides (Johnston)	1			
" tenuifolia (Johnston)	1			
Taeniopteris morrisiana (Johnston)	1			
" tasmanica (Johnston)	1			
Thinnfeldia buftoni (Johnston)	1			
" feistmanteli (Johnston)	1			
" obtusifolia (Johnston)	1	...	...	} Considered by Shirley as = T. odontopteroides
" media (T. Woods)	1			
" polymorpha (Johnston)	1			
" superba (Johnston)	1	...	...	} Considered by Shirley as = T. odontopteroides
" trilobita (Johnston)	1			

	Upper Coal Measures.	Ida Bay.	Lower Sandstones.	Remarks.
Trichomanides spinifolium (T. Woods)	1			
" etting-hauseni (Johnston) ...	1			
<i>Equisetaceous Plants.</i>				
Annularia australis (Morris) ...	1			
Phyllothea australis (Brongn.)	1			
" hookeri (McCoy) }	1	...	...	} Considered by Arber as = P. australis
" ramosa (McCoy) }	1			
<i>Lycopods.</i>				
Lepidostrobus muelleri (Johnston)	1			
<i>Cycads.</i>				
Podozamites distans ? (Presé)	1			
Pterophyllum dubium (Johnston)	1			
" risdonense (Johnston)	1			
" strahani (Johnston)	1			
Sphenozamites fistriantelii (Johnston)	1			
Ptilophyllum oligoneurum (T. Woods)	1			
<i>Conifers.</i>				
Baiera tenuifolia (Johnston) ...	1			
Ginkgophyllum australe (Johnston)	1			
Salisburia hobartensis (Johnston)	1			
Zeugophyllites elongatus (Morris)	1	1		
<i>Affinities uncertain.</i>				
Cryptophyllites tasmanicus (Johnston) .....	...	...	1	
Vertebraria australis (McCoy) ...	...	...	1	} United by Arber with Vertebraria indica (Royle)

(c) The close of the Mesozoic or beginning of the Tertiary was marked by an extensive irruption of basic materials in the form of intrusive sheets and dykes of diabase, which have penetrated all the rock-systems earlier than Tertiary. The rock is of fine to medium grain, of typically hypabyssal structure, and is composed essentially of pyroxene and lime-soda felspar. The general absence of olivine is one of the most useful field criteria for distinguishing the rock from Tertiary basalt. The following are two analyses of the rock from the north and the south of the island respectively, made by Professor Ditrich and Dr. Pohl:—

	Enstatite-augite-bearing Diabase from Launceston.	Quartz, or Konga Diabase from North-West Bay.
SiO ₂	52·49	56·74
TiO ₂	0·62	1·26
Al ₂ O ₃	16·44	15·46
Fe ₂ O ₃	2·60	3·08
FeO.....	5·30	7·58
MnO.....	trace	trace
MgO.....	6·18	2·54
CaO.....	11·71	7·64
Na ₂ O.....	2·06	3·08
K ₂ O.....	1·09	1·59
H ₂ O under 110° ...	0·15	1·28
H ₂ O above 110° ...	1·42	
P ₂ O ₅	trace	0·15
	<u>100·06</u>	<u>100·40</u>

It should be mentioned that the quartzose variety, though frequently met with in the south of the island, is not quite typical for Tasmanian diabase. All the signs of the occurrence of diabase in Tasmania indicate its intrusion into overlying rocks. Its base is not glassy, but rather a felspathic mesostasis; the rock is never scoriaceous, has no horizontal partings between separate lava flows as in basalt, and is sometimes almost gabbroid in texture. The numerous dykes injure the quality of the coal in their proximity, and affect adjoining sandstone and shale by converting the former into quartzite, and the latter into chert or adinole. Most of the coastal headlands in the south-east and west are composed of diabase. In the North they form the promontories at Cape Portland, Tamar Heads, Port Sorell Point, and Mersey Bluff. Over half the island, from the central tableland to the east and south-east, the dissected and faulted country

exposes everywhere sections of the great diabase sills, from which their former Permo-Carboniferous or Mesozoic covering has been removed by erosion. Outliers of the Eldon sill exist as far west as Mts. Sedgwick and Dundas, which are capped by this rock, and there is a dyke or other intrusion at Mt. Heemskirk. While no doubt exists of its invasion of the Permo-Carboniferous and Mesozoic strata, its actual relations to them in the field are frequently obscure, owing to the contacts being more often than not concealed.

VIII.—TERTIARY.

A great stratigraphic break exists between the Mesozoic and the sediments of the Tertiary system. While it is very likely that the time divisions of the Cainozoic era adopted in Europe and America rest upon basic principles of world-wide applicability, it does not at present seem possible to adopt in Tasmania other than a binary classification.

(b) *Neogene or Upper Tertiary* (= approximately Pliocene)—

(4) Terrace drifts and clays overlying basaltic lavas.

(a) *Palaeogene or Lower Tertiary* (= Miocene to Eocene)—

(3) Basalt lavas.

(2) Fluvatile and lacustrine clays and sands. Gold and tin-ore drifts and deep leads. Lignitic clays and leaf beds.

(1) Marine beds at Wynyard, Montagu, Cape Grim, and Heathy Valley, Flinder's Island.

The oscillations of the land surface in the north are difficult to follow. A Pre-Eocene land connection with the continent is considered to have existed; then followed an Eocene depression. At some time in the early Tertiary the land in northern Tasmania must have been higher than now; but prior to the Mid-Tertiary basalt eruptions a prolonged subsidence was in progress, when the clays and gravels of the Launceston basin were laid down as deposits reaching a thickness of 1000 feet. Subsequently many valleys were filled with lava sheets. In Post-basaltic or Pliocene times a rising movement again set in, which restored the Bassian land bridge for a time. The changes of level, however, finally left the floors of the deep leads at Beaconsfield, Lefroy, Back Creek, &c., still below sea-level at their outlets.

In southern Tasmania the indented shore-line of the estuary of the Derwent indicates drowned valleys descending seawards. The leaf beds on the shores of the Derwent have been depressed to below sea-level, and bear witness to late Tertiary or Quaternary advance of the sea on the land.

For the most part, Tasmanian Tertiary deposits are non-marine. In other parts of the world the Tertiary is known as the age of lakes, and this island offers no exception, for lacustrine and fluvial deposits of the period are the prevailing ones. In them are preserved leaf impressions and remains of extinct deciduous trees, *e.g.*, oak, elm, beech, &c., together with eucalyptus, banksia, cinnamon, and various conifers. Examples of these deposits are the lacustrine or estuarine beds of the valley of the Derwent and of the Launceston Tertiary basin. Other deposits fringe existing rivers or were the beds of ancient streams, as along the South Esk and the deep auriferous and stanniferous leads at Lefroy and in the Ringarooma district.

(1) *Marine Beds at Wynyard, &c.*

At Wynyard, on the west side of the mouth of the River Inglis, are beds of fossiliferous limestones of Eocene age. The Sandy Cove bluff, rising to a height of about 170 feet, consists of stratified rocks about 80 feet in thickness, overlaid by about 80 feet of the basaltic lava, which commonly separates the Lower and Upper Tertiaries.

The fossiliferous series comprises a *Crassatella* bed at the base only a few feet thick and superincumbent *Turritella* beds nearly 80 feet in thickness. These are heavily charged with marine shells and corals, of which 316 specific forms have been identified. The *Turritella* beds have yielded impressions of leaves of *Pteris Belli*, *Sapotacites oligoneuris* (Ettingsh.), besides remains of an extinct marsupial, *Wynyardia bassiana* (Spencer).

The species of *Turritella* which have been identified are:—

- T. warbutonii* (T. Woods), abundant.
- T. sturtii* (T. Woods).
- T. tristira* (Tate).
- T. conspicabilis* (Tate).
- T. acricula* (Tate).
- T. murrayana* (Tate).

And of *Crassatella*:—

- Crassatella* (*Crassatellites*) *oblonga* (T. Woods).
- Crassatella communis* (Tate).
- Crassatella aphrodina* (T. Woods).

These beds repose horizontally on the Permo-Carboniferous glacial beds of the Wynyard formation, which dip north-westerly at low angles up to 10°.

At Cape Grim polyzoan limestone in horizontal beds, dipping eastward under basalt, composes the sea front on the West Coast, immediately south of the cape. These beds extend eastwards to the Welcome River. Besides polyzoa, they contain Tertiary echinoderms and brachiopods.

On Flinders Island, near the Patriarchs at Heathy Valley, is a Lower Tertiary shell limestone with marine shells, some of which (*Cucullea*, *Nucula*, *Turritella*) resemble forms found in the Eocene beds at Wynyard.

(2) *Derwent Tertiary Basin.*

The valley of the Derwent exhibits a series of Tertiary sands and clays bordering the present river. They indicate the former existence of lacustrine conditions in the lower Derwent. These beds attain a maximum height of 40 or 50 feet above sea-level, and may be seen at One-Tree Point, Sandy Bay, Cornelian Bay, Lindisfarne Bay, Geilston Bay, &c. At Pipeclay Bluff, Cornelian Bay, where the beds rest horizontally on diabase, the white pipeclay contains remains of the fruit *Plesiocapparis leptocelyphis* (Mueller) and impressions of various leaves. These strata probably extend below the basalt at the Cemetery Bluff, and correspond in age with the infra-basaltic beds of the Launceston Tertiary basin.

At Geilston Bay beds of clay and limestone (known as the Geilston Travertin) occur, containing the following:—*

- Helix geilstonensis* (Johnston).
- Helix huxleyana* (Johnston).
- Helix sinclairioides* (Johnston) or (*H. sinclairi*, Pfr.).
- Vitrina barnardii* (Johnston).
- Bulimus gunnii* (Sowerby)
- Cypris alburyana* (Johnston)

* *Fide* R. M. Johnston in *Geol. of Tasmania*, p. 285

These beds constitute a fragment of the floor of the ancient lake of the Derwent, and were once continuous with corresponding deposits on the west side of the estuary.

The preserved flora of the Derwent Tertiaries is characteristic of the Palæogene in Tasmania, viz., leaves of *betula*, *alnus*, *quercus*, *fulgus*, *salix*, *cinnamomum*, *araucaria*, *sapotacites*, with the fruits *platycoila*, *pentune*, *conchotheca*, *plasiocapparis*, *cordia*, &c.

Higher up the Derwent, near its confluence with the Styx River, are beds of light-coloured clay associated with lignite, apparently derived from conifers. Near Glenora clay leaf-beds occur below the basalt, yielding leaves of *fagus* and *cinnamomum*. Near the Ouse bridge the river flows through Tertiary beds of lignite and clay, containing large tree trunks.

Launceston Tertiary Basin.—This comprises the wide plain within the drainage area of the Tamar and its tributaries. It contains layers of irregularly bedded sandstones and clays, often with lignite. These cover an area of 600 square miles, and attain a thickness of 1000 feet. The plateau has a general height of 500 to 600 feet above sea-level.

The lowest beds are, perhaps, those between Muddy Creek and Supply River, on the Tamar, where a series of horizontal ferruginous sands and white and bluish clays occurs, dipping slightly to the north-west, the lower strata containing *Anodonta tasmanica* (Eth. fil), *Unio johnstoni* (Eth. fil), and numerous leaf impressions (*Cordia tasmanica*, Ettingsh., and *Premna drummondi*, Ett.).

In the auriferous lead at Brandy Creek, Beaconsfield, 270 feet below sea-level, a stratum of black carbonaceous clay has yielded the Palæogene fossil fruits *Spondylostrabus smythii* (Mueller), *Platycoila sullivanii* (Mueller), *Plesiocapparis leptocelyphis* (Mueller), *Cordia tasmanica* (Ettingsh.), *Elaeocarpus bassii* (Ett.), *Pentune allporti* (Mueller), *Conchotheca turgida* (Mueller), and leaves of *cinnamomum polymorphoides* (McCoy); also large trunks of conifers. Similar beds occur at Dilston and Windermere on the east bank of the Tamar. Lignitic beds of Tertiary clays and sands occur east of Mt. George.

The false-bedded sandstones of the Windmill Hill and Sand Hill, Launceston, are Upper Palæogene. They contain leaf imprints of deciduous and other trees (*betula*, *fagus*, *quercus*, *cinnamomum*, *banksia*). At Carr Villa, near Launceston, the boring core showed an impression

of a *betula* leaf, at a depth of 500 feet. Leaf-beds appear on the railway-line at Breadalbane, with lignite impressions of *banksia*, *betula* leaves, &c.

A bore at Belmont went down in the Palæogene sandstone and shale to 894 feet without reaching bottom. This is equivalent to about 200 feet below sea-level. The common leaf impression, *Betula launcestoniensis*, was found.

North-East.—In the north-east the high plateau of sand and gravel, with alluvial tin ore, near Branxholm and Derby, which is capped with basalt, marks the ancient course of the Ringarooma River before it was choked with lava and diverted to its present channel. At Gladstone, the old Mussel Roe stanniferous lead contains fossil wood.

East.—Tertiary leaf-beds also occur in the tin-ore drift in Thureau's Deep Lead, at St. Helens. At Tullochgorum in the valley of the South Esk, sandy clays, with lignite, have yielded fossil leaves similar to those at Muddy Creek.

North-West.—Palæogene alluvial beds occur on the North-West Coast below the basalt sheet which caps the coastal plateau. At Burnie, in a white pipeclay below the basalt, imprints of leaves of European and other types have been found. At Waratah leaf imprints have been obtained from greyish Tertiary sandstone beneath 45 feet of basalt, at a height of 2000 feet above sea-level. These leaves have been identified as follows:—*Eucalyptus kayseri* (Johnston), *Laurus sprengii* (Johnston), *quercus bischoffensis* (Johnston), *Ulmus tasmanicus*, *Cycadites microphylla* (Johnston).

West.—Leaf-beds of similar age, and containing impressions of *Cinnamomum polymorphoides* (McCoy) and *Sapotacites oligoneuris* (Ett.) also occur in the carbonaceous clays and ferruginous sands which form horizontal beds along the shores of Macquarie Harbour from Strahan to Pillinger. The lower beds form a lignitic series, in which leaf forms belonging to the Lauraceæ and Cycadaceæ are found. At Farm Cove, near Pillinger, beds contain fossil resin.

At the Henty River are lignite beds, with remains of leaves, *Fagus jonesii* (Johnston) and *Acacia meiringii* (Johnston).

(3) Basalt Lavas.

Towards and at the end of, the Palæogene, a great outpouring of basaltic lava took place in nearly all parts of

the island. This rock is the effusive expression of a gabroid magma. Its mineral components are lime-soda felspar and pyroxene, with or without olivine. It is here, however, usually olivine-bearing. The olivine mineral is extremely abundant in some varieties, generally in rounded or corroded crystals, but occasionally with perfect crystal form, as in the hyaline lavas of Sheffield. Every variety of structure and condition is represented. In some parts of the island the basalt is highly vesicular (*e.g.*, Conara, Benham Plains, Bothwell, Waratah, Hampshire, &c.). Tachylyte, or basalt glass, with a weathered crust of a beautiful blue colour, occurs at Richmond and Nietta. Columnar structure is common, as at Burnie and other places. On the North-West Coast the basalt occasionally assumes a limburgitic (felsparless) facies, as at Wynyard, on the Wilmot-road, south of Hamilton-on-Forth, and in a dyke on the Emu Bay railway-line, 7 miles from Burnie.

No cinder cones have been observed, but crateriform cones or plugs occur, *e.g.*, east of Lake Sorell, and on the Shannon Tier. The extensive basaltic sheets probably issued from fissures rather than from the more familiar cone vents. The lava choked the river valleys towards the close of the Palæogene, sealing up stanniferous and auriferous gravels, and protecting deep leads, which are now worked for gold and tin.

Some of the basalts belong to the alkaline division of igneous rocks, *e.g.*, at Table Cape, Shannon Tier, and at Sandy Bay, Hobart.

The coarse basalt which forms the promontory of Table Cape, a bold headland near Wynyard, rising 580 feet above sea-level, is composed of labradorite, augite, olivine, abundant apatite, and iron oxide with analcime. Nepheline has been identified in it by Prof. Rosenbusch, who considers that the rock belongs to the trachydolerite group. A similar basalt forms the promontory of the Nut, at Circular Head.

On the Shannon Tier are some small volcanic cones (Haystack, Beehive, Anthill) consisting of melilite-nepheline basalt, erupted through the diabase which crowns the tier. A coarse nepheline-augite rock is associated with the finer grained basalt, but both probably form a geological unit. The constituents of the basalt are nepheline, melilite, olivine, pyroxene, perovskite, apatite, and magnetite. Dr. F. P. Paul's analyses of this rock* are as follows:—

* Foyaitisch-Theralithische Gesteine aus Tasmanien. Dr. F. P. Paul, Vienna, 1906, p. 37.

	I.	II.	III.
SiO ₂	36·17	37·96	33·89
TiO ₂	2·15	2·93	0·64
Al ₂ O ₃	11·88	10·14	9·93
Fe ₂ O ₃	11·37	3·69	15·63
FeO	4·17	7·59	—
MgO	14·22	14·69	16·14
CaO	11·54	16·28	15·19
Na ₂ O	5·38	2·18	2·86
K ₂ O	2·07	0·69	—
H ₂ O	—	1·82	2·90
P ₂ O ₅	0·84	1·13	1·41
ZrO ₂	—	—	—
CO ₂	—	—	1·41
MnO	trace	0·22	—
Cr ₂ O ₃	—	0·08	—
V ₂ O ₅	—	0·05	—
NiO	—	0·04	—
SrO	—	0·05	—
BaO	—	0·06	—
SO ₃	—	0·03	—
S	—	0·04	—
Cl	—	—	—
	<hr/>	<hr/>	<hr/>
	99·79	100·13	100·00
	<hr/>	<hr/>	<hr/>
Specific gravity	3·147	3·150	3·04

One variety of the Shannon Tier rock has been determined by Dr. Paul as nepheline-eudialyte basalt, in which the mineral eudialyte takes the place of melilite as an essential constituent. Dr. Heidenreich's analysis of this rock is as follows:—*

SiO ₂	36·03
TiO ₂	1·13
ZrO ₂	0·21
Al ₂ O ₃	15·19
Fe ₂ O ₃	5·94
FeO	9·55
MnO	0·17
MgO	8·60
CaO	15·52
Na ₂ O	4·23
K ₂ O	1·85
P ₂ O ₅	1·38
Loss on ignition	0·58
	<hr/>
	100·38
	<hr/>
Specific gravity	3·079

* Dr. F. P. Paul, *ibid.*, p. 44.

A melilite-bearing nepheline basalt occurs at the Alexandra Battery, Sandy Bay, near Hobart. Its constituent minerals are nepheline, olivine, pyroxene, melilite, apatite, and magnetite. Dr. Paul has detected in it a little orthoclase and cossyrite. The iron olivine fayalite crystals are visible to the naked eye as red spots in the rock. An analysis of this rock by O. E. White and W. A. Macleod* gives its composition as follows:—

SiO ₂	47.21
Al ₂ O ₃	16.06
Fe ₂ O ₃	11.87
FeO	4.43
CaO	7.34
MgO	0.12
K ₂ O	2.40
Na ₂ O	7.51
Ignition loss	2.55
	99.49
Specific gravity	2.81

IX.—QUATERNARY.

This comprises the Pleistocene and Recent periods. The main topographical features of Tasmania during this era were essentially the same as exist to-day. There were the same mountain ranges, the river systems, the central plateau, the western highlands. Tasmania has remained insular throughout the era.

Since Pleistocene times the north-western part of Tasmania has apparently suffered an uplift relative to sea-level, evidenced by the existence of extensive elevated penepains. These are strikingly evident along the northern coast and in the west of the island, between the ocean and the West Coast range. The recent river systems, rejuvenated by the upward crustal movement, have deeply dissected the area, and seamed it with profound gorges.

Some further change of strand level has taken place subsequently, producing raised beaches on the northern coast and in the islands of the straits. Dune formation has been in progress along the coast lines; terrace drifts show the deepening of channels by existing streams; ossiferous cave breccias have been formed on the floors of caves and in fissures in the Ordovician limestone. Moraine material was transported into valleys by glaciers on the high ranges

* Notes on a Fayalite Basalt from One-Tree Point. Proc. Roy. Soc. Tas. 1898-1899, p. 78.

in the western and central parts of the island. Finally man appeared, and in the course of time, the indigenous race became extinct.

The Quaternary may be divided as follows, but in view of the difficulty of establishing a sequence, it would be unsafe to rely implicitly on the order of succession. Some of the events in the separate divisions may have been actually contemporaneous.

Recent—

- (6) River alluvium and sand dunes. Native shell beds.
- (5) Raised beaches.
- (4) Helicidæ sandstone.

Pleistocene—

- (3) Glacier indications in the Western highlands.
- (2) Cave deposits.
- (1) Pebble and terrace drifts.

Pleistocene.

The Pleistocene period in Tasmania, though not distinguishable by any remains of characteristic organic forms, shared with other countries the climatic features of a glacier epoch. Although Pleistocene glaciation affected the northern hemisphere more profoundly, it was nevertheless a world-wide phenomenon, and the southern hemisphere was not wholly exempt. Tasmania was not buried under a general ice sheet like that which covered Europe and America: no evidence has been discovered of any glaciation in the eastern part of the island, but glaciers unquestionably were developed in the highlands of the west where none exist to-day.

(1) *Pebble and Terrace Drifts.*

At different levels in the large river valleys, terraces of drift were formed which were cut down into later by the rivers as their channels deepened. These are relics of the flood plains of the past. Examples are present in the valleys of the Derwent, North and South Esk, and Gordon rivers. Drift beds of this age occur in various river valleys, containing pebbles of silicified coniferous and other wood, and relics from Palæogene leaf-beds.

(2) *Cave Deposits.*

In Pickett's cave, in the Chudleigh district, a number of sub-fossil bones have been found on the stalagmitic floor,

and in crevices of the Ordovician limestone. These belonged to existing species of kangaroo, kangaroo rat, wallaby, wombat, opossum, &c.

(3) *Glacial Deposits.*

Evidences of the Quaternary glaciation of the highlands are abundant on the mountains of the west and on the elevated plateau of north-western Tasmania. Glaciated rock surfaces can be traced on Mts. Tyndall and Sedgwick to near their summits. The lakes between the western ranges are bordered by moraines. On the western slopes of the West Coast Range numerous moraines occur. The township of Gormanston is on beds of glacial boulder clay of this age, which have been cut through by the Linda Creek. Sections of these beds are exposed in creek banks between the Gormanston Gap and the Linda township. Glacial deposits continue for miles down the valley of the King River. Erratics in the Mackintosh valley and the notable moraines on the Cradle Mountain and Barn Bluff plateau belong to the same age. The plateau between Mt. Pelion and Barn Bluff is characterised by the prevalence of low, rounded hummocks and numerous tarns or lakelets. On the slopes of Barn Bluff are lines of moraine ridges, and from here towards Granite Tor rolling hummocks still occur. Erratics and glaciated surfaces are features of the country round Lakes Dixon and Undine, and on the Frankland Range. On the west side of the Craycroft Range moraine material with large boulders occurs at a height of about 250 feet above sea-level. All round the promontory west of Farm Cove, Macquarie Harbour, moraine boulder material is present at sea-level. From the Denison Range an immense number of ice-borne conglomerate boulders have been carried down and spread over the valley of the Gordon River, and from their disposition with reference to existing topography it may be inferred that the glaciers were active in Quaternary times. The same conclusion may be drawn from the glacial deposits on the north-western plateau, which are well preserved, with fresh-looking rock scorings, and are evidently of an age subsequent to the establishment of the existing configuration of the country.

(4) *Helicidæ Sandstone.*

A shelly sandstone, consolidated dune sand, or arenaceous limestone occurs on most of the islands in Bass Straits (Cape Barren, Badger, Green, Chappell, and Kan-

garoo Islands) up to 100 feet above sea-level, resting in horizontal beds on the granite or older stratified rocks. Its organic remains are shells belonging to various living species of *Helix*, *Bithynella*, *Succinea*, *Pomatiopsis*, *Physa*, *Bittium*, *Truncatella*, &c. *Bithynella nitida* (Johnston) is doubtfully distinct from an existing form, and *Helix simsoniana* (Johnston), found in the white calcareous sandstone or limestone of Kent's group, is not known as a living species in Tasmania.

On Flinder's Island, 2 miles up the River Arthur, and 30 feet above sea-level, is an oyster bed with untravelled shells, suggestive of alteration of level.

(5) *Raised Beaches.*

These are on the same geological horizon as the *helicidæ* sandstone. They exist all along the northern coastline, and on the Straits Islands. Some of them on the latter underlie the consolidated sand dunes (*helicidæ* sandstone), and are found 40 or 50 feet above sea-level. Elevated beaches of marine shingle are seen at the mouths of the Blythe and Emu Rivers, and elsewhere, on the shore of Bass Straits. In the extreme south-west of the island, at Cox's Bight, the flat marsh land along the coast indicates a slight elevation of the country there within the recent period.

(6) *Native Shell Beds.*

Comminuted burnt shells are found in heaps and layers several feet thick at various points on the coast-line and on the shores of estuaries, associated with worked aboriginal flakes. These are the Kitchen middens of the extinct Tasmanian race, and are deposits of, perhaps, greater interest to the ethnologist than to the geologist. The last of this race (Truganini) died in Hobart in May, 1876. When and how woolly-haired negritoid man entered Tasmania is a debatable question. It has been generally supposed that he crossed from Australia before Bass Straits were formed, but if the last separation of the island from the mainland took place as far back as the Pliocene this supposition would involve a greater antiquity for man in Tasmania than is suggested by the insignificant tribal divisions and the superficial nature of the deposits in which remains of his handwork are found.

ORE-DEPOSITION.

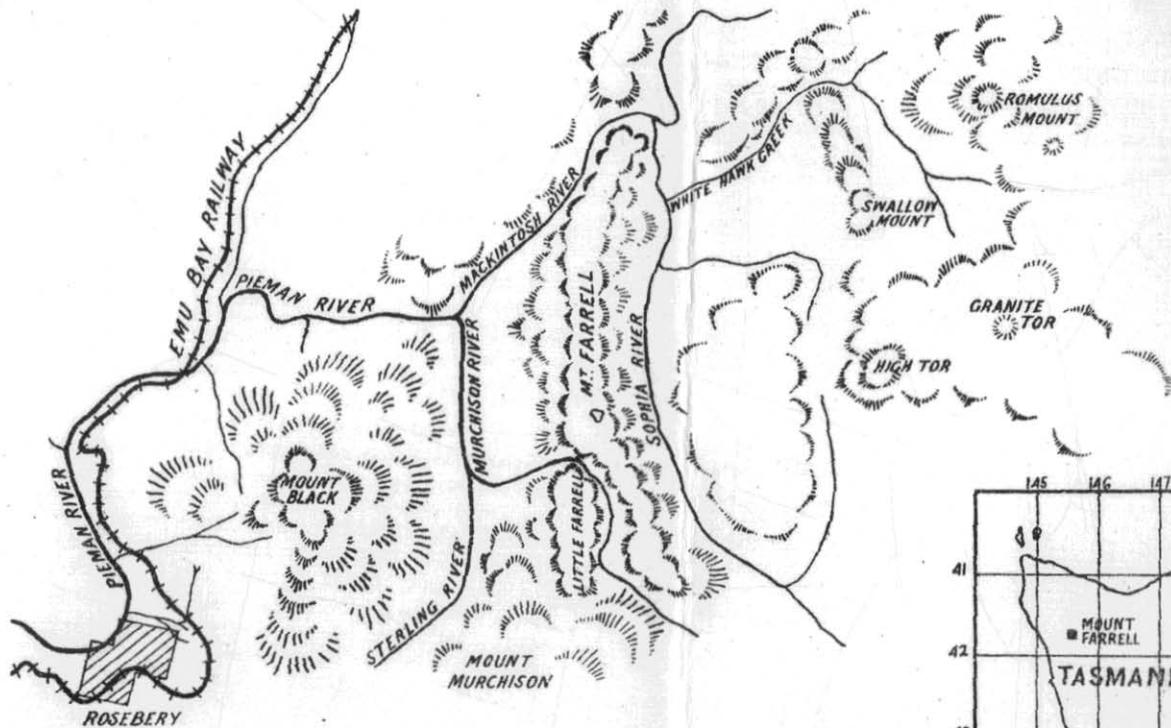
It is a question whether some ore-deposition (copper) is not connected with the porphyroid or granitic eruption of Cambrian age, but undeniably the period during which the deposition of most of our ores was active was the interval between the Upper Silurian and Permo-Carboniferous. Ore-deposition of this period was associated principally with the consolidation of the Devonian gabbroid and granite masses. Nickel sulphide and iridosmine owe their origin to serpentine at the Heazlewood, Trial Harbour, and Dundas. The granite magma is responsible for the silver-lead lodes at Zeehan, the tin and wolfram lodes all over the island, and for the gold quartz reefs of Beaconsfield, Lefroy, Mathinna, &c. A few barren quartz veins occur in the Permo-Carboniferous strata, but outside the exceptional alkaline porphyries at Port Cygnet, the chapter of metal-bearing lode action closed with the Devonian period. Within the term between the Cambrian and Devonian were deposited the great stores of mineral which the mining industry of Tasmania is now drawing upon. The mines of gold, silver, lead, copper, and tin rank among the famous mines of the world. When the small area of the island (26,000 square miles) is considered, her mineral wealth may be regarded as remarkable.

THE GEOLOGICAL SUCCESSION IN TASMANIA.

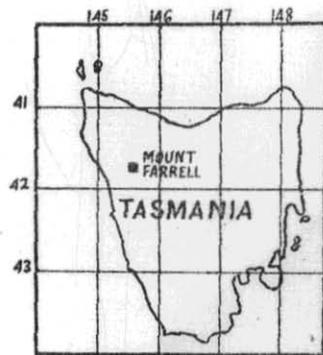
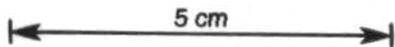
Group.	System.	<i>Representative Formations.</i>
QUATERNARY	RECENT	1. River alluvium and sand dunes. Native shell beds. 2. Raised beaches. 3. Helicidae sandstone of the Straits Islands
	PLEISTOCENE	4. Glacier indications in the western highlands 5. Cave deposits at Chudleigh 6. Pebble and terrace drifts
	NEOGENE	7. Terrace drifts and clays overlying basaltic lavas
TERTIARY	PALAEOGENE	8. Basalt lavas 9. Fluvatile and lacustrine clays and sands. Gold and tin ore drifts and deep leads. Lignitic clays and leaf beds 10. Marine beds at Wynyard, Montague, Cape Grim, and Heathy Valley, Flinders Island
	UPPER MESOZOIC	11. Diabase in intrusive masses, sills, or dykes
MESOZOIC	LOWER MESOZOIC	12. Fingal series or Upper Coal Measures 13. Ida Bay series. Sandstones and shales with coal at Ida Bay 14. Knocklofty series. Variegated sandstones with <i>Vertebraria indica</i> (Boyle), remains of heterocerat fish and amphibians

THE GEOLOGICAL SUCCESSION IN TASMANIA—continued.

Group	System.	Representative Formations.
PALAEOZOIC	PERMO-CARBONIFEROUS	<p>UPPER</p> <p>15. Elaeolite and alkali syenites, with various alkaline porphyries, at Port Cygnet and along D'Entrecasteaux Channel. (Precise age unsettled.)</p> <p>16. Southport sandstones and shales</p> <p>17. Mt. Cygnet and Adventure Bay sandstones and shales</p> <p>18. Upper Marine mudstones overlying Mersey coal: Porter Hill shales and sandstones, Sandy Bay</p> <p>19. Lower Coal Measures (= Greta horizon, New South Wales); Mersey Basin, Preolenna, Henty River; Tasmanite beds</p>
	DEVONIAN	<p>20. Conglomerates, grits, limestones, and Lower Marine mudstones throughout the south-east, north-east, north-west, and midlands; glacial conglomerates, grits, micaceous sandstones, and slaty flagstones in thick beds form the base of the system</p> <p>21. Granite, aplite, granite porphyry usually associated with previously consolidated gabbros and peridotites</p>
	SILURIAN	<p>22. Eldon Valley clay slates</p> <p>23. Fossiliferous limestone, sandstone, and slate at Zeehan, Heazlewood, Queen and Nelson Rivers, Lorinna, &c.</p>
	<p>ORDOVICIAN</p> <p>CAMBRIAN</p>	<p>24. Slate and sandstone in the goldfields of Lefroy, Mt. Victoria, Mathinna, Mangana, &c.</p> <p>25. Limestone on the Gordon, Florentine, and other rivers, at Railton, Mole Creek, Beaconsfield, &c.</p> <p>Insertae sedis {</p> <p>26. Dundas slates and breccias; the Dial Range and Leven slates, breccias, tuffs, and porphyroids; a similar series at Zeehan; the felspathic porphyries of Mts. Iyell, Jukes, Darwin, and the West Coast Range generally.</p> <p>27. Slate and sandstone at the Needles and in the neighbourhood of Mts. Mueller and Wedge</p> <p>28. Dikelocephalus sandstone at Caroline Creek and the Florentine Valley</p> <p>29. Discoidal sandstone in the Loddon River Valley and at Caroline Creek, near Dulverton</p> <p>30. Tubicular sandstone at Middlesex, Five-mile Rise, Mt. Claude, Lemonthyme Hill, Black Bluff, Zeehan, Loddon River Valley.</p> <p>31. Conglomerates, pebbly sandstone, and quartzite on the West Coast Range, Mt. Zeehan, the Thumbs, Denison Range, Railton, &c.</p>
PRE-CAMBRIAN	<p>ALGONKIAN</p> <p>ARCBÆAN</p>	<p>32. Amphibolites of the Rocky River; garnet-zoisite-amphibolites of Hamilton-on-Forth and the Collingwood River Valley</p> <p>33. Quartzitic, sericitic, graphitic, and argillaceous schists and schistose conglomerates of the Frenchman's Cap, Prince of Wales Range, Cox's Bight, Port Davey, Barn Bluff, Ulverstone and Forth, Rocky Cape, Long Plain, Asbestos Range</p> <p>Not yet found <i>in situ</i>.</p>



LOCALITY PLAN



E. K. Ward,
 Assistant Government Geologist.
 15. 2. 1908.

THE MOUNT FARRELL MINING FIELD.

[Four Plans.]

I.—INTRODUCTION.

(1)—GENERAL.

IN the Mt. Farrell mining district, with which this bulletin deals, the writer has been allotted, for purposes of geological examination, a field which has recently attracted no little public interest.

The district can hardly be said to be a new one. It is rather a field to which the prospector has returned with fresh vigour.

The North Mt. Farrell Mine has been exploited with ever-increasing energy, and its output has been materially increased within the last few months. The faith thus expressed in the future of that property has done much towards the general expansion of the mining industry throughout the district.

The favourable condition of the metal market during the year 1907 also materially aided the work of prospecting; and, as a result, during the early months of 1907 there were floated two new propositions on the southern side of the Murchison River, viz., the Tullah and Thomas' Blocks; also, the first-discovered silver-lead mine of the district, T. H. Farrell's old reward claim, was reopened under the name of the White Hawk.

Besides these properties, which are being actively prospected, there have also been discovered other occurrences of ore at both the northern and southern ends of the field. The future of these latter discoveries will depend very largely on the success of the present prospecting operations.

During my visit to the field two fresh finds were made; and this fact serves to indicate that the district is still receiving the active attention of prospectors.

The position of Mt. Farrell—at the northern end of a series of districts notable for their mineral wealth—is also such that additional interest is attached to its geological examination.

The attempt has been made to define the features common to these several districts, so that they may serve as an indication that, where they recur, prospecting work may reasonably be expected to meet with reward; and

this portion of the results of a geological examination must be that which is of more permanent value and wider interest. Special attention has therefore been given to the genesis of the lodes, the general types to which they conform, and their relation to the rock-formations of the district.

(2)—GEOGRAPHICAL POSITION.

Mt. Farrell is situated at the point where the Murchison and Mackintosh Rivers unite to form the Pieman River. The latter finds its outlet to the ocean on the western coast of the island.

Measured in a direct line, the mining field is 35 miles from the coast-line, and it is about 4 miles east of the Emu Bay Railway line.

Mt. Farrell is situated north and a few points eastward of the main West Coast range, of which the culminating peaks are known as Mts. Darwin, Jukes, Huxley, Owen, Lyell, Sedgewick, Tyndall, Read, and Murchison.

The metalliferous belt of the western coast is found to follow closely the trend of the mountain range. The mining fields have therefore a meridional trend; and Mt. Farrell is the most northerly of a series of districts in which copper, gold, silver-lead, and zinc are represented by their several ores. From its geographical position, therefore, the district of Mt. Farrell demands considerable attention.

The only means of communication at present is by the Emu Bay Railway line. A horse tramway connects with the railway at a point 21 miles south of Guildford Junction. However, there is now in course of construction a steam tramway, which, when completed, will materially shorten the present route to the Emu Bay Company's line, and provide a more efficient means of transport to the mining township.

II.—PREVIOUS REPORTS ON THE FIELD.

The first occasion on which an official visit was paid to the field was in the early part of the year 1895, when Mr. A. Montgomery, then Government Geologist, passed through the northern portion of the district, and visited the properties now known as the Tullibardine and the White Hawk Mines.

It was Mr. Montgomery who gave the name of Mt. Farrell to the "rugged rocky range" (up to that time unrecorded), as a tribute to the undaunted endurance of the pioneer prospector of the district—T. H. Farrell.

At the time of Mr. Montgomery's visit no mineral discoveries had been made on the slopes of Mt. Farrell itself.

The report, therefore, of that gentleman on the area contains only his notes on the two properties above mentioned, and some short references to the general geology of the district.

In June, 1900, Mr. Twelvetrees made a short inspection of the district and the mines which were at that time in active operation. His visit was of only one week's duration, and necessarily too brief to admit of any detailed examination of the geology of the area. This report, which contains detailed accounts of the condition of the several mines at that period, is dated from the Government Geologist's Office, on 20th December, 1900.

The next visit paid to Mt. Farrell by a member of the geological survey staff was in March, 1904, when Mr. G. A. Waller made a brief examination. Mr. Waller's remarks on the general geology of the district are of great value, on account of his intimate acquaintance with the geology of the other mining fields of the West Coast range.

Mr. Waller draws attention to the fact that at Mt. Farrell there are found members of the same rock types as occur along the main axis of the West Coast range in an unbroken line from Mt. Darwin northwards. He suggests that the schistose igneous rocks of the district be termed "porphyroids," after the strikingly similar schistose porphyries of Europe. Of this matter more will be said later, when the rocks are treated of.

With regard to the massive conglomerate which forms the main mass of the ridge of Mt. Farrell itself, Mr. Waller's remarks are of particular interest. This formation has been studied by him in several localities on the West Coast, and he concludes that it should be referred to the base of the Upper Silurian. Formerly, it had been considered that the conglomerate was of Devonian age. Of this, also, further mention will be made in a later portion of this report.

III.—PHYSIOGRAPHY.

(1)—TOPOGRAPHY.

The topography of the area is due primarily to the forces which have tilted up the strata to high angles, and secondarily to the natural denuding agencies which have developed the rugged outlines of the surface.

The ridge known as Mt. Farrell is long and very narrow, and owes its character to the nature of the central hard band of siliceous conglomerate. This weather-resisting formation rises at the top of the mountain abruptly from the softer rocks with which it is in contact to a maximum height of about 1600 feet above the junction of the Mackintosh and Murchison Rivers.

The outlines of the surrounding heights are different. Mt. Black, to the west, has well-rounded outlines, and the spurs spread out into the valleys on all sides. Mt. Murchison, which towers above all the surrounding country, shows a series of abrupt cliff faces, with long-graded slopes stretching away on either side.

To the west of the Mt. Farrell ridge lies a broad alluvial plain, which runs back far up the valley of the Sterling River, which occupies the depression between Mt. Murchison and Mt. Black. Its northward continuation is the valley of the Mackintosh River, which joins the Murchison at Mt. Farrell, and flows away westward towards the coast as the Pieman River.

Again, on the eastern side of the Mt. Farrell razor-backed ridge, lies a broad flood-plain—that of the Sophia River—which gathers in the waters of the White Hawk Creek, and joins the Mackintosh River at the northern extremity of Mt. Farrell.

The Murchison River differs from these other rivers in that it has cut its way right through the conglomerate ridge, and now makes its way north and west to join the Mackintosh a little below its junction with the Stirling.

The area drained by these rivers is very considerable, and they are never dry, although the variations in the amount of water passing along their channels are considerable with the seasonal changes.

At Mt. Farrell the average river level is a little over 100 feet below the flat surface of the button-grass plain which marks the old level of the flood-plain.

The region has been elevated since the establishment of this flood-plain, and the river systems are still actively engaged in once more cutting down their beds to the base level of corrosion.

The ancient flood-plain of the Mackintosh River affords some evidence to prove that the uplifting of the region was not effected by one simple movement, for there are still traces of two river terraces left in the undenuded river wash at a point a little north of the town, and west of the Mackintosh Mine.

On the steep banks, also, of the White Hawk Creek, above the old workings of T. H. Farrell, there are terraces of this old river wash.

This elevation of the country is not restricted to the particular region in question, for there are raised beaches at several points on the West Coast. At Strahan, the Tertiary beds are known to form raised beaches, and numerous terraces of gravel are recorded. Mr. Montgomery, in his report on the Corinna Goldfield in 1894, claims that these gravels are of marine origin. However, whether of fluvial or marine origin, the present elevated position of these gravels is indisputable proof of elevation. It may be that the period of this upward readjustment was Post-Tertiary, and followed upon a Tertiary subsidence. Raised beaches of recent sediments have been recorded at Cox's Bight by Mr. Twelvetrees,* and it may be that some parts of the western portion of Tasmania are still undergoing elevation.

The age of the alteration of level in the Mt. Farrell area is not to be definitely determined from the evidence now available.

There is some evidence in the district which may be regarded as indicative of glaciation. In the neighbourhood of the White Hawk Mine there are very large rounded boulders of granite to be seen. These have been undoubtedly derived from the Granite Tor mass, but are now some miles distant from their source. They may possibly have been rounded in beds of the mountain torrents, but they now occur stranded high above the present creek beds. I noticed several on the flanks of Mt. Swallow, 1000 feet above the level of the White Hawk Creek bed at the mine.

These boulders certainly have the appearance of glacial erratics, but no other of the phenomena usually to be seen in glaciated areas were noticeable.

Mr. R. M. Johnston, in his paper entitled "The Glacier Epoch of Australasia,"† correlates the evidence of these boulders with that of the moraines, roches moutonnées, &c., of many other places to prove a former glaciation of the western highlands of Tasmania.

Taken in conjunction with other evidence, it may be admitted that these rounded boulders are true glacial erratics, and that the region has been subjected to ice action, yet the topography of the area has not been

* Report on Cox's Bight Tinfeld, December, 1906.

† Royal Society of Tasmania, 1893.

seriously modified by such ice action. If other traces of glaciation were impressed upon the district they have since been obliterated by the action of other surface agencies, unless perhaps Lake Herbert represents a rock basin gouged out by the ice action.

The topography, therefore, of the Mt. Farrell district as a whole is that of an elevated region in which the erosion cycle has once reached maturity, but of which the features are now suffering a more rapid alteration, for a comparatively recent alteration has taken place in the general level of the district, and in consequence the river systems have been rejuvenated.

(2)—METEOROLOGY.

The rainfall at Mt. Farrell is undoubtedly very heavy, although no statistics can be adduced to give an idea of the actual amount of precipitation. The following figures, taken from Walch's Tasmanian almanacs, show the total rainfall for a period of 12 months at some of the principal points on the West Coast of Tasmania.

Mt. Read is quite close to Mt. Farrell, but its elevation is considerably greater.

Total Rainfall 1st October to 30th September.

	1899-1900	1900-1901	1901-1902	1902-1903	1906-1907
Mt. Read	—	—	77·91	83·61	126·95
Zeehan	101·33	106·00	94·50	105·31	100·33
Mt. Lyell	94·48	131·20	114·53	118·71	117·23
Waratah	88·03	90·33	73·3	94·48	109·40

The township of Mt. Farrell is said to possess a milder climate, and a drier one, than other spots on the West Coast, on account of its sheltered position. Nevertheless, the annual rainfall is considerable, and is not very evenly distributed. The winter and spring are said to be the wettest seasons, while from the middle of December until March fairly fine weather is prevalent.

Of this rainfall, during the rainy seasons by far the greater proportion must run off the steep surface slopes to the rivers. The snow that caps the highest peaks lingers for a time, and then augments the supply of water to the mountain torrents.

Some small proportion of the rainfall must be held continuously by the surface mantle of soil and peaty growth. The so-called "button-grass" plains and slopes retain their

dampness long after the rain has ceased by the action of this vegetable growth; otherwise, the return of the rain to the rivers is rapid, and the rise of a river is to be noted almost instantly after the rain has been observed to fall.

This heavy rainfall on a country of steep slope must necessarily cause a very considerable amount of rock-waste to be carried away downhill to the rivers, and prevent the accumulation *in situ* of any weathered rock-masses. The only retarding agent tending to arrest this downhill movement is the dense vegetation of the district, which exerts a strong binding influence on the surface-mantle of soil; and in the case of the button-grass growth, the whole of the underlying material is covered and protected from the denuding agents.

On the western slopes of Mt. Farrell the whole surface-soil can be seen to be creeping downhill where sections of the surface-soil are exposed by the numerous trenches cut there. The cleavage planes of the slates, which dip to the west in the undisturbed ground a foot or two below the surface, are seen at the surface dipping to the east. The slate is soft and cleavable, and it has been pushed so far by the general soil-creep that the dip of its cleavage planes is inverted.

(3)—THE EFFECT OF THE TOPOGRAPHIC FEATURES ON MINING.

Prospecting and Exploitation.—On the whole, the topography of the district may be said to be very favourable to the exploitation of the mineral belt. The steep grade of the western slopes of Mt. Farrell along which the mineral belt runs has indeed prevented the accumulation of the rich gossanous material which often caps the silver-lead lodes of other mining fields. In fact the downward soil-creep has in many cases quite covered up all traces of an outcrop, although the lode lies only a few feet below the present surface.

But the creeping surface-soil forms only a very shallow layer, since it is removed almost as soon as it forms, so the prospector has not much overburden to remove in most cases when trenching for the lodes.

The creeks cut across the country on these western lodes, and have therefore aided the prospecting of the main portion of the field very considerably.

On the other hand, on the south side of the Murchison River, the streams, on the whole, flow in a more northerly direction as they leave the northern slopes of Mt. Murchison, and run with the strata, rather than across; yet the

Tullah lode was picked up in a stream flowing westward from the slopes of Little Farrell.

Both the White Hawk Mine and the Tullibardine owe their discovery to the existence of these natural sections afforded by the creeks.

The Murchison River itself has cut across the rock-formations and laid bare several occurrences of ore, both of lead and of copper, to which reference will be made later.

Once located, the lodes have been readily exploited by adits driven into the sides of the mount; and these adits, driven towards the central core of the mountain, are usually nearly at right-angles to the strike of the lodes. The north Mt. Farrell Company owes the discovery of its "No. 1 lode" to its lowest level adit, which intersected this body of ore, which does not extend upwards as far as the surface. In fact, the aid afforded to mining by the physical configuration of the country will be apparent when it is remembered that there is not a shaft on the field that serves for the raising of ore to the surface.

Water-supply.—The narrowness of the ridge at the top of Mt. Farrell, and the steepness of the slopes, cause one serious drawback. In consequence of the small area exposed, and the rapidity with which atmospheric moisture leaves the mountain sides, the rainfall, heavy though it is, is, on the whole, insufficient to supply the needs of a mining community of the size of Mt. Farrell, if dependence is to be put only upon the rainfall on the western slopes of the mount.

At the present time there are only two concentrating mills on the field, and of these one is inactive.

The North Mt. Farrell Company's mill is supplied with water issuing from the underground workings of its own mine, and the Mackintosh; but this is inconsiderable in amount. The supply is augmented by a pipe-line that has been constructed to the top of the mount to carry down the waters of the small lake on the southern crest of the ridge. This lake is of small extent, covering only 10 acres, and its catchment area is also small, so that the present demands on its contents are all that can be met. The dry season of the year, for about three months after Christmas time, renders this lake supply a doubtful one for a plant in continuous action.

Races are cut to tap the several streams on the mountain side, but these, too, are apt to fail in the dry season, and the water from underground alone is left.

As regards the mines situated away from the Mt. Farrell ridge: On the south side of the Murchison River

no concentrating is being done at the present time. In the event of developments underground warranting a milling plant, the machinery site will undoubtedly be chosen on the banks of the river. And indeed any concentrating mill of the future will need to be built on the river banks or in immediate proximity thereto.

As regards the White Hawk and Tullibardine properties, the water-supply offers no difficulty, should operations at these mines create the demand.

Power.—The configuration of the country is such that, were the quantity of water sufficient, all necessary machinery could be actuated by hydraulic power.

The North Mt. Farrell Mine utilizes its lake supply to drive a 9-foot Pelton wheel, and generates thus a part of the power necessary for driving the concentrating machinery. The lake supply is conveyed from the syphon by pipes and races to the top of the ridge, and thence descends direct in a pipe to the mill. At present this pipe is not full to the top, so that the available head could not be ascertained. A reservoir chamber is needed at the top of the ridge of such capacity that it can carry enough water to maintain a full head for the two shifts during which the mill is running.

The White Hawk Mine is very favourably situated as regards both water-supply and the available head at which it could be delivered with small expense, for the White Hawk Creek drains a large area of country and descends to the mine by a very steeply-graded gorge with several waterfalls.

IV.—GENERAL GEOLOGY.

(1)—THE ROCK TYPES REPRESENTED ON THE MT. FARRELL FIELD.

The various rock formations which require description will be treated of under three heads—

- (a) The igneous rocks.
- (b) The sedimentary rocks.
- (c) The metamorphic rocks.

A.—THE IGNEOUS ROCKS.

There are several groups of igneous rocks on the field, each of which must be looked at separately.

(1).—*The Porphyries and their Associates.*

The first group to be considered is the acid-intermediate series, of which so many different facies are present. These are all gradations from the granitoid varieties

south-east of the main ridge of Mt. Farrell, to the porphyries and felsitic types further westward. On consideration of the many features shared in common by all these types, I feel convinced that they are to be taken together as one geological group.

The Holocrystalline Types.—The track from Mt. Farrell along the eastern bank of the Murchison River to the sections in the south-east affords several exposures of a medium-grained basic granite, or syenite, which merges by insensible gradations into a green porphyritic felsite, to be described later.

This syenite—showing to the naked eye equidimensional constituent crystals of dark-green biotite mica and hornblende, pink orthoclase felspar, and the pale greenish feldspathic mineral, with an indistinct cleavage—appears like a granite, but the poverty of quartz in the rock is plainly apparent.

Microscopically the rock appears to be a fairly normal syenite, altered by dynamical stresses and masked by reconstitution. The hornblende still remains here and there in idiomorphic crystals, but most of it is altered, and its place taken by chlorite and epidote. The same alterations have taken place in the case of the biotite. In one section I noticed a mineral which appeared to have been augite, but was almost wholly altered into chlorite.

The felspars are clouded by kaolinization, and the plagioclase more so than the orthoclase. The latter has a faint reddish tinge in thin sections. As regards the exact member of the plagioclase series present, I was unable, through the decomposition of the rock, to obtain satisfactory extinction angles.

Quartz is present here and there in graphic intergrowth with the orthoclase. Apatite is common in stout unaltered idiomorphic crystals.

In crystallization, the plagioclase seems to have preceded the hornblende, while the orthoclase was subsequent to it.

The crushing has subjected all the minerals to a state of strain, and has even produced actual fracturing in many cases. Where the minerals have withstood crushing without actual rupture, and where they remain sufficiently undecomposed, their extinction is "shadowy" or "wavy."

These rocks are found in the southern and south-eastern portions of the field, at the Osborne Blocks, and at Kitson's. On the Section 2940, in the name of H. J. Kelly, a variety occurs that may be termed a true granite, from the greater prevalence of quartz.

The Felsitic and Porphyritic Types.—Intercalated with the sedimentary rocks all through the district are a series of porphyritic rocks which appear to me to correspond in general composition to the holocrystalline members above described, but to have consolidated under different physical conditions. By a series of chemical analyses this matter could be settled, but in the meantime the question cannot be definitely decided.

The southern portion of the field will, by reference to the geological map, be seen to consist very largely of these rocks, which form broad zones or very narrow bands in the slate.

From point to point their mineralogical constitution can be seen to alter even in the same continuous belt of rock. A felspar porphyry thus can be traced into a quartz porphyry or into a fine-grained felsitic rock wherein no crystals can be distinguished by the unassisted eye, and the texture is quite homogenous.

Variations in the structure are equally gradual. The uncrushed rocks are comparatively easily distinguished without microscopic aid, but in the field these simple types are found to merge into the schistose varieties so gradually that no divisional line can be drawn between the crushed and uncrushed portions; and uncrushed blocks of irregular lens-like shapes occur, quite surrounded by the crushed types.

Again, in the field one is often in doubt as to whether the cleavable schist under observation belongs to the igneous series, or whether it is a variant of the associated sedimentary rocks. In such cases the weathered surfaces of the schist afford some information, since the quartz crystals of the rocks, which were originally unmodified quartz porphyries, often resist the weathering agents that gradually disintegrate the rest of the rock, and so stand out in relief. In this way I found several doubly-terminated quartz crystals left in relief on weathered faces or edges.

By weathering these rocks have their appearance considerably altered in most cases. The aspect of the massive varieties is least affected, and the surfaces are clean and smooth where there is no surface-soil above. At one point, on Section 2864, the progress of weathering on the massive rock, which has an elaborate system of small joint planes developed in it, has produced a rude spheroidal structure.

In some localities, notably near the mouth of No. 4 tunnel on the North Mt. Farrell Mine, and a little to the

east of the Langdon Mine, the rock weathers to a honey-combed aggregate, which has all the appearance of a lava with its vesicular cavities caused by the expansion of imprisoned gases at the moment of solidification. Some specimens were so full of these cavities as to resemble a pumice.

It is on evidence such as this that the conditions under which the rocks solidified are to be determined. That is to say, it is possible to judge whether these felsites and porphyries were true *effusive* rocks which poured out on the surface as lava flows, or whether they were *intrusive* rocks which forced their way between the other rocks which were already formed, by the observation of these peculiarities.

By the microscope it can be shown that these felspar porphyries near the North Mt. Farrell workings carry filled vesicular cavities. These are apparent on weathering as empty elongated spaces. The unweathered rocks show in this section these vesicles filled with calcite chlorite, and often a layer of chalcedonic silica.

The vesicles thus filled are considerably elongated, but always in one general direction. This evidence, when taken together with that of the presence of fragmental igneous rocks (to be described later), seems to me to point with certainty to the existence of volcanic action within but a short time of the period of sedimentation, during which the slates were formed.

None of these vesicular rocks were observed to the east of the slate series. They are always on the western side; and on Section 3263 at least the igneous rock was clearly intrusive into the slate, for tongues of the igneous rock can be seen protruding into the slate.

The western boundary of the slates would therefore seem to have been, in all probability, on the horizon of the former surface. The original surface is now tilted to a high angle by subsequent warping.

The effusive rocks which poured out on this surface would then be the surface representatives of the plutonic syenites and granites, and the intrusive porphyries.

A further sign of rapid cooling, such as would take place at the surface, was noticeable in the rocks close to the horizon of the tuff. In one thin section the microscope reveals a ground-mass of extremely fine grain, showing a considerable number of roughly concentric cloudy markings. These are, in my opinion, caused by the progress of weathering along the perlitic cracks caused by

the rapid cooling of a rock, once glassy, but since devitrified.

The schistose varieties of this igneous series weather to a grey rock with a very rough surface, especially where the edges of the planes of schistosity are exposed. The uneven hardness and resistance to solution are the causes of the rough surface, and on these weathered edges it is sometimes possible to distinguish uncrushed idiomorphic crystals of quartz.

One feature of some persistence, and especially noticeable wherever the schistose igneous rocks are found, is the occurrence of very numerous veinlets of quartz traversing the members of this series in every direction. The quartz is often coloured pink, and the veins consist in many instances of small crystals, whose longer axes are at right-angles to the length of these numerous intersecting cracks. The width of these veins of crystalline and massive quartz is small, the great majority being under half an inch wide, and very seldom are veins of over an inch wide. The silica has not been deposited solely in the veins, for it has in many instances thoroughly impregnated the rock, and caused it to assume the character of a chert.

This silicification, which is evidently of later origin than the rocks in which it forms so prominent a feature, took place after the main crushing of the region had been effected. For the veinlets are usually undisturbed in the schistose varieties of the porphyries. It is true that there are several occurrences of the fracturing and contortion of these veins, and in some cases I found the quartz crystals of the vein-filling deformed by a movement of the walls to which they are attached. However, these cases are exceptional. The elaborate fracturing of the porphyries may have been caused by the crushing forces which induced the schistosity, but the filling of the fractures with silica was for the most part of later date.

Microscopically these rocks show many features of interest, and of value in determining their relationships.

The massive porphyries display best the original mineral constitution of these rocks, for the development of the schistose structure has been attended by a reorganization of the molecules, and the original character is very largely masked.

The phenocrysts most common in the least altered types are of quartz and plagioclase felspar. Orthoclase felspar is present but not common, and of the plagioclase series the more acidic members are the ones commonly found.

Sericitization and mechanical deformation have in many cases made it impossible to determine the feldspar which is present. But the low values for the extinction angles, when measured from the albitic lamellæ, render it clear that the plagioclastic feldspars are commonly of the composition of oligoclase. Secondary albite is often present in small clear crystals in the reconstituted ground-mass.

The orthoclase is more frequent where quartz is present in addition to the feldspathic phenocrysts.

In no cases are the feldspars quite fresh, and they are frequently almost completely replaced by sericite or a quartz-albite aggregate.

The quartz appears sometimes with its crystal outlines well developed, but has more usually suffered corrosion by the magma, and has its boundaries embayed. Very seldom is the quartz free from the "shadowy" extinction consequent upon a state of strain.

Ferromagnesian minerals are rare, and never free from alteration; but in one specimen collected from near the Tullah town-side there was well defined hornblende only slightly chloritized. I also noticed a mineral, which may have been a pyroxene, present in the feldspar porphyry of the Langdon section. In a few slides there are chloritized remains of a mineral which seems to have been biotite before its alteration.

Epidote is common all through the series, and is usually to be seen in granular aggregates.

The ground-mass is sometimes little altered, and is a fine-grained micro-felsitic aggregate, which has corroded its way into the phenocrysts.

There is no visible sign of fluxion, save for a slight tendency of the feldspars to arrange themselves with their longer axes in one general direction. The quartz phenocrysts, being more equidimensional, do not exhibit any such tendency. The proportion of phenocrysts to ground-mass is very variable.

The crushed varieties of these rocks are clearly of this group as regards origin, when seen in thin sections, however widely their microscopic characters may vary from those of the typical porphyries.

The chief variation introduced by the crushing is the development of a wavy banding throughout the rock. This closely resembles the fluxion structure often visible in this class of rocks, due to a movement of the magma during the process of crystallization. Here, however, the uncrushed types show no such fluxion structure in any of the thin sections prepared for examination, and the

banding is, in my opinion, of later date than the solidification, and due to dynamic stresses.

In the much-crushed types the phenocrysts have been shattered, and the fragments drawn out into *augen*, or they show signs in polarized light of being in a condition of considerable physical strain. The ground-mass becomes entirely changed into a quartz-albite-sericite aggregate, in which the sericite is strung out in wavy zones, and in some varieties a considerable amount of calcite is present in addition.

Chlorite is also common, especially in the rocks associated with the holocrystalline varieties at the Osborne Blocks and near Kittson's. It is sufficiently abundant to impart a deep green tint to the rock, which resembles anything but a quartz porphyry to the unaided eye. The chlorite in thin sections is strongly coloured, and is extended in wavy lines in much the same way as the sericite of other varieties.

Summing up the evidence collected with regard to these rocks, we may say that they all belong to one series of intrusives and effusives.

Their mineral composition indicates that they are not, in very many cases at least, typical quartz porphyries and feldspar porphyries, but rather quartz keratophyres and keratophyres; for there is an almost constant predominance of the sodic over the potassic feldspars.

With the description given here of the rocks of Mt. Farrell it will be interesting to compare the notes of Messrs. W. H. Twelvetrees and W. F. Petterd on "The Felsites and Associated Rocks of Mt. Read and Vicinity."*

Many of the rocks there described are identical with those from the Mt. Farrell district—occurring, as they do, in one continuous belt with these.

The crushed varieties of these keratophyres may well be termed "porphyroids," since they correspond in all respects to the rocks originally thus named in Germany. In fact, Professor Rosenbusch, the eminent petrologist, after examining some of the rocks of Mt. Read, has written:—†

"Undoubtedly we have here strongly dynamically altered forms of the acid eruptive rocks. The typical porphyritic structure, the nature of the phenocrysts, the still-recognisable fluidal structure, the nearly entire absence of dark constituents, the occasional spherulitic

* Proc. Roy. Soc. Tas., 1898-9, pp. 33-46.

† *Ibid.*, p. 43.

forms still recognisable in their replacement products (quartz, albite), all point with certainty to members of the quartz porphyry family, and, with great probability, not to quartz porphyry in the narrower sense, but to quartz keratophyre and keratophyre. . . . The rocks greatly resemble our German occurrences in Westphalia, the Fichtelgebirge, and Thüringen, and especially the occurrence in Wales. These are the forms which in Germany were originally called porphyroids and flaserporphyries."

Mr. Waller, in his report of 1904, proposed the term "porphyroid" for the schistose rocks of this series. It has been adopted, to some degree, by the mining community, but is used quite without discrimination. The present detailed description of the schistose porphyries has been given in order to give a greater degree of definition to the term "porphyroid," and to indicate clearly the exact meaning of this word, which is used in the later portion of this bulletin. The rock is an important one in the Mt. Farrell mining field, and with the slates forms the common country rock of the lodes. Associated here and there with the green quartz porphyries of the Osborne Blocks are types which seem to be only variants from the rocks of this series, yet which are remarkable for the presence of actinolite.

One of these, from Section 2145, on the western side of the Murchison River, was examined microscopically, and proved to be an actinolite rock.

The actinolite showed tints varying from pale yellow to pale brown and pale green. Beyond the actinolite, which occurs in the form of allotriomorphic crystals or radiating bunches, there is only scattered iron ore and a sporadic prism or two of epidote.

The relation of such a rock to the more acidic members of the series is not clear, especially as no information was to be gained from the field occurrence. It may be that this type is merely a more basic segregation from the normal magma; but such a suggestion can be little more than a speculation in the present state of our knowledge of the district. The outcrop whence the described specimen was obtained was in proximity to the workings marked in the map. Hence it is possible that the actinolite is due to a local alteration of the quartz felsite by the agency of mineral-bearing solutions. And in this connection it may be mentioned here that coarse actinolite accompanies the occurrence of galena some distance to the south, on Section 2865.

The Fragmental Types.—On the extreme western flank of Mt. Farrell, at a point near the south-western corner of the northern section of the Mt. Farrell Company's leases, is a very remarkable rock, which appears to be an altered volcanic tuff. It is in immediate contact with the felspar porphyry which shows the vesicular cavities filled with chlorite calcite and chalcedony referred to above, but the actual junction could not be traced on account of the surface cover. The western continuation of this rock is entirely covered by the button-grass plain at the foot of the mount.

In appearance the rock is, on the whole, deep green in colour, but with grey and reddish blotches irregularly distributed. The varying splashes of colour are due to angular fragments, which are of different composition—some chalcedonic, others apparently fragments of the pink-coloured uncrushed porphyries.

At the junction of the Mackintosh and Murchison Rivers, still further to the west, a very similar rock is to be seen here and there; and the tramway cuttings afford sections which show that the fragmental varieties pass by quite insensible gradations into the massive porphyroid. We may look upon them as the fragmental porphyroids, or "clasto-porphyroids."

With microscopic aid it is still more apparent that these rocks are certainly fragmental, and yet possess many features in common with the other porphyroids.

The felspar crystals embedded in its mass are very considerably altered, with a great development of kaolin and epidote. In some the original crystal is replaced by an albite-epidote mosaic, with more or less silica and calcite in addition. The interstices between these altered crystals are filled with a mixture of chlorite, epidote, calcite, and kaolin.

In one slide there was visible an angular fragment of a glassy igneous rock. This piece seems to me to afford certain evidence of the shattering of an effusive rock by volcanic action. The glassy fragment is stained pale brownish by decomposition, but still shows a number of clear microlites possessing a straight extinction; and it possesses, in addition, a well-developed perlitic structure, which has been accentuated by the progress of weathering.

(2)—*The Granite Porphyry of White Hawk Creek.*

The sedimentary rocks of the White Hawk district—sandstone, limestone, and pebbly grit—have interbedded with them a dyke rock, which is a true "microgranite," or "granite porphyry."

It forms a broad dyke, which dips westward with the sedimentary rocks and outcrops on the eastern boundary of the leases.

The rock has a felsitic ground-mass, which is sometimes pink, sometimes green, and in which the porphyritic crystals of quartz felspar and biotite are set.

It is clear that considerable alteration has taken place since the rock first solidified—even to the naked eye. There is a considerable development of chlorite, by which in some cases the ground-mass, in others the felspars, are almost replaced by the secondary green mineral.

Where undecomposed the felspars are fairly large and pink.

Microscopically it is a typical microgranite, which is free from the effects of dynamic metamorphism, but altered by weathering. The ground-mass is a fine granular aggregate of quartz and orthoclase, in which are phenocrysts of quartz, biotite, orthoclase, and plagioclase.

The quartz has suffered considerable corrosion by the magma, and its borders are ragged, and sometimes deeply embayed. The felspars are also corroded, but not to the same degree as the quartz. The biotite shows usually its crystal outlines, and basal sections appear as cleanly cut hexagonal plates.

Decomposition has altered the biotite almost completely into chlorite—sometimes massive in form, at other times in tufted radiating aggregates.

The felspars are kaolinised or sericitized, and in some cases the decomposition has been attended by the introduction of iron and magnesium, and finely-divided chlorite penetrates the crystals. Epidote is present in small amount.

All through the ground-mass there is finely-divided chlorite, which imparts the prevalent green colour to the rock. The definite determination of the felspars is difficult, inasmuch as their alteration leaves little more than bare traces of original structure in most cases. They are quite commonly zoned, and both single and multiple twinning are still recognizable.

Whether this microgranite belongs in origin to the magma which has produced the plutonic mass of Granite Tor, or whether it is another variety of the series above described, cannot be determined from its mode of occurrence.

It lies in position between the two varieties of the igneous rocks, and nearer to the granite on the east.

The great distinction between members of the two groups is that the series already described all show more or less the effect of crustal movement.

Yet in the White Hawk area all of the rocks are noticeable for a freedom from the signs of mechanical deformation in a district of such considerable disturbance.

In age there is but little difference between the two groups of igneous rocks, so that the relative progress of decomposition is not of value as a criterion in distinguishing them.

The granite porphyry here described is quite uncrushed, the alterations that have been effected being simply the result of the work of surface agencies.

(3)—*The Granite of Granite Tor.*

On passing up the valley of the Mackintosh to the northward, an examination of the river gravels shows an ever-increasing proportion of pebbles of a holocrystalline rock quite different in type from the syenitic granite above described as occurring with the porphyries.

This other is a typical coarse-grained acidic granite in most specimens. Both muscovite and biotite micas are usually present, but some varieties show an almost complete absence of biotite and abundant silvery-white muscovite. The rock is coarser in grain than the syenitic granite of the Osborne Blocks, and often carries porphyritic crystals of orthoclase as much as an inch and a half in length.

This is the rock which occurs *in situ* at Granite Tor, and which has many features in common with all the other tin-bearing granites of Tasmania. Tin is reported to have been derived from this granite also.

Microscopically viewed, the rock is perfectly free from all signs of dynamic metamorphism.

The felspars, both orthoclase and plagioclase, are in a fair state of preservation, and only kaolin has resulted from their alteration. Their crystal outlines are well defined, and they have clearly preceded the quartz in crystallization. Muscovite and biotite are abundant, and the latter is sometimes chloritized.

This plutonic mass of granite appears to dip underneath the mica schists on its western border, and probably is connected in depth below the Mt. Farrell field with the other granitic outcrops of Mt. Heemskirk and the Meredith Range.

(4)—*The Diabase Pebbles.*

Among the pebbles which constitute the beds of the Murchison River and tributaries are some well-rounded ones of medium-grained diabase. This rock does not appear anywhere in the district *in situ*, and the pebbles must have travelled many miles from the eastward mountains by the agency of the surface-streams, and perhaps to some extent of glaciers. They are frequent in the pebble beds of the modern streams and in the older river deposits intersected by present streams or exposed by mining operations.

The diabase is known to occur *in situ* at Barn Bluff and at the Eldon Range, from both of which waters now flow westward by the valley of the Murchison; so these pebbles are probably derived thence, and have reached their present position by the transporting agency of the steep-graded streams.

B.—THE SEDIMENTARY ROCKS.

(1) *The Slate and Associated Crushed Grit and Conglomerate.*

These form the main sedimentary series of the central portion of the mining field; and although the lodes are not confined to the zones in which they are found, yet the productive lodes at the present time are situated in these old fragmental rocks.

There are all gradations—from the conglomerates, against which the harder and massive conglomerate of the central ridge of Mt. Farrell abuts, to the fine-grained slates further to the west. The grain is coarser on the eastern side of the belt than on the western.

The coarse varieties are easily recognised by their rounded pebbles of quartz, many of which have resisted the crushing forces. Some of the pebbles are drawn out into "eyes," and the whole rock structure is altered. The crushed grits of grain intermediate between that of the conglomerates and the true slates are at times very difficult to distinguish from the porphyroid, especially from the more markedly schistose varieties of the latter.

All varieties of this series show unmistakable signs of crushing, and the attendant reorganization of their contents, so that they cleave readily into flakes. The coarse kinds part in roughly parallel directions, while those of finer grain show a clean slaty cleavage for the most part.

At a few points in the neighbourhood of fracture-planes there has been an impregnation with silica, and the slates become hard, massive, and non-cleavable.

Where mining operations have penetrated these slates and exposed them it can be easily seen that there has been considerable alteration of both the structure and composition in the immediate vicinity of the lodes. The No. 4 tunnel of the North Mt. Farrell Mine has penetrated the altered zone, and runs far into the unaltered slate beyond. This latter at this place is a dark cleavable slate with fine-grained iron pyrites along the parting-planes. I could not perceive any visible graphite in the slate; yet where the lodes traverse the rock the appearance of graphite is noticeable, and the iron-bearing mineral is the carbonate, not the sulphide.

The structure of the slate near the lodes is also different. The even slaty cleavage is replaced by a remarkable contortion and brecciation of the whole rock. The cleavages appear to dip in any direction, and the lines of parting often appear intricately folded, fractured, and overthrust. These phenomena indicate that much of the stress which produced the fractures now filled with ore must have been of the nature of compression.

The majority of the rocks of this series are dark in colour, but there are some associated light-coloured rocks which, in my opinion, are to be classed with them.

To the west of the lode-bearing slates in the Mt. Farrell, North Mt. Farrell, and Mackintosh areas is a narrow strip of this pale clay schist or slate. The belt is distinguished from the ordinary slate in the geological map and section herewith.

At the North Mt. Farrell Mine there is a narrow belt of the dark slate still further to the westward; but in this case, as in all other visible sections along this belt, there appears to have been some degree of movement between the light and dark slates at their contact. The relation between the two is therefore not definitely certain on the evidence available. The persistence of the belt will be seen by reference to the map to be remarkable. I traced it northward as far as the Mackintosh River in Section 2909. Southward the rock is to be seen near the mouth of the main lower-level adit of the Mt. Farrell Mine, and extends till it is hidden by the button-grass plain.

An entirely similar rock is the country rock of the Tullibardine copper property, where it is obviously inter-laminated with the dark slates on either side.

In the South Murchison section the eastern tunnel has been driven in a pale-coloured slate of a somewhat similar appearance. Here the pale slate is interlaminated with the darker, the junction being visible at the mouth of the adit. Between the ordinary dark slate and the paler variety there is no unconformity nor any plane of separation. The colour changes abruptly, and the slaty cleavage becomes less well marked.

The rock from the Mt. Farrell Mine was sectioned, and shows a number of small quartz granules strung out in wavy lines, and between them undulating bands of sericite and kaolin.

A specimen from the South Murchison section was also examined microscopically. It showed an even more homogeneous texture. The sericitic bands are so fine as to be nothing more than strings. Calcite has made its way in along the planes marked by the strings of sericite, and forms eyes here and there.

With regard to the structural features of the members of this series, a very strong distinction should be made between the bedding-planes and cleavage-planes.

The two are being constantly confused on the field, and may lead to serious misunderstanding of the geological structure.

The slates especially are very seriously contorted at times, and the cleavage-planes are always the prominent feature, whereas the bedding-planes are not visible at all in the great majority of instances. In fact, it is an extremely difficult matter on this field to determine the dip of these sediments, when the beds are considered as a whole. The mining operations have given one or two exposures of the divisional lines between the members of the slate series and between the porphyroid and the slate; but in all such cases there has apparently been some degree of movement between the two rocks in contact, and the passage of meteoric water along these planes has masked the relationships of the rocks. In such cases as were open to observation the dip of the rocks seemed to be to the westward, and at an angle of from 60° to 70°.

At the South Murchison Mine the contact line between the pale and dark slate is nearly vertical, but inclining to the west.

The planes of schistosity dip almost always to the west, but there are great local contortions of these rocks, both near the lode fractures and in the unproductive zones; for instance, above the workings of the Farrell Blocks, on Section 2397, the planes of schistosity strike north-west

and south-east, whereas their normal strike throughout the field is parallel to the main axis of the Mt. Farrell ridge.

(2)—*The Massive Conglomerate of the Mt. Farrell Ridge.*

The core of the Mt. Farrell ridge is a rock which in its typical development is a coarse conglomerate, but with which are interbedded finer-grained sandstones, or even shales. These rocks are obviously all members of one great period of sedimentation, and must be treated of together.

The conglomerate is usually of a pinkish colour, and almost wholly quartzose in composition. The pebbles consist of all varieties of quartz—massive, banded, and chalcidonic—and of a quartz schist or quartzite schist. This latter schist is nearly all quartz, with very little pale-coloured mica, and the layers of mica are often contorted.

The cementing medium in the conglomerate is also siliceous, and usually very small in amount when compared with the large bulk of the rock that is composed of the pebbles. The sandstones also are almost wholly of silica, and are stained red by oxide of iron.

The strike of the beds is practically the strike of the mountain ridge, but it varies widely at one point near the fault-plane which traverses Section 2796.

The bedding-planes are not decipherable where the massive form is met with, and neither strike nor dip can be ascertained; but the coarser type passes over abruptly into the finer, and the structural relations become visible. There is a band of the finer-grained sandstone running the length of the mountain, from the south end to the fault-plane, almost on the very centre-line of the ridge; and on the eastern slopes, towards the valley of the Sophia River, the finer-grained sediments can be seen outcropping here and there through the button-grass.

The southern end of Mt. Farrell shows a great local thickening of the conglomerate, and a south-east spur of the mountain, which extends along the eastern bank of the Murchison River, is wholly of conglomerate and its associated sandstone.

The Murchison River breaks across the conglomerate at the southern end of the mount, and on the south side of the river the same beds are to be seen as on the northern; and "Little Farrell," as the portion south

of the Murchison River is called, has the same general aspect as the larger part on the other side of the river.

Viewed from the top of the southern end of the mount proper, the structure of Little Farrell is plainly visible. The same massive beds of coarse conglomerate are apparent, with the interbedded sandstone, but the finer-grained varieties of the eastern slopes of Mt. Farrell are not seen on the southern side of the river.

The structural features presented by the rocks of this series are of some interest, as they assist considerably in explaining the structure and geological history of the district.

The strike of the main series of beds varies from N. 50° W. at the south end of the mount to N. 10° W. above the Farrell Blocks trenches; and approaching the fault-plane, whose strike line has a bearing of 112°, the strike of the finer beds is continually making towards the westward, till it bears N. 45° W. Northward, beyond the fault-plane, the strike is N. 10° E.

At the southern end of the mount, where the spur runs out in a south-easterly direction, the strike-lines follow the spur round till their bearing is N. 30° W.

The dip of the beds which form the ridge of the mount, above the chief mining centre of the field, is practically 90°, and as the ridge passes southwards this vertical structure of the main beds is preserved.

The finer-grained beds on the eastern fall of the mount are mostly covered by button-grass, but appear to dip to the west.

Passing northwards, the main series of conglomerates acquire an inclination to the eastward as the fault on Section 2796 is approached, and on the south side of the fault dip east at 80°. Across the fracture-plane the structure is different. The more westerly members of the conglomerate series lie at an angle of 30° with the horizon, while the eastern beds, from the centre of the ridge eastwards, dip east at 70°.

The change of dip is abrupt, and I think it is due, not to a movement of the crust after the formation of the whole series, but to a tilting of the region during the process of sedimentation.

The main fault that intersects the series is a dip-fault, and its effect can be clearly seen from Innes' track along the foot of the mountain on the western side.

The weathering of the bent strata and the breaking-off of blocks of rock across the joints and bedding-planes makes the sediments, when viewed from the track, appear

to dip east on the west of the ridge at the south side of the fault gorge, and lower down on the same cliff faces to dip to the westward. However, the writer's observations showed that the dip was always to the east, or rather north-east.

The conglomerate series rests unconformably upon the complex of slates, porphyries, and porphyroids, with an unconformity between the two formations. The best position for observing this contact is from the south end of Mt. Farrell, and looking across the gorge of the Murchison River at the cliff section exposed on the southern side.

The vertical beds of coarse conglomerate on the western boundary of the series abut directly against the crushed conglomerate, which is the coarsest facies of the older crushed sediments. The divisional line is very sharply defined, and the older conglomerate has its planes of schistosity dipping away to the west at an angle of about 70°. The conglomerates are seen to continue right down into the bed of the river.

From the south side of this gorge, and looking northward, the beds appear vertical at the top, and yet as they approach the river seem to bend slightly and dip a little to the east. The inaccessibility of this portion of the mountain on the north side of the gorge prevented me from verifying this distant observation at closer quarters.

The conglomerate certainly comes right down to the river at this point, but the vast amount of boulders which have been broken away by the surface agents of decay and disintegration completely hide the actual contact of the conglomerate and the adjacent rocks at low levels. For the hard siliceous fragments broken away from the mountain crest do not easily disintegrate to form fine rock waste that can be borne away by the rivers, and accumulate at the foot of the gorge as a jumble of angular blocks of all shapes and sizes.

From the point where the river cuts through it, the conglomerate thins out on the south side, and disappears altogether not far to the east of the Tullah property.

At the northern extremity of the mount the same difficulty is experienced in finding the relations of the conglomerate to the rocks on which it rests, for the fragmental blocks conceal the junction.

The mountain seems to be split in two at its northern end by a strike fault. I could not find the actual fracture-line, for the cover of button-grass conceals everything. A

trench on the gap between the two bluffs of conglomerate shows the underlying rock to be of the slate series, and one or two outcrops of slate appear on the slopes of the gap leading down to the river at the extreme north end of the mountain. The western portion of the conglomerate here seems, to have been separated from the eastern by a fault. If so, the fault has the effect of producing an increasing downthrow of the displaced portion as we go north. No trace of the split is to be found southwards, and the conglomerate is, on both sides of the gap at the north extremity of the mountain, of the most massive type, so that the bedding-planes cannot be distinguished.

The conglomerate bluffs weather to bold, bare, rounded knobs, and support no vegetation. The button-grass has crept up high on the slopes, and even covers part of the ridge, but on the whole the outcrop is bare and sharply defined.

Fragments of all sizes of the conglomerate occur along the valleys of the Mackintosh and Murchison Rivers. These are, for the most part, just blocks which have reached their present position by the relative lowering of the rest of the region by the action of the rivers.

However, I noticed some large boulders, notably some of several tons weight near the Farrell Siding, distributed here and there at all altitudes throughout the district.

In a region whose river systems have been continually undergoing modification, these blocks may have reached their present places by river action, but there remains the possibility of comparatively recent glaciation to account for the distribution of these as erratics.

This conglomerate is similar in character to that which forms a capping on so many of the West Coast mountains; and in all probability the beds at Mt. Farrell belong to the same period of sedimentation as the other entirely similar conglomerates. However, there are, of course, many breaks in the continuity of the series, yet none so great that they cannot be explained by the existence of either original breaks or gaps since formed by crustal deformation and surface degradation.

With regard to the origin of the conglomerate at Mt. Farrell, there are several points of interest to be considered.

It has been stated that the massive type consists almost absolutely of well-rounded pebbles of quartz, and that

these are considerable in bulk when compared with the interstitial sand and cement.

This uniformity in the composition of the pebbles, their general uniformity of size by the sorting-out of the finer material, the considerable regularity of the stratification along the original strike-line—all these argue for a local derivation by the action of the sea.

Contrast with them the pebble-beds forming at the present time in the channels of the Murchison and Mackintosh Rivers, and these features, especially the uniformity of size and composition of the pebbles, will be the more apparent.

The absence of pebbles of the porphyries and syenite seems remarkable, for the conglomerate admittedly overlies the complex of slates and porphyries unconformably, so that these latter might well be expected to have contributed towards its bulk.

The quartzite and quartz schist pebbles seem to have undoubtedly been derived from the great masses of these rocks on the eastern side of the valley of the Sophia.

One is inclined to suppose that a tilting of the region took place at the time of the formation of the conglomerate which brought the sea-level to a line at the base of these quartzites, and below which the slates and porphyries were so far submerged as to be beyond the range of wave action. I am not aware of the nature of the rock formations which lie east of the quartzites, other than the mica schists (to be mentioned later) and the granite of Granite Tor.

Whatever be the mode of the origin of the conglomerate, there have been some changes since its formation. The tilting referred to above, and the fracturing of it, are subsequent; and in addition to these major movements, there has been a minute shattering of the whole series, and a later infiltration of silica. The whole of the formation is characterized by a complex of small intersecting veinlets of silica, which often cut through the pebbles and cementing matter as well, and the matrix seems to be rendered more dense by a siliceous impregnation.

With the silica is a certain amount of specular hematite. In spite of some rumours to the effect that galena was present, the only metallic mineral I found was this hematite.

At the level of the track passing through the gorge cut by the Murchison River, at the south end of the mount proper, there seems to be a tendency for the conglomerate to assume a schistose habit.

This is no doubt due to the stresses that have produced the tilting, and supports the idea that the beds have been bent upwards rather than that the whole series has been tilted as a block, and supports also the observations made from Little Farrell with regard to the structure of the series as a whole.

(3)—*The White Hawk Sandstones and Limestone.*

The White Hawk district, at the north-eastern extremity of the area examined, consists of a series of sedimentary rocks intruded by the granite porphyry dyke rock above described.

These sediments consist of three formations—a bed of limestone lying between a sandstone on the west, and a sandstone which has coarser pebble-beds interstratified with the finer material on the east.

The upper sandstone (western) of the series is fairly uniform and fine in grain. The dip is apparently in harmony with that of the other associated beds, viz., westward. The dip angle is 47° where it junctions with the limestone, but rises to 75° on the western boundary of the central White Hawk lease. The strike is about 10° east of north.

These beds proved fossiliferous at a point north-west of the original outcrop of ore discovered by Tom Farrell.

The fossils have been referred to Mr. Robert Etheridge (Jun.) for description, and the remarks of that gentleman on them are appended.

The limestone is a massive one of a dark bluish-grey colour, wherein part of the calcium carbonate has recrystallized. On weathering the surface of the rock becomes irregular from inequalities in the rate of solution, but the ridges found on a weathered surface show no signs of organic structure. The bed at its lower side where it rests upon the lower sandstone has a westward dip of about 40° .

There are very perfectly developed joint-planes, of which the best-marked series dip eastward at an angle of from 50° to 60° . The action of surface-waters in dissolving out portion of the carbonate along these joint-planes renders their presence very prominent near the surface, and the rock seems at first sight to be dipping eastward.

As is usual in limestone areas, there are many cavities of solution visible at the surface, which have been gradually enlarged until they form caves. Most of these lead down into the heart of the rock through the progress of rock-solution along bedding-planes.

Their influence on the mining has so far not been serious, for the work done has been at shallow depths. The White Hawk Creek, at the mine, is running on the limestone just at its junction with the lower sandstone, and the water cannot but be a great hindrance to future working at a greater depth.

The drainage from the hill to the west of the mine also can be seen to find its way in part by underground channels to a lower level.

The lower sandstone formation consists of a series of normal sands and a coarse pebbly grit. Portions of the formation, especially on its lower side, have been silicified into quartzites.

The thickness of the whole series is only from 130 to 150 feet, but as the slope of the eastern side of the creek gorge almost coincides with the dip of the rock the thickness appears to be much greater.

Fossils were obtained from this horizon also, and with the others from the upper sandstone were submitted to Mr. Etheridge, whose remarks are:—

“I have examined the specimens referred to in your letter, and although very poor impressions, I believe them to be as follows:—

“(a) Sandstone below White Hawk limestone contains impressions of one of the varieties of *Rhynchonella borealis*, Schlotheim, a well-known and widely-spread Silurian species.

“(b) Sandstone above White Hawk limestone contains many impressions of the brachiopod I have from time to time identified from Tasmanian strata as *Rhynchonella capax*, Conrad, and named var. *meridionalis*, and still believe to represent that species. In America it is one of the fossils characteristic of the Hudson River Group.”

So the age of this sedimentary series is definitely fixed as Silurian.

There are two points of interest in the geology of this area when considered together with the rest of the district. It is noticeable that the coarser sediments—the pebbly grit referred to above—are on the extreme east of the series where the formations rest against the granite porphyry. This feature is in harmony with the relationship of the older crushed sediments—slate and crushed conglomerate—to the structure of the district.

Further, the still more noticeable feature of these rocks that distinguishes them from the other rocks of the district is the freedom from the signs of intense crushing.

While it is true that the small area here considered has not yielded to the intense crushing to the same degree as the rocks to the west and south-west, the series must have had a very great pressure to withstand; for to the west lie the slates and porphyroids, that bear witness to dynamical stresses in the immediate neighbourhood.

The whole block of country of which these strata form but a portion may have successfully withstood the crustal movement, and though the rocks have been tilted their particles may not have been forced over each other and drawn out in lenses. The nature of the rocks is such that the crushing stresses could have left but little traces; yet the block may have been part of the "foreland" against which the crushing of the other rocks has taken place.

But even so, the proximity of the highly altered rocks to the west makes one reflect further on the remarkable preservation of the original characters.

In my opinion the simplicity of the chemical composition of the sandstones and limestones has had a good deal to do with the absence of alteration.

Contrasting these rocks with the porphyroids we see a chemical composition of marked simplicity as against the equally marked complexity of the constitution of the igneous rocks.

Mention has already been made of the fact that all the members of the syenite-felspar porphyry series are probably very closely related in chemical composition, although their texture and mineral constitution varies continually. And these variations are beyond doubt due to varying physical conditions imposed upon the different facies at the time of their solidification. A variation of the physical conditions after consolidation, namely the subjection of the rocks to intense lateral pressure, has caused a secondary readjustment of the molecules, and the reorganised porphyries become porphyroids.

The several minerals of secondary origin, notably epidote, calcite, albite, and quartz, all take their origin by variations in the physical conditions to which the rocks are subjected.

But in the case of rocks that are almost wholly composed of calcium carbonate or of silica, no such molecular readjustment is possible. The originally finely divided calcium carbonate may crystallize and form a crystalline limestone, but no further change can result.

(4)—*The River Gravels.*

The only remaining sedimentary rocks of the district are the river-bed deposits, for the most part unconsolidated. The present rivers have cut their way down through an older alluvial accumulation that bears strong resemblance to that forming in the flatter reaches of the rivers now. The broad plain that lies at the foot of the western flank of Mt. Farrell is dissected here and there by streamlets that make towards the present-day rivers.

The deposits of this old flood-plain are a series of beds of gravel and sand, with the coarser beds at the bottom and the finer above them. The pebbles are of all sizes, and of very varying composition, although the quartose ones predominate. Many of these have undoubtedly been set free from the conglomerate of the ridge of the mount; and there are pebbles of the conglomerate itself containing several of the older pebbles and their cement all smoothed down together to form the single pebble of to-day.

These river alluvial deposits are restricted mainly to the broad plains through which the main rivers run, but I also came across a few small terraces on the White Hawk Creek which were formed of river gravel.

C.—THE METAMORPHIC ROCKS.

The alterations that have been effected by regional metamorphism in the rocks of both sedimentary and igneous origin have already been described in dealing with those groups.

There remain only some types whose unaltered state is now not so clear that we can trace the nature and degree of alteration from the original condition.

The Quartz Mica Schists.

These metamorphosed rocks form a fringe along the eastern boundary of the district, and are of chief interest in that they have contributed so largely to the formation of the massive conglomerate of the mountain.

Their relations to the slates are not to be seen on account of the broad flood-plain of the Sophia River and its dense cover of button-grass. However, there seems to be some definite continuity between them and the sedimentary series of the White Hawk district.

The writer was able to make no more than a cursory examination of this outer fringe, but it may be well to record the observations that were made.

Ascending the north-western spur of Mt. Swallow, which rises from the White Hawk Creek at the mine (see the sketched locality plan), the granite porphyry becomes a little finer in grain, and then a white quartzite is met with, which contains a little pale mica here and there.

The massive quartzites and the micaceous varieties or quartzitic schists seem to be inextricably intermixed, and their extent towards the east is considerable—about 2 miles. The only mineral contents of this belt with which I met were a small blow of hematite on the Mole Creek track, on the north-west side of Mt. Swallow, and a little disseminated arsenical pyrites further south.

Following the Mole Creek track eastwards the quartzite gives way on the eastern side to a broad belt of rock, which becomes more and more micaceous. Bands of the almost pure quartzite recur, but the rock here is normally a mica schist, which in some places becomes so fine in grain as to resemble a normal slate. These mica schists are quartz-biotite-muscovite aggregates, and show some local contortion of the bands. The planes of schistosity usually dip west.

This rock continues right up to the acid granite of Granite Tor, and seems to overlap the granite at the contact. Southwards from Mt. Swallow the Mole Creek track passes over the same quartzites and quartzite schists, and the bare bluffs on the eastern walls of the valley of the Sophia River are of the same material.

The granite porphyry is met with on the track a good deal further east than the White Hawk occurrence, and the quartz mica schists also seem further east. On the present visit I was unable to determine whether the strike takes a south-easterly bend on passing south, or whether the granite porphyry widens on its southward continuation, or whether a dip-fault has displaced the series.

The only other occurrence of similar rock types in the field is at a point between the White Hawk Mine and the Tullibardine.

A series of low, sharply defined ridges, running a little east of north, on the eastern side of the Mackintosh River, are formed of a dense quartzite, which carries a little pale green mica.

The western scarps of the ridges are very steep, and are covered with disintegrated blocks of this quartzite. This boundary suggests that there is a fault-plane striking north and south, but the button-grass completely covers all the surrounding country. To the east lies the upper sandstone of the White Hawk series, and to the west are

the slates of the Tullibardine area, but the junction-lines are invisible, and the presence or absence of any intervening strata undetermined.

(2)—THE GENERAL SEQUENCE OF EVENTS LEADING TO THE PRESENT GEOLOGICAL STRUCTURE.

The following are the principal events which have succeeded each other in the area under consideration. They are presented in the order of their occurrence, as far as can be ascertained from the study of the rocks themselves and their field relationships.

1. *The First Period of Sedimentation.*—The series of sedimentary rocks, of which the slates of Mt. Farrell form the most considerable portion, appear to be the oldest rocks on the field. The passage from a conglomerate on the east through grits to the slates on the west seems to indicate a gradual submergence of an old basin. The old floor on which these sediments were laid down is not now recognisable; unless it be the quartzites and mica schists which outcrop on the eastern side of the valley of the Sophia River.

As regards the age of the slates, it can hardly be fixed as yet. Lithologically their resemblance to the Dundas slates is marked. These latter are fossiliferous, and of Ordovician age. But at Mt. Farrell no fossils have been recognised in this formation.

The slates may quite possibly have been contemporaneous with the sediments of the White Hawk area, now known from fossil evidence to be Silurian.

2. *The Intrusion of the Older Igneous Rocks.*—While it may be that these rocks are, in part at least, older than the slates, the writer considers the bulk of the evidence points to their later appearance.

The rocks which now appear as diverse types seem to me to belong to one great series, and to have resulted from one magma. The syenites, quartz porphyries, felspar porphyries, and their schistose derivatives show a remarkable difference between the south-eastern and the western portions of the district. In the former there are the holocrystalline types, between the two are the evidences of intrusion into the slate series, and on the west are the volcanic members. The suggestion at once presents itself that we may have here the various phases of a great intrusion of igneous material, of which the portion which remained far below the surface solidified and formed the

holocrystalline syenites. Portion may have spread laterally in the form of sills through the slates, and another portion again may have reached the surface to form lava-flows and volcanic tuffs.

It is certainly possible that the intercalated sheets of porphyroid were contemporaneous lava flows; but some of them are certainly intrusive, and some also are effusive.

At least two horizons of the fragmental type of porphyroid were detected—one near the main road of the Tullah township, and one at the junction of the Mackintosh and Murchison Rivers. The great thickness of the porphyroid to the west of the slate appears to be due to a great succession of lava flows.

The relations of these igneous rocks to the slates will always be somewhat obscure, on account of the subsequent alteration. There are very few visible outcrops of the junction lines, and the distinction between the two groups is sometimes very difficult in the field.

If this hypothesis be correct—and there are no discrepancies between the evidence afforded by either the igneous rocks or the associated sediments—the eastern portion of the field, now at the level of the surface, must have been deeply buried. The coarser sediments of the slate series would thus be the lowest beds of that series, and the syenites typical plutonic rocks.

3. *The Inversion of these Rocks before the Formation of the later Conglomerate.*—The newer conglomerate and its associated finer-grained sediments show a marked structural contrast to the older sediments on which they lie unconformably. The eastern beds in the newer conglomerate are the finer, and the western beds are coarser. And the appearance presented by the conglomerate as a whole gives the impression that the western beds were the first formed of that series. This being so, the whole of the pre-existing formations must have been completely inverted by folding. If the igneous rocks are, as considered by the writer, older than the conglomerate, they must have shared in the folding.

In this tremendous crumpling of the crust a very considerable degree of schistosity must have been developed in the folded rocks, and at a date prior to the formation of the newer conglomerate.

This folding may have produced the fractures which have later served as circulation channels for the metal-liferous solutions.

4. *The Formation of the Newer Conglomerate.*—Following upon the lastmentioned folding of the region came the submergence of the area and the formation of the conglomerate (and the sandstones of the same series).

The submergence may have been such that most, if not all, the igneous rocks were below the reach of wave action, and if so the absence of pebbles of these rocks would be accounted for.

The age of this rock formation is considered by Mr. G. A. Waller to be Upper Silurian.* He refers the red conglomerates of the West Coast to the base of the Upper Silurian, since the fossiliferous strata of the Upper Silurian period rest conformably on them at Zeehan.† Also on Mt. Jukes the sandstones interbedded with the conglomerate contain Upper Silurian fossil remains.‡

There are sediments of Upper Silurian age in the White Hawk area of the Mt. Farrell district; but their relation to the massive conglomerate of the mountain is not yet known.

During the formation of the conglomerate and its accompanying sandstones there was at least one further tilting of the region. For the eastern beds at the northern end of the mount are not conformable with the western. The eastern beds dip towards the western, but there is no folding. I believe the change of dip is purely an unconformity, not a synclinal fold. At all events, I could not see any repetition of the coarser beds, as might have been expected if a fold were present.

South of the fault which traverses Section 2796 the dip of the eastern beds is less easily recognised, on account of the cover of button-grass on the east side of the ridge.

5. *The Folding of the Region in Late Silurian or Devonian Time.*—After the formation of the sediments of Upper Silurian age, the region suffered yet another lateral thrust. Under the stress the crust was again buckled, and the tendency of the movement was to restore the older sediments (of the slate series) to their former position.

The conglomerate of Upper Silurian age was by this movement tilted almost upon edge, for the greater part of its extent at Mt. Farrell.

A great fracture occurred during or after this folding, and is marked by the fault plane near the northern extrem-

* G. A. Waller: "Report on the Mt. Farrell Mining District," 1904, pp. 2 to 6.

† *Ibid.*, p. 4.

‡ *Ibid.*, p. 6.

ity of the mount. And the rocks south of the fracture plane have been pushed to a higher angle than those to the north of it.

This crustal movement would undoubtedly cause the development of a schistose structure throughout the region, and all rocks of greater age than this period would be affected by it. The conglomerate appears but little affected. The slates and igneous rocks, which may have already, as explained above, been rendered schistose, would have their schistose character still further intensified. The direction of the strike of the planes of schistosity in general conforms to the axial strike of the mountain, although local variations do occur.

At this period, if not at a still earlier date, the shales became slates. The pebbles of the older conglomerate were drawn out, and a schistose mantle formed round the felsitic rocks. The holocrystalline rocks, too, were crushed, but the signs are less apparent.

Accompanying the minute crushing there may have been developed at this period some at least of the fractures, which later became impregnated with metallic ores. The siliceous rocks of the mountain, the conglomerate and sandstone, are fractured in all directions, and are recemented by a later infiltration of silica.

The sedimentary rocks of the White Hawk area are tilted, but otherwise unaffected, except perhaps by the development of a few fractures, the position of which is very hard to determine.

6. *The Intrusion of the Devonian Granite of Granite Tor.*—The plutonic mass of granite at Granite Tor intruded at a date later than the crushing of the older rocks of the district. It is a granite which is distinctly more acidic in composition than the members of the older igneous series. But still more marked than the difference of composition is the freedom from signs of crushing in this more acid granite.

I was not able on this visit to examine in detail the relation of this granite to the remainder of the rocks of Mt. Farrell and the neighbouring districts. However, in my opinion, it is more than probable that the outcrop at Granite Tor is merely one point where the agents of denudation have laid bare portion of a huge granitic mass which possesses in depth unbroken continuity.

We do know of the outcrop of an entirely similar granite at several other points, namely at Cox's Bight, Heemskirk, the Meredith Range, Hampshire Hills, and the Dove

River. Moreover, at the Renison Bell Mine, near Rosebery—a locality intermediate between the points where the granite outcrops—there are tourmaline-bearing quartz porphyry dykes. In the same neighbourhood, at the Colebrook Mine, there occur the borosilicate minerals axinite, datolite, and danburite. These occurrences both point to the existence of the granitic mass below the surface. For the tourmaline quartz porphyry dykes are the apophyses of such a mass, and the borosilicates are beyond doubt the result of the reaction on the country rock of the boric emanations given off from a cooling granitic magma.

From this it appears that the Mt. Farrell district is underlaid in depth by the granite which appears to the east at Granite Tor and to the west at the Meredith Range and Heemskirk. And the existence of the mica schists lapping over the granite on the sides of Granite Tor supports this view. For these mica schists appear to be sediments of varying grain altered by contact metamorphism, and the granite dips under them where I investigated the junction of the two rocks on the western flanks of Granite Tor.

The period of the intrusion of this deep-seated mass of granite, which has certainly liberated the mineralizers and given rise to the ore deposits at the localities abovenamed, must have been later than the Upper Silurian and previous to the Permo-Carboniferous.

In deciding this matter of age, it is necessary to regard the various outcrops of this uncrushed granite as outcrops of a single geological unit. For my part, I consider that we are justified in doing so. The evidence regarding the age is conclusive, and may be briefly cited under three heads*.

- (1) The rocks of greater age than the Upper Silurian are folded and rendered schistose by the disturbance of the region. The granite in question is free from such foliation.
- (2) The granite is known to be intrusive into the ultrabasic igneous rocks of the gabbro, pyroxenite, and serpentine types at Trial Harbour. These ultrabasic rocks are intrusive into the Upper Silurian strata at Heazlewood and Zeehan. The granite and gabbro may possibly be two extremes of differentiation of one original magma; and the granitic veins in the

* See G. A. Waller: "Report on the Zeehan Silver-Lead Mining Field, 1904," p.p. 11 and 12.

serpentine may be the result of final stages in the consolidation of the one main mass. However, even if this is so, the gabbro-granite magma has intruded into strata known from fossil evidence to be of Upper Silurian age. Also, the granite intrudes into the peculiar sandstone, which has been called the "pipe-stem" or "fucoid" sandstone, at the Dove River, and the River Forth, in the Middlesex district.

- (3) On the other hand, the granite is not intrusive into the Permo-Carboniferous strata, but exists in the form of rounded pebbles as a constituent of the conglomerates of that system; and at Ben Lomond the Permo-Carboniferous strata have been observed to rest upon the denuded surface of the granite.

7. *The Period of the Deposition of the Ores.*—After the main period of crushing of the country rocks of the field came the filling of the fissures, which were either already prepared for the impregnation by the previous crushing, or were superinduced upon the crushed rocks by later stresses. We know that this filling of the fissures was of later date than the crushing, as we find fragments of the crushed rocks cemented into the uncrushed lode matter. Yet by this statement it is not intended to convey the impression that all movement had ceased at the time of the filling of the fissures. For it will be seen later that the lodes themselves show signs of movements which have brecciated their metallic contents.

The filling of the fissures must have taken place at more than one period, for there seem to be two distinct types of vein-stuff.

The first impregnation appears to have been a siliceous one, and to have produced quartz-veins free from metallic minerals other than iron pyrites.

Later, there must have been still further strains developed in the rocks of the district, and a fresh set of fractures resulted. Some of these cut across the original quartz-filled fissures, as may be seen in the section exposed by the open-cut of the North Mt. Farrell Mine. It is to this later filling, with its prevalent gangue of iron carbonate, that the productive lodes are due.

The age of the fissure-filling I believe to be that of the intrusion of the Devonian granite; and I believe the introduction of the metallic ores to be due to the intrusion of that mass. It is now a firmly established fact that the

later stages of the consolidation of a deep-seated mass of granitic composition are accompanied by the emission of highly heated vapours, which, under such conditions of high temperature and pressure, have the power of holding in solution metallic compounds.

On their expulsion from the igneous rock, and during their ascent into the upper regions of the earth's crust, they experience a fall of temperature and pressure which eventually suffice to cause precipitation of the metallic contents in the channels which are serving at the time to carry the vapours or solutions upwards.

It is, I believe, to the Devonian granite that we must look for the immediate source of the metallic compounds of the Mt. Farrell district; and the age of the impregnation is therefore that of the final stages of the granitic intrusion.

8. *The Events subsequent to the Formation of the Lodes.*—The events of later date than the vein-filling, which have modified the geology of the district, are two in number:—

- (1) Further movements have taken place between the already fractured segments of the crust. These readjustments have modified the structure of the lodes themselves, since the former fissures have remained planes of weakness, and the strains have been relieved by their reopening and the differential movements of the walls.
- (2) Surface agencies have operated on the region, and carried away much material, and deposited the river alluvials. These agencies have not been uninterrupted by movements of deep-seated origin, for we find the older river flats cut into by the warping of the region since their formation, with the consequent revival of the corrosive power of the streams.

V.—ECONOMIC GEOLOGY.

(1)—THE RELATION OF THE ORE-BODIES TO THE SEVERAL ROCK TYPES.

When any one single mining property on the Mt. Farrell field is considered apart from the surrounding leases it may appear that the ore-bodies are restricted to a certain lithological group.

In other words, the nature of the country rock may appear to have influenced the lode in the several particu-

lars of width, mineral composition, richness, or even position.

It is a matter of most vital importance to the field that this matter should be carefully considered.

The guidance of the present development work on the mines is not the only point at issue. The whole feature of the district, and the further prospecting for the yet undiscovered lodes, are concerned with the correct interpretation of the geology of the known parts of the field.

And in the examination of these known facts it is absolutely necessary to regard the field as a whole. The several properties are dealt with separately in a later part of this report, and their particular features noted. At present the matter of the lode phenomena exhibited by the field as a whole will be discussed, and the changes in the composition and structure of any one single lode at different points along its course taken into consideration; for the boundaries marking-out the mining sections are artificial, and have no place in the general discussion of natural phenomena.

This matter may seem perfectly obvious, and not worthy of mention; yet it is owing to an exaggeration of the value of local phenomena, and the attempt to make these of general application, that no little energy and capital have been fruitlessly expended on the Mt. Farrell field.

It is an old-established view held by many mining men that the metallic contents of ore deposits have a genetic relationship to the country rocks with which they are associated.

The practical aspect of this statement means that if the country rock, which is usually of great extent as compared with the lodes enclosed in it, and easily found, be sufficiently diligently searched, the possibilities of the discovery of lodes are great; and, moreover, it is held that in some classes of country rock lodes of one composition will be found, and in other rocks there will be lodes of different composition.

It does not seem possible to separate this view from the idea, even if no actual expression is given to it in so many words, that the country rock is responsible for the formation of the lodes; that is to say, that by the action of some process or processes the country rock has actually provided the metallic contents of the lode. The ore-bodies are thus thought to be merely the metallic contents of their country rocks gathered together in a concentrated form.

And there are many occurrences of the metallic ores that lend colour to this view, and which will lead the

prospector astray unless he is careful to distinguish between the great classes of the country rocks enclosing within their boundaries the metallic minerals sought by the miner, viz. :—

- (a) The country rock which is part and parcel of the same rock-mass from which the ores also have been derived, *i.e.*, which has certain definite genetic relationships with the ores.
- (b) The country rock which has had fissures formed in it by the action of internal or external causes, or which has from the time of its formation held certain cavities which may act in the same way as superimposed fissures.

These cavities, in this class of associated country rocks, supply only the empty place for the lode-filling, which is introduced from without in solution. These solutions are now generally admitted to be ascending hot solutions similar to those which appear at the surface in volcanic regions, or which have been tapped by mining operations.

That they derive their aqueous content, their heat, and the metallic salts in solution from some deeply seated igneous rock is now also admitted by most mining geologists.

The deposition of the metallic ores in the cavities through which these solutions circulate on their ascent, is due to definite physical and chemical laws; the chief causes of precipitation being the decrease of the temperature of the solutions in their ascent, and the lessening of the pressure to which they are subjected.

- (c) The country rock which has held disseminated through its mass a certain small proportion of some metallic compound, and from which meteoric waters have leached out the metallic content, once widely disseminated, and have redeposited it in more concentrated form in the larger cavities or fissures.

When once the prospector has realised that these several classes exist, he must learn to interpret the phenomena of the field with which he is concerned, and to decide the class to which the ore deposits of the district belong; for the genesis of the lodes is the most important point to be decided when future operations are being planned.

Applying the above generalities to the case of the Mt. Farrell lodes and their surroundings: The relationship cannot be that of the first class above mentioned, in that we find lodes, whose general similarity will be indicated later, occur in rocks of widely different origin, viz., the slates which are undoubted sediments, and the porphyries or their derived schistose types which are certainly of igneous origin.

Although the occurrences of tin and some other ores, and perhaps even some silver-lead ores, are of this character, the lodes of Mt. Farrell cannot possibly be considered to bear this relationship to the rocks within which they are contained.

It remains then to decide between the other two types.

The criteria by which we are able to judge whether the lode-material was introduced from without, or whether it was gathered together from within the enclosing rock-mass, are several.

Of greatest importance for this purpose are a series of exact analyses to determine the amount and distribution of the metals in the country-rock, and the state in which they exist there; that is to say, whether the metal is present uncombined, or in combination with sulphur, or as a constituent of the rock-forming silicates. This work has not been attempted with regard to the field in question; but extremely valuable and laborious chemical work has been performed on other mining fields, from which general conclusions have been drawn.

The great majority of metalliferous lodes may, by the application of these methods, be shown to owe their metallic content to the introduction of the material from sources outside of the immediately enclosing rocks. This is a general statement that is applicable to most ore veins, and the so-called "lateral secretion" theory cannot be made applicable to more than very few mineral occurrences.

In the disproving of the views of the believers in lateral secretion, the most elaborate work that has been done was performed at Freiberg, whose lodes offer several points of similarity in composition to those of Mt. Farrell.

In making the above general statements it is assumed that the lodes of Mt. Farrell do not differ as regards origin from those of other similar mining fields.

There are certain other features presented by the lodes and the country rocks which point to their mutual independence.

Lodes of the same character, possibly even different portions of the same lode, are found to occur in both the massive felspar porphyry and the schistose porphyroid on the south side of the Murchison River. Whether the lode that is now being prospected by the Thomas' Blocks Company extends northward into the slate belt is not determined so far. If it does, the example taken becomes still more instructive, and proves, for that part of the district at least, that lodes are not restricted to the igneous rock and its derived schist.

We know, for the more northerly part of the field, that the productive lode of the Murchison River Mine is in the porphyroid, and those of the North Mt. Farrell mines are in the slate.

It is true that in the case of the Murchison River Mine the presence of the porphyroid seems to be necessary for the existence of the lode. This is one of the cases which calls for further investigation.

In a later portion of this report it will be seen that the Murchison River lode is one the strike of which varies considerably from that of the other lodes of the field, and the course of which cuts obliquely across a narrow belt of porphyroid enclosed within the slate. The productive zone in the lode is restricted, as far as has yet been determined by mining operations, to the zone which is enclosed between walls of porphyroid. The lode-fissure extends beyond the porphyroid band on both the northern and southern side; but it has obviously pinched at each end, and the small amount of prospecting work done in these two directions has not yet disclosed an ore body of sufficient size to be payable.

Yet the lode-channel is continuous, and galena is visible on its track, as well as the siderite which so commonly accompanies the lead ore on this field.

With regard to these phenomena, the writer is strongly of the opinion that the existence of the broad ore-shoot in the porphyroid and the relatively narrow track of the ore in the slate is due, not to the difference in composition between the two rocks, but to the difference in the behaviour of these rocks when they were subjected to the strains which resulted in the fissure now traceable by its ore-filling and the development of characteristic minerals along its course.

There are no two rock-masses of the earth's crust which can be expected to behave in exactly the same way under strains sufficient to produce deformation; and in this case the physical dissimilarity between the two rocks

is considerable. The porphyroid at this spot is a very massive type, with few of the markedly schistose characters. It appears to have broken, under the deforming stresses, along a plane, in the same way as a brittle object might break if submitted to such treatment.

But in the case of the slate, the trace of fracture, though quite distinct, is not clean cut as in the porphyroid; it is rather a fracture zone. Moreover, the two walls of the fracture appear to be different in the two rocks where the lode is in porphyroid; the alteration of the country rock and its impregnation with the lode-matter is slight and the wall is clean. On the other hand, the slate carries the lode-material disseminated through it beyond the actual fracture.

All this evidence points to the fracture having been one of actual displacement when it was formed in the porphyroid, and to its having been a "distributive" break in the slate; that is to say, although the total result may have been the same, the single fracture has its place taken by an elaborate system of minute dislocations. This fracturing was of prior date to the utilization of the cavities by the metalliferous solutions.

The nature of the fractures has undoubtedly had a great influence in governing the distribution of the circulating metal-bearing solutions; but beyond this the influence of the country has not been effective in the control of ore-deposition.

Another case that calls for investigation, as it seems to have given rise to a belief that change of country has been accompanied by change of the lode-filling, is that of the copper lode exposed by trenches on the northern section of the Mackintosh leases.

This occurrence of copper is situated in the narrow belt of pale-coloured clay schist very close to the slate boundary. Now, in the same mining section in the south-west corner the slate contains the galena lodes which have been worked, off and on, by tribute parties; and in this case the pale clay schist lies a little to the west of the lodes, so that the impression is given that the lead lodes are present in the slate and the copper in the clay schist.

I regret that no work has been done to try and expose the geological structure between the two occurrences mentioned. Still I am of the firm belief that they are both on one and the same lode-fissure, and that this lode-channel traverses at a very small angle the junction-line between the clay schist and the slate.

The occurrences spoken of are directly in the line of several other outcrops, and it seems to me more than probable that the series are on a continuous fracture system.

As regards the change of composition of the lode-filling with the change of country, the alteration is neither so abrupt nor so considerable as is generally thought.

All through the field there is present, in constant association with the galena, a certain amount of copper pyrites. In all the mines it is noticeable, and at times is found in considerable bunches, even in a mine so free from other metallic minerals than galena as the North Mt. Farrell.

The same variation in the lode-filling is noticeable with respect to other minerals, namely, in the distribution of zinc-blende and the antimonial ores.

The inference to be drawn from these local concentrations of one or other of the metallic minerals is that from point to point along one lode-channel or along the general line of fissuring in the district there have been variations in the relative proportions of the different metallic elements present in the solutions which have brought the ores into the fissures; and these variations have occurred during the primary filling of the fissures, and are not secondary phenomena caused by the leaching-out from the lodes of one or more other mineral constituents, for the variations are noticeable where the lodes are perfectly free from all signs of weathering, leaching, or secondary deposition.

The common feature shared by both the copper and lead deposits on the Mackintosh northern section is the development of siderite as a gangue mineral. This fact affords additional evidence that the mineral-bearing solutions in each case have been of the same character, although the proportion of the metals present has varied.

And still more conclusive is the fact that in the south-west corner of the Farrell Blocks section, north and adjoining the Mackintosh property, there is a lode-formation which I take to be the continuation of this same series, and in which both galena and copper pyrites occur. Here the lead content seems to be once more asserting itself, and is noticeable further north on the Farrell Blocks property, and in the section, No. 2909, further north.

Again, it should be pointed out here that in the case of the prospecting work that has been done on the Tullibardine property a few miles further north, the same alternations of lead and copper ores are to be found; and

some parts of this area show both lead and copper occurring together.

Where the two metals seem most cleanly separated from each other on the Tullibardine lease, the country rock is the same—the pale clay schist.

With this evidence of actual facts of occurrence before us, the control of the country rock on the lode-filling can be hardly appreciable, as regards primary ore-deposition; and the Mt. Farrell district does not show any feature which is not open to question in favour of the interrelation of the lodes and the walls enclosing them.

Before leaving this subject there remains the question as to whether the silver content of the galena in the White Hawk Mine is affected by the fact that the lode is in limestone country. I have heard it stated on the field that a high, or even average, silver content could hardly be expected on account of the presence of limestone, and parts of the Zeehan field were mentioned as affording similar instances.

This has been recorded by Mr. Waller, in his report on the Zeehan field (page 17).

It is a question which requires a good deal of detailed investigation before any explanation can be given of the phenomena. As regards the White Hawk property, the ore from which low silver returns were obtained is thoroughly oxidised, and the progress of weathering may alone account for a relative impoverishment in silver.

There is no doubt but that the silver content of the ore would be removed more rapidly than the lead by oxidation and leaching; and I have seen assays of the White Hawk galena which are of normal tenor. Whether these show the average value of the ore remains to be seen. At least some of the ore is not below the average of the field, and it may prove that the low values obtained from the gossans are due to weathering; and in limestone country it is well known that oxidation proceeds to a very much greater depth than in other rocks less permeable to meteoric water.

(2)—THE ORE BODIES OF MT. FARRELL.

It is found that metallic ores are almost invariably discovered grouped together in certain definite associations with each other, and with certain characteristic gangue minerals. These constant associations give a few well-defined paragenetic groups or lode types. And the lodes of Mt. Farrell, while differing among themselves, conform strikingly to some of the well-known lode types.

A.—LEAD ORES.

The Spathic Lead Ores.

Beck defines this type in the following words* :—

“In this class the gangue consists essentially of the carbonates, calcspar, brownspar, rhodochrosite, siderite, and quartz. The ore minerals are argentiferous galena, argentiferous sphalerite, and less often, pyrite, marcasite, tetrahedrite, both with and without silver, together with high-grade silver ores, especially ruby silver and argentite.

“The structure is usually imperfect, and but seldom well branded. The ore minerals frequently occur sprinkled through the gangue.”

It is to this type that the main producing lodes of the district belong. The lodes that have been worked on the Mackintosh property, the North Mt. Farrell and the Mt. Farrell leases, all conform closely to the type.

The only feature in which these lodes differ at all from the description of the general type is this—that there is uniformly present in the lead ores a certain amount of copper pyrites, and more of the copper than the iron pyrites.

This copper pyrites is sometimes very prominent in bunches, but usually occurs as small irregular blebs scattered through the lode.

On the south side of the Murchison River the same general lode type is the characteristic one, and the ore of Thomas' Blocks shows the features best.

The Tullah Mine exhibits a difference of lode-structure that may seem to mask its mineral composition, but the same lode type is undoubtedly represented.

To the north of the main productive area, the type again recurs where the lead is found on the Tullibardine property.

With regard to the gangue minerals that are associated with the galena the carbonates are practically always strongly predominant. (Reference is being made here to the lead lodes, not to the barren siliceous quartz reefs.)

There is usually a little silica either restricted to a certain zone or in irregular veinlets and bunches in the gangue.

The carbonate mineral is usually siderite, but minor amounts of calcite, dolomite, and intermediate varieties like ankerite also occur.

* Weed's translation : “The Nature of Ore Deposits,” Vol. I., p. 243.

These carbonates containing less iron are noticeably present where the enclosing walls are freer from iron, as where the lodes traverse the pale clay schist or the porphyroid.

The proportion of lead to zinc sulphide varies very much in even the same mine; yet zinc-blende is not such an important mineral as in the sulphidic ore of the Murchison River Mine.

Of the antimonial ores there seems to be a very irregular distribution. They occur rather in pockets and bunches in a lode, the general character of which is quite normal. These bunches usually afford high returns on account of the fahl-ore, which carries silver, as a rule. The occurrence of this class of ore seems most common in the Central Farrell and the Murchison Extended (lately North Murchison) leases, Sections 1980 and 1075.

I have been informed that ruby silver ore has been seen at various times in small amount on several of the mines, but did not meet with any specimens during my examination of the field.

At Thomas' Blocks there occurs, in addition to the carbonates, a small amount of white and purplish fluorite on the walls of the lode.

The Pyritic Lead Deposits.

Beck's description of the type is this* :—

"In the pyritic lead veins, quartz, galena, sphalerite, pyrite, arsenopyrite, and chalcopyrite are most abundant. As accessory constituents of the gangue we have hornstone, jasper, ferruginous quartz, calcspar, siderite; more rarely, brown spar and chlorite. . . . The vein-filling has a prevailingly massive structure, in which the vein minerals occur, either commingled or in separate compact masses. More rarely the ingredients are arranged in bands."

To this description the ore of the Murchison River Mine answers almost in every particular. In addition to the sulphides mentioned, pyrrhotite is common. The blende seems the most abundant of the sulphides, but the others all appear predominant in various parts of the lode.

Among the gangue minerals there is usually a little siderite near the walls, but it is inconsiderable; and in one spot in the centre of the formation there was a small

* Weed's translation: "The Nature of Ore Deposits," Vol. I., pp. 235 and 236.

clean pocket of barytes. The ore also carries gold in small amount.

Other Occurrences of Lead Ores.

Here and there, on the south-eastern portion of the field are occurrences of galena associated with chalcopyrite, and no traces of walls are visible. The country rock is chloritized quartz keratophyre or quartz felsite, and the ore occurs as scattered blebs in the rock.

These deposits, as far as can at present be determined, do not seem likely to produce much ore.

Yet another type of occurrence is to be seen on the slopes of Mt. Murchison, on Section No. 2865, where the galena is associated with barytes and actinolite, together with calcite and quartz.

This may possibly correspond to the type of veins called by Beck the 'barytic lead veins.'*

"In this class of veins," according to Beck, "the gangue consists of predominant barite, with fluorspar and quartz or jasper, besides calcspar. These minerals are generally intergrown in a remarkably thin-banded structure. The barite especially occurs in finely-crystalline crusts (calcbarite); the fluorspar in diverse tints, but mainly green and yellow. The ore minerals, which either form thin crusts or appear sprinkled through the gangue, consist of argentiferous galena, often developed in large flakes, pyrite and marcasite; also zinc-blende, copper pyrite, gray copper, and at times rich silver ores."

In the occurrence on Section 2865 no sign of fluorite was seen. However, it may have been present, as there was only a very small excavation to examine at the time of my visit.

The gangue is a mixture of quartz and barite, and iron pyrites is associated with the galena. Coarse columnar actinolite is associated with the gangue on the borders of the metalliferous area; but there is far too little done on the work to determine anything more than the presence of the minerals mentioned.

The other occurrence of lead ore is that between Kitson's workings and this last-described deposit. The galena occurs as fine dust-like particles in a very pure barytes. There is no sign of an economically valuable lead deposit here. The barite is treated of in a later portion of this report.

* Weed's translation: "The Nature of Ore Deposits," Vol. I., p. 258.

B.—COPPER ORES.

The Cupriferous Veins.

The most considerable amount of copper present on the Mt. Farrell field is found in veins of a rather strange type, to which some reference has been already made.

In the opinion of the writer, they are closely connected genetically with the spathic lead ores, and are due to variations in the composition of the ore-bearing solutions at different points along the fracture system.

Both quartzose and spathic copper ores are well-known types found in many parts of the world. The occurrences at Mt. Farrell resemble to some extent the spathic ores described by Beck in these terms* :—

“The gangue of these veins includes some quartz, but often consists chiefly, and sometimes entirely, of various carbonates, particularly ironspar, as well as calcspar and dolomite.

“Barite is very common, and is at times accompanied by fluorspar. The ore minerals are chalcopryrite, bornite, glance, tetrahedrite, and pyrite. Cobalt and nickel ores and various other ores also occur as accessory minerals.”

This description applies to parts of the cupriferous bodies at Mt. Farrell; but the usual gangue is almost wholly quartz with small stringers of carbonate, and the primary ore is almost always, if not always, chalcopryrite.

If the views stated above are correct, viz., that these copper occurrences are local variations from a somewhat similar lead type, the gangue is apt to become very much more siliceous where the copper is present.

Both the Mackintosh and the Tullibardine ores are strikingly similar, and are of this character: In immediate proximity to each, galena is to be seen, both alone and in association with the copper pyrites.

Unfortunately, both properties are but little developed, and future operations will afford much more information on this subject.

The Disseminated Ore of the South-eastern Sections.

The Osborne Blocks and the more southerly sections show several minor occurrences of ore which do not appear to be fillings of the usual types of fissures. They seem rather to be lenses of ore disseminated through the somewhat altered country rock.

* Weed's translation : “The Nature of Ore Deposits,” Vol. I., p. 226.

One such occurrence on the Osborne Blocks is in immediate proximity to a large blow of hematite; but whether the two have one origin it is impossible to say.

In these cases the copper ore is almost always chalcopryrite. Some bornite is present at times, and fine specks and facings of galena are usually associated with the copper. These remarks apply to the occurrences of the Osborne Blocks, and to some extent to the small pocket of chalcopryrite visible on the slope of Little Farrell on C. Thomas' section. In the latter case there is quartz showing more prominently than in the other cases.

On the northern slopes of Mt. Murchison there is another of these hematite blows which shows stains of copper sulphate where it has been cut by a short tunnel, and the neighbouring porphyroid is flecked with green spots of malachite.

C.—ORE DEPOSITS OTHER THAN THOSE OF LEAD AND COPPER.

Between Kittson's workings, in the section now charted in the name of L. Jolly, and the two 40-acre sections, there is a very well defined reef of almost pure barite, which seems to occupy a fissure of considerable length.

Its possible value as a source of salts of barium is dealt with later.

At Kittson's workings, Section 2829, there are several small veins running in all directions, which contain a mixture of iron and copper pyrites, with some specular iron ore. In addition, at one spot there is a fair quantity of native bismuth and a small amount of a steel-grey sulphide of copper, lead, bismuth, and antimony—probably lillianite.

Some rich silver ore is stated to have come from this spot. The mineral containing it could not be detected in the workings at the time of my visit.

In mentioning other ores it is well to remember that tin ore has been recovered from the granite of Granite Tor not far from the White Hawk Mine.

D.—THE QUARTZ REEFS.

There are some well-defined barren quartz reefs at Mt. Farrell which have caused much waste of time, energy, and capital on the part of prospectors.

By very many on the field they are still regarded as possible sources of lead ore, and this idea is well shown in

the term "main lode" applied to one of these reefs on the Mt. Farrell Mine.

A matter of great importance to the central productive portion of the Mt. Farrell field is the correct interpretation of these quartz reefs.

Their definition is usually excellent, as they occur for the most part in the slate, which readily weathers away from the reef or carries numerous "floaters" of quartz to mark their presence.

Their horizontal extent is considerable, and the width sufficient to suggest large bodies of stone in depth; but it is their relation to the lead ores that is the important point to decide.

As regards age, there is excellent evidence to show that the lead veins are of later date than the quartz reefs.

Looking at the face of the open-cut in the North Mt. Farrell Mine from the north, the most striking feature is the clean-cut intersection of the quartz by the lead ore bodies. The "horses" of mullock left standing, in the exploitation of the ore, are belts of slate traversed by very numerous veins of quartz, which dip rather flatly to the west. These veins seem to be part of a more massive body of quartz, which is seen at the surface in more solid form a little further north (at the north end of the open-cut). This body of quartz is typical of the others on the field and here at least is intersected at a small angle by the lead ore veins.

The quartz reefs being older, we may well expect them where fractured to be traversed by the lead ores, and to contain lead ores where this later impregnation has taken place.

This is well shown in the case of the Mt. Farrell Mine, with its rich shoots of ore enclosed in quartz. For on this latter section the quartz body is full of vughs, partly filled in many cases with crystalline quartz. A long line of vughs, connected in depth with the main fissure by which ascending solutions have brought up the metallic compounds, seems to have served as the cavity necessary for the deposition of the ore. Where the continuous line of ore-filled vughs joins the main fissure, or how it is connected, remains as yet unknown. The facts that are certain are—that the ore is entirely surrounded by quartz; that other lines of empty vughs occur—empty, because the ascending solutions had no access to them from below—and that where the lead ore occurs siderite is always visible, whereas the quartz away from the galena-

siderite veinlets is quite barren, and contains only undigested fragments of slate.

The same phenomena are exhibited by similar quartz reefs in slate on the sections south-west of Thomas' Blocks south of the Murchison River.

The fractures which have admitted the filling of quartz have remained, perhaps, still planes of weakness; and during subsequent fissuring and impregnation a fracture parallel with the original one, or even coincident with it, has formed and been filled. But the ore-filling is of a totally different type to the quartz impregnation, and the characteristic mineral of the later invasion of material is the carbonate of iron.

Whether the minute fissuring of the porphyroid and felspar porphyry previously mentioned is a part of the phenomena of, and simultaneous with, the filling of the larger fissures with quartz is not certain from the evidence gathered. However, on the Tullah Mine and at the Langdon the silicified igneous rock has been refractured and penetrated by metal-bearing veinlets; and this impregnation show some close resemblance to the secondary filling of the bodies of quartz. The felspar porphyry has preserved more of its character during silicification than the slate; for the quartz reefs seem to have almost completely replaced the slate, and only small fragments of the latter remain here and there embedded in the solid quartz.

E.—THE IRON ORES.

There is a considerable amount of hematite, of both specular and compact varieties, in many parts of the field. Much specular ore is scattered through the conglomerate of the Mt. Farrell crest in association with the quartz veinlets.

There is on the north-western flank of Little Farrell a considerable mass of the older schistose conglomerate almost completely replaced by a compact red hematite.

Other very massive outcrops appear in the chloritized quartz keratophyre and quartz felsite of the Osborne Blocks; and yet another similar to these is the porphyroid on the northern slope of Mt. Murchison, in Section 3070.

So the impregnation of iron ore is of later date than the alteration of the porphyries, and perhaps of later date than the conglomerate of the mountain ridge. It is certainly younger than the latter if the impregnation of all the rocks has been simultaneous.

(3)—THE DISTRIBUTION OF ORE IN THE LODES.

The internal structure of all the lodes of the field is in most cases very complex, and the ore minerals share in the complexity.

At times there is a distinct banding of the veins, and usually the several bands are parallel to the general direction of the lode. The clean hand-picked "firsts" are obtained from these portions of the lodes. But any one lode will often show both the banded structure and a brecciated structure as well in the same face; and the ore in this crushed portion is usually scattered through the gangue, and the mixture constitutes the average "seconds."

When banded there is not a noticeable alternation of ore and gangue. It is rather a parallel arrangement of galena of varying grain in the majority of cases. In no case did I observe a separation of galena from blende in the banded portions of a spathic vein.

The galena in the pyritic vein of the Murchison River Mine is partly as clean banded ore, which is sometimes well over a foot wide, and part is distributed through the other sulphides.

In the Mackintosh southern section, where J. Geddes is working, the clean ore forms a series of overlapping lenses on the footwall.

The fahl-ore is irregularly distributed through the lodes, even in those where it seems more common.

The copper veins show an even more patchy distribution of the metal through the gangue in the small faces exposed by present workings.

In the North Mt. Farrell Mine, of which the workings are the only considerable ones on the field, there seemed to be no definite pitch of the richer shoots of ore.

There are undoubtedly shoots, for the lode-fracture often is traceable by a seam of pug and the development of siderite on one or both sides in the slate country beyond the point where the galena is present in sufficient amount to be payable.* This is shown by the "No. 1 lode" of the North Mt. Farrell Mine.

Still, the workings are as yet shallow, and more definite information will be available later.

* "Payable ore" is difficult to define for these mines. It may be reasonably stated to be ore of such grade that from 12 to 15 tons of ore will give 1 ton of galena concentrates, *i.e.*, with a width of lode of from 6 to 8 feet.

The way in which the rich patches of first-class ore cut out abruptly is remarkable in this mine. From visit to visit each face shows considerable changes, both in the total amount of ore and the proportion of firsts.

In my opinion, the presence of the rich bands and pockets of ore is due mainly to the structure of the main and subsidiary fractures in the country rock, and the degree of access to these fractures that has been afforded to the mineralizing solutions.

In the Murchison River Mine this structural peculiarity (referred to above in discussing the influence of country) is so pronounced that the whole of the payable ore is in one great shoot enclosed between porphyroid walls, while the fracture continues beyond on either side. In this case the shoot is pitching southwards at an angle of 55°.

With regard to other variations in the ore, there has already been mention made of the change from a lead to a copper-bearing type along the line of the Mt. Farrell-North Mt. Farrell-Mackintosh fracture. I feel confident that this is one continuous fracture system, that extends right to the Mackintosh River, although its mineral character alters.

Variations of the ore in a vertical direction cannot be said to have been proved by present workings. There is apparently no sign of a progressive impoverishment of the lodes, nor of the galena being replaced by other sulphides. The North Mt. Farrell Mine is again the one from which most information is to be gained; and even here workings are as yet not below the level of the button-grass plain. Still, the lowest workings show no visible falling-off in the amount of first-class ore, even if the assay returns of the firsts average slightly poorer.

The Langdon Mine shows a very abrupt passage of galena into almost pure resin blende in a very short vertical depth, but the workings are very small, and no generalisation could be made applicable to the district from this occurrence alone. Moreover, future operations might reveal at this spot a return of the predominance of lead ores over zinc.

(4)—THE STRUCTURE OF THE LODES.

Fissure Veins.

The majority of the lodes of the Mt. Farrell district are what are commonly known as fissure-veins. The term is used here in a purely general sense. The nature of the filling, whether metalliferous or not, is not implied, nor

the manner of the filling, nor the amount of actual filling and the proportion of ore due to metasomatic replacement.

It is merely implied that the veins have, on the whole, a tabular form, and that their present location is governed by the existence of pre-existing fractures, which have served as circulation channels to the ore-bearing solutions. These channels have been chosen by the vein-forming solutions as affording the easiest path to regions of lower pressure.

The fissure veins of Mt. Farrell are in no case single simple ones which fill one clean fracture.

The fracture systems are usually complex, and the ore veins are the same.

There may be a single main fracture with subsidiary ones leading into it at various angles. This is so with regard to the Murchison River Mine and the south workings (J. Geddes' tribute) on the Mackintosh leases.

And the main fracture itself is generally rather complicated, consisting of the actual plane of separation and the crushed zone of country alongside. This crushed zone is usually crumpled and contorted to a high degree, and the metallic minerals, galena and blende, together with the siderite, quartz, and remnants of crushed slate, make up the main bulk of second-class ore.

Slickensiding is usually to be seen on the walls of the main fracture, and indicates a relative movement between the walls in a vertical direction. The main fracture usually has a certain amount of pug.

As regards the origin of the fractures, little information can be ascertained yet. The slate in the neighbourhood is much contorted, and overthrust faults can be seen on a small scale; yet how far compressional forces have contributed to the actual fracturing is hard to say.

The fissures, once formed and filled with ore, have certainly reopened in some places, and the further movements have resulted in the brecciation of the lodes. This lode material of brecciated galena and quartz with pug is well shown on the No. 2 level of the North Mt. Farrell Mine at the extreme north end of the workings, where the soft wet puggy ore runs in on the drive.

The "sheeted zones" or "lode formations" which carry the ore in the Tullah Mine and the Tullibardine are similar, save that the fracture is a distributive one rather than simple. A broad belt of the country suffers simultaneous impregnation.

As to whether the limestone country of the White Hawk district carries any fissures of longitudinal continuity, I was not able to determine at the time of my visit.

The galena in the quartz of the Mt. Farrell Mine forms in a sense a fissure vein of lead ore. It is, however, rather different from the other cases in that there have been two distinct periods of filling. The first period was characterized by an absence of metallic ores, and partial cavities, or "vughs" were left in the quartz then introduced. Some of these cavities, of which the directions and dimensions varied a little, were in continuity with each other. They were also continuously connected with the fractures by which the metallic ores were introduced at a later date; so that, while the lead ores are, in the main, deposited in a separate system of fractures, the older fractures have also served as loci for the deposition.

The ore in the Mt. Farrell Mine has been deposited in the heart of the quartz body. On the southern section of the Mackintosh lease (J. Geddes' tribute) the quartz forms the footwall. The fracture in this latter case has re-opened along the western edge of the quartz, which has adhered to and given stability to the footwall. The subsidiary fractures which lead from the main fracture are all on the hanging-wall (western) side of the lodes.

Disseminated Ores.

The disseminations of copper pyrites and galena show no structural characteristics at all. In one case, near the Osborne Blocks' cage, the joints in the chloritized quartz felsite cut across the ore, and are clearly of later date. The primary ore does not follow any visible divisional plane or cavity in the rock.

(5)—THE STRIKE AND DIP OF THE LODES.

There appear to have been several main directions of fracturing of the crust in the district:—

- (1) The main lode-line, which extends from the Mt. Farrell Mine northwards through the North Mt. Farrell and Mackintosh sections, and the Farrell Blocks. The trend of the fracture is, on the whole, a few degrees (9°) east of north; and the dip is between 60° and 70° to the westward.
- (2) The Central Farrell and Murchison Extended (North Murchison) Mines are situated on a

fracture system which trends almost due north and south, or a degree or two to the west of north. The dip is west 60° - 70° .

- (3) The Murchison River lode bears N. 28° E., and thus offers a sharp contrast to the others. It is practically a vertical lode.
- (4) On the south side of the river the fractures strike almost invariably west of north. There is little work done, and the figures given must be used with great caution, since they are observations made over very short lengths of lode outcrops, or short development drives. Thomas' Blocks lodes strike about 25° W. of N. The Tullah lode strikes 8° W. of N. at the surface. Foy's lode, near Kittson's, strikes N. 21° W.
- (5) The Langdon Mine, to the west of the Tullah town-site, is remarkable in that the lode there strikes due east and west. The dip is to the north.
- (6) The northern occurrences at the Tullibardine are very difficult to judge as regards strike, but the prevalent direction of the fractures seems to be east of north about 20° .

With regard to these characters there are a few points of further interest.

The striking feature of the whole system of fracturing is the abrupt change of strike in the case of the Langdon Mine. The existence of an east-and-west fracture in connection with a north-and-south series in this district would not appear remarkable. Here, however, the east-and-west fracture alone appears. There are certainly in the immediate vicinity a few very small fractures running at different angles, but no north-and-south series is visible. The presence of such a fracture system may yet be proved, and its presence seems quite probable from the general structure of the rest of the district.

In the Mt. Farrell Mine the south workings on the western lode show a remarkable series of changes in the strike. From the main adit the lode-channel is driven on for 145 feet on a bearing of 23° . The next 50 feet of driving have a bearing of 9° . Then the lode resumes almost the old course, and is followed for 25 feet on a bearing of N. 25° E. Here a split occurs, and the western drive bears 25° for another 50 feet. The two portions reunite and continue for 100 feet on a bearing of 26° ; and then

the lode again returns to its former course of 9° , along which 125 feet of driving has been done.

There seems, then, to be two main directions to the course of the lode— 9° and 25° ; and the reason for this lies probably in the fact that the slate has a distinct "grain." Some part of the break runs with the grain and some portion across it.

(6)—THE ALTERATION OF THE WALL-ROCK OF THE LODES
BY MINERAL-BEARING SOLUTIONS.

Coincident with the introduction of the metals into the fractures, and consequent upon the chemical activity of the solutions which have been the carrying agents, there has been usually some marked degree of alteration of the wall-rocks in immediate proximity to the lodes. The change has been caused by the introduction of fresh material from without, or the the partial alteration of the minerals already present in the country rock.

In the North Mt. Farrell Mine the slate, in its least altered form—away from the lodes—is seen to be a pyritic one; yet near the lodes the iron mineral is seen to be the carbonate. Pyrite is to be seen in the lode itself, but the slate seems to have been freed from the sulphur content near the lode fissure.

The iron carbonate may possibly have been all introduced by the lode-forming solution. But if it has, the pyrite has all been removed from the slate. It seems more probable that the iron has been provided by the pyrite, and that siderite is the result of carbonated solutions reacting upon the sulphide.

Besides this alteration there is a notable development of graphite in some places where the lodes occur in the dark-coloured slate.

The graphite may be an original constituent of the slate, but I could not find it in any spot where the lode-forming influences have not been at work; still, in no case did I observe it in any other rock than the dark slate.

The other characteristic alteration effected in the rocks enclosing the lodes is the development of a waxy micaceous aggregate, which has a smooth or even greasy feel in some cases.

This aggregate is perhaps best termed pinite, in that it answers to Dana's* description:—"A general term

* "A Text-book of Mineralogy." Edition 1899, p. 466.

used to include a large number of alteration products, especially of iolite; also spodumene, nephelite, scapolite, felspar, and other minerals. In composition, essentially a hydrous silicate of aluminium and potassium, corresponding more or less closely to muscovite, of which it is probably to be regarded as a massive, compact variety, usually very impure from the admixture of clay and other substances."

The dark-coloured slates are not visibly altered in this way. No microscopic examination has been made to find whether the alteration has been effected, even though not visible to the naked eye.

In the pale-coloured clay schists, however, the change is well defined. The rock already contains a considerable amount of sericite,† but this is materially augmented, and a yellow to green waxy product results.

This is to be seen on the Mackintosh and Farrell Blocks sections, as well as with both the lead and copper veins of the Tullibardine; in fact, wherever the lodes traverse this clay schist.

The porphyroid suffers an entirely similar alteration, and the spathic type of lode is accompanied by a greater degree of change than is the pyritic.

The country of the Thomas' Blocks main lode is this porphyroid which has been strongly attacked in this way.

In this section the rock still shows the idiomorphic and embayed quartz phenocrysts, but almost the whole of the rest of the rock has been replaced by the pinitic aggregate.

The same is true to a less degree of the country rock enclosed in the lode-formation of the Tullah Mine.

This is the type of alteration which has been termed "sericitization."

Yet another alteration has taken place in the case of the disseminations of lead and copper ore on the Osborne Blocks.

Here a silicification of the chloritized quartz felsites is the characteristic accompaniment of the ores. The silica has proceeded into the quartz felsite, and filled up the minute cracks, and has bodily displaced the igneous rock as well. The invasion of quartz is gradual, and there are no clearly defined lines between the unaltered and altered quartz felsites.

† *Vide supra*, p. 22.

(7)—THE SECONDARY ALTERATION OF THE LODES.

One of the striking features of the Mt. Farrell field is the small amount of oxidised ore that has been formed by the action of the meteoric water upon the lodes.

The outcrops, where they are visible, are covered with a very thin rusty coat, which shows a little—very little—lead sulphate or carbonate.

As a rule, the outcrops are only laid bare in the stream beds. On the other portions of the hill-slopes the soil-creep brings a cover of the country rock from higher up the slope, till the lode outcrop is completely hidden.

So any oxidised crust that could form would tend to join the surface material on its downhill path, and the conditions necessary for the accumulation of a gossan have not existed since the present physiographic cycle began.

A few ironstained lumps of ore with a core of galena can be still picked up in the creek beds, but no gossans are to be found of any value or extent. Even the pyritic mass of the Murchison River Mine has a very small capping of gossan.

Lead carbonate is practically not to be seen. There are a few crystals on the Murchison Mine in the ironstone near the surface. I saw a little on the surface of the North Mt. Farrell and Mt. Farrell Mines. The White Hawk Mine contains a little more; but there the country rock is limestone and far more permeable by surface-waters.

In no case was there visible any silver chloride or other secondary silver ores.

The quartz reef of the Mt. Farrell Mine containing the vughs filled with lead ore has arrested the downhill creep of the ore, and the result is that secondary processes have there been operative. The unfilled vughs have assisted by enabling an active circulation of surface waters to attack the upper portions of the deposit. Some of the contents of this upper portion have been leached out, carried downwards, and redeposited at lower levels. The lead is redeposited in the form of octahedral crystals of galena, whereas the first-formed ore is invariably cubic in form.

The octahedral galena is found either deposited upon the cubical metal in the heart of vughs, or embedded as fairly-perfect crystals in a greenish kaolin occurring in pockets along the borders of the primary fillings of the vughs. A similar deposition of secondary octahedral galena upon the primary cubical mineral is mentioned by

Van Hise as occurring in the lead deposits of the Mississippi valley.*

But for this case, the lead ores of the field show no sign that can be taken as undoubted evidence of secondary concentration.

The existence of rich shoots of secondary ore has not been proved; and this point is one of great commercial interest. It is frequently stated on the field that the mining operations are as yet "too shallow." The apparent inference is that deeper workings will lay bare richer ore; but such richer ore is only to be confidently expected when a zone of leached ore has been passed through in the upper workings.

The bulk of the lead ore at Mt. Farrell is, even at the surface, practically fresh and undecomposed, and, with the single exception indicated, free from leaching, and not enriched by secondary processes. Still, this fact carries much comfort to mines like the North Mt. Farrell, whose first-class ore can be therefore confidently expected to descend. It is not the result of a local concentration, nor due to the formation of a zone of secondary enrichment that might be expected to give place to poorer ore with deeper development.

The copper deposit on the Tullibardine lease has suffered some degree of alteration, and the copper that has been leached out of the upper portions of the lode has been redeposited, in part at least, in the form of native copper.

This native copper is in a very fine state of division, and is distributed through the ironstained clay schist between the seams of cupriforous quartz.

Its quantity will probably not prove to be considerable. The zone that has, by the leaching processes, provided the native copper is not more than a few feet in depth; and the total bulk of copper ore in the formation cannot be expected to produce much secondary ore.

(8)—THE UNDERGROUND WATERS.

Before venturing to formulate an account of the mode of origin of the lodes of Mt. Farrell, it will be well to consider the phenomena now presented by the underground waters. For the ores have been undoubtedly deposited from solution, and the origin of the ores is involved with the origin of the solutions which brought them to their present position.

* Van Hise: "A Treatise on Metamorphism," pp. 1145 and 1146.

When the rainfall at Mt. Farrell is taken into consideration the underground workings appear to be remarkably dry. The water that is met with is restricted to the planes of movement of the rocks, and the rock-masses between these fracture-planes are dry.

In the North Mt. Farrell Mine practically the only water that finds its way into the workings is to be seen where the clay schist is in contact with the dark slate.

The lodes are always damper than the country rock. For instance, the Mt. Farrell south workings on the western lode show a good deal of water, and the neighbouring crosscut in country rock is nearly dry throughout.

Moreover, the water makes its way downwards in every case which I observed, with the exception of an occurrence in the Mt. Farrell Mine. This is in the quartz body which contains a number of vughs, as already explained. The main adit on the northern workings has cut across the quartz reef, and a bubbling spring of water appears in the sole of the drive. This spring is directly below the main line of ore-filled vughs mentioned above. But the spring-water is fresh and cold, and is clearly the surface-water that has an intake at some point higher up the hill. The exact channel by which it has travelled is not visible; yet there is probably a main cross-fracture dipping west and connecting in depth with the cavity in the quartz by which the water ascends.

The circulation at this point appears to be free, and the flow considerable; yet it must be remembered that this freedom of circulation was impossible until mining operations penetrated the fractures at a level below their intake. Before mining began the natural circulation must have been very much more restricted.

Even now there are cases that show how "tight" the lodes are. The Mt. Farrell northern workings contain a shaft beneath which a drive on the lode has been put in; and during my visit to the field, lasting over nine weeks, the water had not drained out of the shaft.

It is stated on the field that the amount of water that drains away from the mines does not vary much with the seasonal changes. My visit to the field was too brief to judge this matter by personal observation.

There is no evidence at Mt. Farrell at present available to show the existence of any other water in the mines than that which has fallen on the surface as rain, and which has made its way downwards under the influence of gravity alone. Yet it cannot be granted that this surface-water

can have been the agent whereby the lode-matter has been introduced into the fractures.

For the alterations that have been effected in the wall-rocks, as well as the insolubility of the lode-forming minerals in pure and cold water, lead us to believe that the solutions which produced the lodes were hot, and that they contained salts in solution; and further, that these solutions ascended from deeper portions of the crust by paths of considerable downward continuity. These circulation-channels which offered the least resistance to the ascending mineral waters were the main fracture planes of the district.

The surface-waters have had very little to do with the lodes. Their effect in modifying the mineral composition of the lodes which the ascending waters have deposited has been dealt with under the head of the secondary alteration.

The unoxidised ore being found almost at the surface, it is not remarkable that no line can be drawn to show the "ground-water level." This line, which marks the level below which any excavation remains permanently full of water, may be said to almost coincide with the ground-surface in most portions of the field.

In the White Hawk limestone it is naturally at a lower level, but how far down below the adit level it exists was not determined when I visited the property.

(9)—SUMMARY OF THE GENESIS OF THE LODES.

As the result of the consideration of the facts dealing with the Mt. Farrell district which have been gathered together, and the comparison of these facts with those now known concerning other mining fields, a brief outline may be formulated of the most probable origin of the lodes. The views of the writer on this subject must be held to be neither original nor unusual. An attempt is made here to apply to the Mt. Farrell field the results of conclusions arrived at by many mining geologists, especially in America and Germany, concerning the origin of ore deposits.

First of all it becomes apparent from what has been said above concerning the independence of country and lode, that the proximate source of the ores must be sought outside the rocks in which they now occur.

The question arises then, "To what portion of the earth are we to look to discover their origin?" And in answer to this question it should first be stated that metallic ores

which are the fillings of cavities or fractures in rocks at a date subsequent to the formation of the rocks themselves (*i.e.*, the so-called *epigenetic* ore deposits) have almost invariably been introduced from below.

Looking downwards, we are at a loss to see any rock-mass which differs from that which contains the lodes on the surface, for the development of the mines in depth can hardly be said to have been started yet.

Here the geological structure observed is of assistance.

The only rock-mass which can be considered to underlie the rocks of the field in depth is the granite which outcrops at Granite Tor, and appears there to be dipping below the mantle of mica schist towards the west.

The majority of mining geologists are of the opinion that the ore deposits of deep-seated origin derive their metallic contents from plutonic igneous magmas, and that granitic magmas especially are the proximate sources of the metallic minerals. The granitic magmas during their solidification, give off a quantity of mineralized vapours and solutions, which ascend by the most accessible channels, and deposit their metallic contents during the ascent.

We know that there is a very large area of Western Tasmania underlaid by a granite mass, which at its outcrops at Hampshire Hills, Middlesex, Cox's Bight, and Heemskirk is stanniferous.

The country overlying this granite is mineralized in many places, for it is a much-folded, and therefore much-fractured area; and some of the minerals found with other ores show characters which help to connect them genetically with the tin ores. Such minerals are those which contain boron and fluorine.

The discovery of fluorspar at Thomas' Blocks is of great importance in this search for the origin of the Mt. Farrell lodes, for fluorspar is a mineral most characteristic of the lodes, either in granite or in immediate proximity to granitic masses. It is, for instance, a common gangue mineral in the Middlesex tin-wolfram deposits, and on the north-east tin-fields is common near the lodes.

The only other mineral which occurs at Mt. Farrell, and which is a common associate of the typical ore-veins of granitic areas, is native bismuth, which is quite plentiful at Kittson's workings in the south-eastern portion of the field. So we may reasonably infer that Mt. Farrell owes its mineral impregnation to the granite which outcrops at the places mentioned.

The agent by which the metallic contents of the lodes were borne to their present position was undoubtedly, in the main, water; but the solutions rising up the lode-fissures were probably of complex composition, and, like the waters of the hot springs of to-day, they probably contained sulphur in the form of sulphides or sulphates of various elements, together with carbonic acid, free and combined. Such heated rising solutions would cause the alterations of the wall-rocks that have been mentioned.

The confinement of these ascending solutions to the main deep fracture-planes is explained by the fact of their deep-seated origin. The deeper fractures would be the ones which would offer paths of less resistance to the imprisoned vapours.

Once formed, the lodes have shared in the general degradation of the region by surface agencies. They have been attacked to some extent by the processes of oxidation, but the accumulation of the oxidized material has been prevented by the physiography of the lode-bearing zone.

VI.—THE MINING PROPERTIES.

(1)—THE NORTH MOUNT FARRELL MINING COMPANY, NO LIABILITY.

The sections held by the company are the following:—
4116-93M, 68 acres; 2722-M, 40 acres; 1074-M, 20 acres;
3262-93M, 76 acres; 1867-M, 80 acres; 2351-M, 75 acres;
292-w, 10 acres; and 82-w, 4 acres.

Of these sections, that which is numbered 3262-93M is much the most important, and carries the principal workings and the concentrating mill.

From the accompanying geological map it will be seen that the lodes worked by this company are situated on the western side of the slate belt, and close to the narrow band of pale clay schist.

There are four main levels at which work has been carried out. These are named respectively No. 1, No. 2, No. 3, and No. 4, and are separated by vertical distances of about 60 feet. The workings have disclosed the presence of three main lodes, which converge towards a point situate in the neighbourhood of the open-cut.*

Of these lodes, the eastern one, called by the management the No. 3 lode, seems to be undoubtedly the principal one. It conforms, on the whole, to the general direction of strike of the fracture which runs southwards through the

* See plan of mine workings, Plate IV.

Mt. Farrell ground and northwards to the Mackintosh River. Its continuity is much more pronounced than the other two, and the distribution of ore more uniform. The other two lodes are nevertheless valuable assets, for although the present output is being maintained mainly by the No. 3 lode, the No. 1 and No. 2 lodes will almost certainly provide much ore with deeper development.

The No. 1 lode, situated almost on the edge of the main body of slate, and in immediate proximity to the clay schist, strikes about N. 35° E., and dips westwards at about 60°. It is a very broad lens of ore, which was first encountered in driving the No. 4 level crosscut.

On development it was found not to extend upwards very much above the No. 3 level, where it splits into two bodies separated by mullock.

All the ore has been stoped out of this lode above the No. 4 level, with the exception of a small pillar above this drive.

There has been a large body of ore removed, as the total length of this ore lens is, on the No. 4 level, 240 feet, and it has been stoped out for a width of 35 feet in places.

All of this ore having been removed, I was unable at the time of my visit to inspect and note its characters.

There have been drives put in northward on the line of this lode, which is marked out by a slight development of the carbonate of iron in the country rock; but on both levels a blank of about 120 feet was met with.

A crosscut driven west on the No. 3 level, at a point a little south of the intersection of this barren channel with the No. 2 lode, met with an ore-body, which is now being prospected. Assay returns, showing 82 per cent. of lead and 60 ozs. of silver per ton, have been obtained from the galena at this point.

This body is now being prospected northwards on the No. 4 level, and a lode 4 feet wide has been proved. A little first-class ore is showing, and the footwall is deeply slickensided. On the No. 3 level the grooving of the wall-rock was noticeable on the hanging-wall side of the lode, and no defined footwall was visible.

A short crosscut was put in to the westward on the No. 4 level to test the width of the formation. Some galena was met with, but no defined wall. Work is proceeding along the line of the lode.

It may be that this ore-body is a continuation of the No. 1 lode, but it seems more likely to be a separate branch lode from which some ore has been won at the surface a little further northwards on the No. 2 level.

The only other work done upon the western ore-channels is a winze sunk from the No. 4 level on the No. 1 lode. It has been sunk some 30 feet, but was full of water at the time of my visit.

I am informed that the ore on the No. 4 level for the whole length of the ore-shoot was of good quality; and there seems to be every reasonable prospect that deeper workings will expose a continuation of these values in depth.

The No. 2 lode has a strike about N. 17° E., and the westward dip is steeper than that of the other lodes. This lode has been productive of ore, especially above the No. 2 level, whence stopes have been carried to the surface for 750 feet in length. Recently the track of the ore-channel has been driven on at the No. 1 level, and the strike changes through a wide angle rather abruptly. The fissure seems to be making towards the No. 3 lode-channel as if it would unite with it.

Between the Nos. 2 and 3 levels this central ore-body has been productive for about 400 feet, for which length stopes have been carried for nearly the whole height. Between levels No. 4 and No. 3 there are stopes for a length of 250 feet, but the southern extension of the lode-channel shows ore of poorer grade.

On the No. 4 level the same abrupt change of strike is noticeable as on the No. 1, and there seems no doubt that this ore-channel will join that of the No. 3 lode if traced out in future workings.

The No. 3 lode is the principal source of the ore which is being won at the present time. It is a lode from 15 to 22 feet in width, and a brecciated zone about 6 feet wide on the footwall side.

No hanging-wall at all is to be seen. The boundary of the lode on that side is arbitrarily fixed by the grade of the ore. There seems to be a definite footwall with a seam of pug, but ore is often obtained beyond this wall.

The pug sometimes carries ore, a fact which seems to indicate later movement in the lode-channel. The veinlets of metal in the main body of ore are irregularly distributed; but the larger seams of firsts run with the direction of the channel.

The strike varies in the portion developed from a few degrees west of north to about the same amount east of north.

The dip is between 60° and 70° to the westward.

In developing this lode the prospecting drives have been pushed forward in the brecciated zone on the footwall,

and have been timbered. The ore is broken out from the lode later, and this ground needs very little timbering.

From this No. 3 lode there still remains much ore to be won from that portion which is already being worked.

On the No. 4 level it has been stoped out for 120 feet south of the main crosscut to a height of 15 feet. Then, on the northern side of the crosscut, there are about 540 feet of stopes from which 18 feet of ore have been removed.

On the No. 3 level there is not so much work done at the southern end. At a point 30 feet north of the rise which runs from the No. 4 to the No. 2 level the stopes begin, and reach a height of 30 feet at a distance of 180 feet from the rise. In the next 180 feet their height rises to 50 feet, and continues at that level above the drive for another 75 feet, where the rise is taken from No. 3 level up to the open-cut. North of this point there is hardly anything more than development work done.

Vertically above these stopes last mentioned (with a vertical height of 50 feet from the level) there is a block stoped out to within a few feet of the open-cut from the No. 2 level, but no further stoping is done on this level. The ore above the drive is practically unknown, and trenches are being put in on the surface to endeavour to locate the outcrop. Since my departure from the field it has been reported that the lode has been picked up.

At its northern end this lode encounters the quartz, which appears to pitch S.S.W. from its outcrop in the open-cut. Beyond this it has not been followed on the No. 4 level, but a drive has been continued northwards past the quartz on the No. 3 and No. 2 levels.

The ore-body changes in character after traversing the silicified zone, and consists mainly of a wet running pug charged with brecciated fragments of quartz, galena, and slate. This is especially noticeable on the No. 2 level, where the ore-body has run in on the drive. This ore resembles that which is worked about 150 feet further north, in the Mackintosh section. The galena is said to be finer in the North Mt. Farrell workings, but the ore does not appear different in general character.

At the south end of the present workings on this lode there is a silicified zone of the slate met with, and the lode seems much disturbed and poor. Still, the channel of the circulation is there, and the development of this end of the property should reasonably prove further payable ore in this direction. The grade of the ore cannot be expected to remain quite uniform throughout, and it should be

remembered that during the earlier days of the mine this No. 3 lode was passed through in a crosscut which penetrated into the country 35 feet beyond the lode, and the presence of the lode was not detected.

At the present time the No. 4 level crosscut is being driven eastwards, and has attained a total length of 900 feet from the mouth of the adit. It is being driven in the hope of meeting with further lodes to the east of the present system.

The grounds for supposing that any ore-bodies occur on the property in such a position that they might be cut by this tunnel seem to me insufficient. The occurrence of lead ore in the quartz reef on the Mt. Farrell Mine is one possessing many singular features, and it would apparently be remarkable indeed if the North Mt. Farrell Mine met with any similar body of ore. As indicated above, and referred to again below, the existence of the vughs filled with ore requires a very exceptional chain of circumstances, and the existence of a separate lode system of any magnitude further to the east is not yet proved.

There is, it is true, a small veinlet of ore on the south-eastern boundary of the open-cut; but I regard this as purely a subsidiary fracture, and not likely to possess any great horizontal extent.

The quartz masses in the slate have been shown to be of separate origin from the lead ores, and the quartz reef on the Mt. Farrell property bends sharply to the north-east, and then disappears on entering the North Mt. Farrell lease. There are other quartz outcrops further north, but while of similar origin to the main masses, their continuity with these is doubtful.

The North Mt. Farrell output is largely made up from their second-class ore. The proportion of first-class ore to seconds is shown in the table below. The concentrating mill has lately been enlarged, and it is estimated that it is now capable of treating from 65 to 70 tons of ore per shift of eight hours.

Mill Scheme.—From the bins the ore goes to the jaw-crusher, which reduces it to a size of 1 or $1\frac{1}{4}$ inch. Thence it passes to trommels, which separate the fines. The latter go straight to the tables, and the coarse material passes to two topping jigs.

Thence the ore passes to the coarse rolls, which crush it to $\frac{3}{8}$ -inch; and deliver it to the first sizing trommel. The oversize passes to the second rolls, and the remainder is elevated to the jig-trommels.

There are four screens, whose apertures are as follows:— $\frac{1}{4}$ -inch circular, $\frac{3}{16}$ -inch circular, $\frac{3}{32}$ -inch circular, and $\frac{3}{8} \times \frac{1}{32}$ -inch slots. These screens control the supply to the first four jigs; and the fines which pass through the last screen go to the tables.

The middle products of the jigs go to the second rolls.

These second rolls feed the sizing-trommel on the other side of the mill. The oversize (above $\frac{3}{8}$ -inch) is returned by an elevator to the rolls. The remainder of the ore passes to the jig-trommels. There are four jigs on this side also, and the material they treat is sized by screens with the same apertures as on the other side of the mill. The fines pass to the tables. The middle products of these jigs go to the dump.

The tables include two Cards, one Wilfley, and one Sperry.

In addition, it is proposed to put in a regrinding plant to deal with the middle products from the tables and second jigs. This addition will undoubtedly greatly improve the efficiency of the mill.

The value of the mine and mill products may be seen from these figures, which are the averages of the assays between the months of July and October, 1907.

	Lead. per cent.	Silver (ozs.) per ton.
No. 3 tunnel, firsts	62.3	64.9
No. 4 tunnel, firsts	58.9	62.8
Jigs	51.1	47.9
Slimes	55.2	44.9

THE NORTH MT. FARRELL MINING CO., NO LIABILITY.

Comparative Statement, showing Average Results for the Last Seven Half-years.

	October 31, 1904.	April 30, 1905.	October 31, 1905.	April 30, 1906.
Crude ore, total quantity handled	6956.77 tons	6337.13 tons	7838.95 tons	10,304.92 tons
Crude ore, quantity handled for each ton of marketable ore produced	7.24 tons	7.70 tons	9.66 tons	8.75 tons
Crude ore, silver recovered, per ton	9.45 ozs.	9.61 ozs.	6.39 ozs.	6.02 ozs.
Crude ore, lead recovered	8.40 per cent.	8.50 per cent.	6.15 per cent.	6.17 per cent.
Crude ore, quantity produced	876.79 tons	809.52 tons	811.28 tons	1175.5 tons
Marketable ore, total value at mine	£7393 3s. 5d.	£8905 15s. 3d.	£7371 10s. 10d.	£11,588 1s. 9d.
Marketable ore, net value per ton at mine	£8 6s. 4d.	£11 0s. 0d.	£9 1s. 8d.	£9 13s. 9d.
Marketable ore, average silver assay	68.42 ozs.	74.10 ozs.	61.82 ozs.	52.87 ozs.
Marketable ore, average lead assay	60.83 per cent.	65.51 per cent.	59.51 per cent.	54.07 per cent.
Crude ore, total quantity handled	12,091.53 tons	12,382.05 tons	13,506.1 tons	—
Crude ore, quantity handled for each ton of marketable ore produced	8.51 tons	8.1 tons	7.6 tons	—
Crude ore, silver recovered, per ton	6.19 ozs.	6.33 ozs.	6.91 ozs.	—
Crude ore, lead recovered	6.71 per cent.	6.54 per cent.	7.36 per cent.	—
Crude ore, quantity produced	1430.68 tons	1501.6 tons	1778.91 tons	—
Marketable ore, total value at mine	£15,872 13s. 10d.	£17,574 9s. 4d.	£21,505 11s. 10d.	—
Marketable ore, net value per ton at mine	£11 3s. 5d.	£11 14s. 0.7d.	£12 1s. 9.4d.	—
Marketable ore, average silver assay	52.69 ozs.	51.1 ozs.	52.47 ozs.	—
Marketable ore, average lead assay	57.16 per cent.	53.53 per cent.	55.91 per cent.	—

(2)—THE MT. FARRELL MINING COMPANY,
NO LIABILITY.

This company holds the following sections:—2409-93m, 80 acres; 2410-m, 80 acres; 2656-m, 10 acres. The main workings are situated on Section 2409, and are situated on the northern and southern boundaries of the section.

There is one well-defined lead-bearing lode on the property, and this is, in my opinion, undoubtedly that which continues northward through the North Mt. Farrell and Mackintosh leases. On this property it is referred to by the management as the "western lode." A considerable quantity of ore has been recovered from the occurrence in the strong quartz reef, which is a filling of a line of vughs with lead ore, and at both the northern and southern workings on the Section 2409 the quartz mass has been prospected.

The Northern Workings.—The main adit starts from the northern boundary, and runs in some 725 feet on a bearing of 109°. It is situated 180 feet above the No. 4 tunnel of the North Mt. Farrell Mine.

The tunnel was started in massive porphyroid, and continued in this for 289 feet. Then followed 49 feet of pale clay schist; and then 225 feet of slate were passed through before the "western lode" was met with.

This lode was driven on northwards for 23 feet. It shows quartz and siderite, and carries some milling ore here and there over a width of 3 feet.

Southwards the lode has been driven on for 175 feet, and in the last few feet a deviation to the east was made to carry the workings under a shaft formerly put down on the surface. Some 20 feet back from the face of this drive, the workings were again carried southwards for 53 feet on the lode. The lode contains from 2 to 3 feet of milling ore, in which bunches of firsts are to be found. There is a well-defined footwall on this lode, which dips to the west at 60°. The hanging-wall was good up to the point where the drive deviated to the east. As in the case of the North Mt. Farrell No. 3 lode, the footwall country here sometimes carries ore behind an apparently sharply defined wall.

The strike of the lode here is between 22° and 25° east of north. As mentioned above, the lode-fissure has two prominent directions of strike in this section, viz., 9° and 25° east of north; and the northern workings conform to the latter direction.

On driving the main crosscut another 88 feet eastwards a big quartz formation with a total width of 50 feet was met with. It dips west at 70° . The hanging-wall is well defined, and the quartz is massive on this side; but on the footwall side there are numerous vughs and fragments of undigested slate in this quartz.

A drive has been carried southwards along the hanging-wall of the quartz on a bearing of 185° for a distance of 159 feet. A little galena was visible now and then at the junction of quartz and slate.

When the main crosscut had been driven 44 feet past the hanging-wall of the quartz body some second-class lead ore was met with. The crosscut was continued another 30 feet, and finally abandoned in a dense pyritic slate like that intersected by the No. 4 level crosscut of the North Mt. Farrell Mine east of the lodes.

From the point where the second-class ore—siderite and galena—was met with, a rise was put up. For the first 16 feet only payable seconds were met with, but these gave place then to clean first-class ore, which continued to within 10 feet of the surface. This remarkable ore-body turned out to be due to the filling of a long line of vughs in the quartz with lead ore. The ore is entirely surrounded by quartz, and the central cavity of the vughs was not completely filled with ore.

The vughs pitch in all directions, and the ore-channel has a most irregular form. The ore from this pipe carries a little carbonate of iron and a compact green mineral, which I take to be a mixture of sericite and kaolin. Octahedral (rarely with dodecahedral modifications) galena occurs on the outer surfaces of the mineral crust, having apparently been deposited on the cubical galena by secondary processes. It also occurs in very perfect crystals in the soft pug and brecciated quartz sometimes found on the borders of the vughs. The whole of the ore at this place shows a brownish stain from the presence of limonite.

At the top end there is some zinc blende with the siderite and green sericite-kaolin aggregate. Most of the ore had been removed from this rise at the time of my visit. A little remained on the level on the north side of the main crosscut in a mixed gangue of quartz and carbonate of iron. There is a spring of water bubbling up on the level from below at this point.

From the south drive on the hanging-wall of the big quartz formation, at a distance of 68 feet from the main adit, an eastern crosscut was driven through the quartz

for 46 feet. An empty vugh was passed through at 21 feet. At 40 feet a body of quartz and siderite was met with, and a rise was put up on it for 69 feet. At the lower end of the rise very little metal was showing, but at the top good seconds were found. The rise was abandoned at 69 feet from the level on account of bad air. A candle would only just keep alight at the time of my visit. This rise was later connected with the upper workings by sinking from the intermediate level.

At a distance of 100 feet from the crosscut just mentioned another eastern crosscut was started from the south drive. It was in some 37 feet at the time of my visit, and was in a silicified zone of slate carrying clean quartz veins.

On the surface above these workings some considerable prospecting has been done. An open-cut 12 feet deep and 18 feet wide has been broken out at a point 40 feet south of the first rise. Veins of clean ore occur in the quartz at this place, and some firsts have been bagged. To prove the occurrence an adit was driven 30 feet lower down, and met with the ore distributed irregularly through the quartz; and 8 tons of firsts were recovered in the work.

Some 15 feet below these workings a short intermediate level has been driven, and good ore proved. These workings are 85 feet above the lower level.

In prospecting the good second-class ore south of the first rise a fresh body of firsts was met with similar to that in the first rise. The work done on this has resulted in the proof of the continuation in depth of this ore to the second rise put up from the lower level. The upper workings are now connected with the lower by this rise also.

This occurrence of ore has been mentioned in an earlier part of this report. It seems to me to be undoubtedly due to the passage upwards of mineral-bearing solutions through long lines of connected vughs in the quartz. The two rises are similar in general structure, but the No. 1 rise carried much more first-class ore. At the intermediate level the ore seems to have been more scattered through the quartz. There appears to be, on the evidence of the two rises, a shoot of first-class ore pitching north at a steep angle.

There is nothing to show the existence of another line of ore-filled vughs, and the present system of prospecting (from the lower level south drive by crosscuts across the quartz body) does not appear to me to be either the least

expensive or the most likely to prove the existence of other pipes. I should recommend that the prospecting in a southward direction for the ore contained in the quartz be continued on the intermediate level, where the track of the ore is better defined. Any apparent downward continuation of ore could then be prospected at a lower level without the uncertainty which exists at present.

At the lower level I should recommend that the prospecting work be done by driving on the line of the two rises already located, rather than by crosscutting from the drive on the hanging-wall of the quartz-mass. This latter method is nothing more than blind stabbing, and the small horizontal extent of the pipes makes it a very easy matter to miss the ore when within even a few inches of it.

The question of prospecting northwards on this level is worth considering carefully. The ore-shoot appears to pitch in that direction, and the northern boundary of the section is about 400 feet distant.

A shaft was sunk at the outcrop of the western lode for a depth of 50 feet, and abandoned. It contained water at the time of my visit, but was being gradually drained by the south drive on the western lode below it.

At the surface there is some good milling ore, said to be from this shaft, but I could not see the ore *in situ*.

The Southern Workings.—The upper adit level has been put in for a distance of 236 feet on a bearing of 107° . At 207 feet from the entrance a short drive has been put in northwards for 51 feet bearing 21° , and a crosscut driven westwards for 21 feet on a body of second-class ore. The main workings on this level are 29 feet further east, where a drive runs north for 102 feet on a bearing 25° . A rise has been put up for a few feet on ore, and a couple of narrow stopes 3 feet wide taken out. I saw a couple of inches of firsts on the footwall here.

No work was being done on this level at the time of my visit.

The main adit is driven on a bearing of 57° for a total distance of 342 feet. A short drive has been carried northward (bearing 14°) from the end for 25 feet. No ore was met with in this end of the adit. At a point 263 feet from the mouth of the adit the "western lode" was driven on. For 145 feet the bearing is 23° , then for 50 feet it is 9° . At this point a crosscut was driven eastwards.

Beyond the crosscut the course of the western lode is $N. 25^{\circ} E.$, and at 25 feet past the crosscut the lode splits with a "horse" of slate between the two portions.

The western drive of the two runs on for 50 feet past the split on a bearing of 25° . Here there is a rise, which has been put up for 40 feet, and two stopes have been taken out for a distance of 60 feet on fair milling ore.

Then the two arms of the lode rejoin, and the lode is followed for another 100 feet on a bearing of 26° . The course then returns to 9° , and the face at the time of my visit was 125 feet from the bend.

Taken all through its length, the western lode represents about 3 feet of milling ore, and the lode-channel is well defined always.

It is to this ore-body that the company must look for the main bulk of the milling ore of the future. There may be other more concentrated bodies of ore discovered in the quartz reef, but their presence is so far unproved.

Further prospecting of the quartz has been done on this level. At a point 196 feet from the main adit on the western lode drive a long crosscut has been put in eastwards for a total length of 334 feet on a bearing of 105° . At 217 feet the quartz body was met with. At 264 feet a few splashes of galena were met with, and short drives were put in for 25 feet northwards and 15 feet southwards on a bearing of $N. 15^{\circ} W.$ The metal cut out, and work was abandoned.

At 287 feet on the eastern boundary of the quartz another short drive was started northwards, but abandoned after being carried for 10 feet.

The eastern crosscut was continued for 50 feet past the quartz, and abandoned in dense pyritic slate.

The prospecting was continued on this level from a point 15 feet west of the hanging-wall of the quartz, and 202 feet from the western lode drive. There a drive has been carried northwards for 100 feet on a bearing of 2° , and from that point the drive turns to the east to cut the quartz body. Occasional splashes of galena are to be seen in the quartz here, but always associated with siderite.

The milling ore from the mine is stacked separately on the tip to provide a nucleus for future milling operations.

A little work has been done below these main southern workings on the northern boundary of Section 2410, but nothing more than slate carrying carbonate of iron is visible. At a point 30 feet from the south-west corner of the northern section, and on the line between the two sections a tunnel was started to test the western portion

of the property. It runs for 80 feet on a bearing of 66°, but only chloritised porphyroid, in which some hard silicified zones were found, was penetrated. Some quartz and iron carbonate were visible, but no ore. The tunnel is now used as a magazine.

On the southern section a little surface-trenching has been done at two other spots. On the eastern boundary a little galena is visible in the creek, which crosses the line in several places. This spot is very close to the line of the lodes met with in the Central Farrell property, and the ore-channel may be connected with that fracture system.

Further south a trench 2 chains long has intersected an indefinite formation. The trenches are narrow and shallow, and consequently do not afford much information. There is a certain amount of gossan carrying pockets of carbonate of lime, and in this gangue a few splashes of fahl-ore and copper pyrites are visible. The country rock, to judge from the weathered material intersected by the trench, is slate.

Appended is a table which will give an idea of the grade of ore from this mine. It has been compiled from the sale notes of the company.

SALE NOTES OF ORE FROM THE MT. FARRELL MINE.

Date.	Net Weight.	Assay Value.		Total Value per Ton.	Metal Quotations.		
		Lead.	Silver. (oz.)		Lead (per Ton).	Silver (per oz.).	d.
	tons. cwt. qrs.	per cent	per ton.	£ s. d.	£ s. d.	£ s. d.	d.
Nov. 27, 1906 ..	6 15 3	71.8	91.9	27 8 7	19 5 0		35.54
Jan. 7, 1907 ..	31 19 0	69.6	94.6	27 11 10	19 18 9		34.80
Feb. 8, 1907 ..	22 10 1	67.5	91.0	26 2 5	19 13 9		33.85
May 3, 1907 ..	16 12 1	70.0	92.7	26 18 2	20 5 0		32.97
May 3, 1907 ..	17 19 3	69.1	97.6	27 8 0	20 5 0		32.97
May 27, 1907 ..	12 4 1	65.0	90.5	25 3 11	19 15 0		32.77
June 7, 1907 ..	14 12 3	67.5	90.0	26 6 4	20 7 6		33.50
July 17, 1907 ..	8 16 0	60.4	80.0	23 5 1	20 2 6		33.30
July 17, 1907 ..	8 17 3	56.2	74.0	21 17 1	20 10 0		33.51
July 22, 1907 ..	8 19 3	56.4	76.9	17 18 8	20 12 6		33.71
Aug. 28, 1907 ..	19 12 2	54.4	72.2	16 6 10	19 12 6		33.70
Oct. 31, 1907 ..	13 13 3	67.9	97.1	21 16 4	20 1 3		31.82
Oct. 31, 1907 ..	7 11 1	66.4	92.3	19 5 3	18 5 0		30.28
Dec. 13, 1907 ..	5 4 3	57.0	72.1	17 12 11	15 15 0		28.85
Jan. 16, 1908 ..	5 6 2	53.2	74.6	16 7 9	14 11 3		27.80

(3)—THE MURCHISON RIVER SILVER AND LEAD COMPANY,
NO LIABILITY.

The company's leases are the sections thus numbered:—
3263-93M, 60 acres; 1980-M, 80 acres; and 1286-M, 5 acres.

The latter is the mill site.

Of the two sections on which mining operations are carried on, that numbered 3263 carries the principal workings.

The lode which has been exploited on this section has a strike of N. 28° E., and is very nearly vertical, dipping if anything to the east; so its structure is quite distinct from that of any other of the lodes of the field thus far exploited.

The lode-fissure traverses obliquely a belt of porphyroid, which is at this point 70 feet wide, and strikes due north. On either side of the porphyroid is slate, and the dip of the igneous belt is about 70° to the west. The productive portion of the lode-fissure is that which is enclosed within the walls of porphyroid. The lode-channel extends into the slate at both ends, but little has been done to prospect these northern and southern continuations.

The lode has been worked by means of an open-cut and two high-level adits near the outcrop, and one low-level adit which starts almost on the level of the button-grass plain and intersects the lode some 87 feet below the level above.

At the time of my visit the mine was inactive, pending the reconstruction of the company.

The recent work has been restricted to the open-cut and the block of ore between the No. 3 and No. 2 levels.

Above the No. 2 level almost all the ore has been stoped out.

No. 1 Level.—The adit at this level was driven eastwards on a bearing of 279°, and was continued right through the main lode into the country beyond.

The main lode matter has now been removed. Further to the east there were two minor veins of ore from which a little mixed blende and galena have been obtained. These are apparently branches of the main lode, and their dip is towards the latter.

No. 2 Level.—The adit was driven on a bearing of 277°, and 40 feet below the upper one. The ore above this level has been almost wholly stoped out.

No. 3 Level.—The main crosscut was driven eastwards on a bearing of 260°. Its total length is 513 feet, of which

the first 450 feet were in slate and the last 63 in the porphyroid. At this point the lode was cut, near the northern extremity of the shoot. A drive has been carried both north and south on the ore-channel.

At a point 27 feet north of the main crosscut the ore-shoot was left, but driving was continued for another 75 feet. The lode-fracture is well marked by a seam of pug an inch wide. There is a little galena on the footwall, but no payable ore was met with. At the northern end of the drive a short crosscut was put in to the west, and the porphyroid encountered, but no galena was visible, and work at this end of the drive was abandoned.

The south drive has been extended for 109 feet on a bearing of 210° . The lode pinched out when the porphyroid country was left at a point 106 feet south of the main crosscut. The lode thus extends for 133 feet in a horizontal direction. At a point 53 feet south of the main crosscut a crosscut was driven west for 25 feet on a bearing of 305° . There a short drive was started north and south parallel to the main drive. Some blende galena and siderite was here visible for a width varying from a few inches up to 2 feet. The metal seems to make towards the main ore-body, with which it should junction about 20 feet above the level, the dip being easterly.

The ore in these short drives (12 feet on either side of the eastern crosscut) is displaced by a slide, which is also visible in the main drive. The slide dips south at an angle of about 50° , and the displacement of the lode is apparently about 4 feet. The lower portion of the ore is moved to the west of the upper portion by this amount. The eastern crosscut was continued for another 45 feet eastwards. The porphyroid country was left at a point 48 feet east of the south drive, and the rest of the crosscut is in slate.

These eastern workings were abandoned, as the only ore met with (in the east drive) was lost after being followed a few feet.

At a distance of 109 feet from the main crosscut the south drive turns slightly, and from this point to the end the bearing is 184° . This change of direction is noticeable, as the drive followed the lode-fracture all the way. It would appear that the fissure which traverses the porphyroid at an angle of about 30° from the north and-south line is merely a local variation. The fracture in the slate does not differ materially in strike from other fissures in the field. This matter is, of course, important

in future prospecting work, both in this section and those adjoining.

At the bend in the south drive a winze has been put down on ore for a vertical depth of 56 feet, and a drive 20 feet long put in northwards at 50 feet.

The winze was full to the collar of water, and I could not inspect these workings. It is stated that a slide was met with at this point; and possibly it may be the same slide visible on the level 56 feet north from the winze, and pitching in this direction.

At a point 29 feet south of the winze an easterly crosscut was put in some 10 feet without meeting ore; and 8 feet further south another crosscut was driven west for 17 feet with similar results. Beyond this latter crosscut the south drive extends some 24 feet. The face shows carbonate of iron with galena and blende. The dip is to the westward, at an angle of 60° . The footwall is dense and hard slate, but the hanging-wall slate is graphitic, and the carbonated zone extends into this crushed graphitic slate for about 4 feet.

The main ore-shoot, *i.e.*, that portion of the lode-channel enclosed within the porphyroid, is said to have given excellent ore all along the level. The average width of first-class ore is said to have been 10 inches, while 30 inches of clean ore were met at a point 20 feet north of the winze.

This being correct, there remains a fair bulk of good ore to be yet extracted below this level.

Above the No. 3 level, and between it and the No. 2 level, some ore has been stoped, but the greater portion yet remains untouched. It does not extend to the surface, however, for the shoot is pitching to the south at an angle of about 55° .

The shoot was met with on the No. 3 level, at a vertical depth of 87 feet below the No. 2 level, some 60 feet further south than the corresponding point above.

The width of the lode exposed in these stopes varies from 4 to 7 feet. I saw some good first-class ore along the western boundary of the lode-formation, but the bulk of the ore consists of massive mixed sulphides of the type known as a "pyritic lead ore." The mineral composition has been noted above.

The work done up to the present has proved a roughly rectangular block of ore, extending from the surface to at least the No. 3 level, and from 4 to 7 feet in width. The other dimension is about 100 feet; but the pitch of the

shoot makes the length appear some 30 feet greater when measurements are made along a horizontal line.

It yet remains to be proved whether the structure of the lode will alter in depth when the porphyroid zone is penetrated. The nature of the fissure in this rock seems to have entirely controlled the circulation of mineral-bearing solutions, and the slate contains but little mineral matter; but the fissure, of which the upper portion is in porphyroid, must, if its strike and dip continue uniform, pass through slate in depth.

A trench has been made to the south-east of the open-cut for a length of a chain. Some vegetable soil containing a little bog iron ore is exposed. I do not think this is the capping of a lode.

The company has erected a mill on the button-grass plain to concentrate their second-class ore.

Mill Scheme.—The mill is divided into two sections—coarse and fine. From the bin the ore goes to a jaw-crusher, and thence to a trommel, the screen of which carries holes of 13 m.m. diameter. The fines run on. The coarse goes to a picking-table and then to the coarse rolls. There is a topping-jig below taking the "roughs" from the first sizing-trommel (screen apertures 13 m.m. diameter). The tails from the jig are elevated to the coarse rolls, and pass again down the mill. The four sizing-trommels have apertures in the screens of 13 m.m., 9 m.m., 5 m.m., and 2½ m.m. in diameter respectively.

From that which holds the material over 9 m.m. in diameter the ore passes to two jigs. Each of the other two trommels feeds a separate jig. The ore before reaching these latter fine jigs is passed through an upward current separator, and the fines go on to the tables.

Below the last trommel are two spitzkasten, giving two grades of ore. The coarser goes to a Wilfley, and the finer to a Phoenix-Weir table.

Middlings from the table are elevated, and pass to the water-classifier on the fine side of the mill, and are again passed over a Wilfley table.

On the fine side of the mill the procedure is this:—The second products from all the jigs are wheeled back to the elevator, and thence go to the fine rolls, and then the second series of sizing-trommels, the screen apertures of which measure 4 m.m., 2½ m.m., and 1½ m.m. The ore that is caught by the 4 m.m. trommel is returned to the fine rolls by the elevator. The other two trommels supply ore to two jigs.

The ore leaving the last trommel runs to an upward current classifier. The coarse product is treated by a jig and the fines pass to the spitzkasten, and then to a Wilfley table. The middlings from the table are returned to the spitzkasten, and then again to the table.

The concentrates from the mill are mixed with the hand-picked ore to constitute the saleable ore. No distinct grades of mill concentrates are made.

The following assay returns will give a reasonable representation of the value of the mine products. They are from the assay books of the company, and the assays were made during 1907:—

Description of Ore.	No. of Assays Averaged.	Lead.	Silver.
		per cent.	(oz.)
Gossan (from open-cut)	6	..	34·5
Crude ore	14	5·9	11·6
Hand-picked ore	9	51·9	67·4

Sales of Ore by the Murchison River Silver and Lead Co., N.L.

Date.	Quantity of Ore.	Lead.	Silver.	Gold.	Net Value.
			(oz.)	(oz.)		(per ton.)
	tons. cwt. qrs.	per cent.	per cent.	per ton.	£ s. d.
May, 1907.	12 7 3	43·75	57·1	·045	12 10 1
May, 1907.	57 0 1	47·85	64·1	·043	14 1 3
June, 1907.	80 14 3	42·8	55·55	·07	12 6 3
June, 1907.	32 9 1	43·8	55·75	·057	12 8 10
July, 1907.	33 18 0	43·95	59·15	·06	13 4 6
July, 1907.	16 17 1	41·3	55·6	·078	12 8 0
Aug., 1907.	31 7 3	28·5	40·9	·095	8 11 9
Aug., 1907.	29 8 1	34·825	47·15	·09	10 8 6

The other lease held by the company, viz., No. 1980, is that which was formerly known as the Central Farrell.

On this lease there are two parallel lodes, which have been prospected at two levels; and a trench has been cut for a chain where a creek has cut across the outcrop.

The lodes are separated by a narrow band of porphyroid, and are themselves in slate. The dip of the country is westward, and the lodes follow this dip, which is from 60° to 65°.

At the surface the strike seems to be about N. 4° W., but the underground workings show the strike to be due north and south.

The creek section shows slate on the western side, with a lode 2 feet 6 inches wide to the east of it; then 9 inches of slate, followed by 10 feet of porphyroid. The footwall of the porphyroid shows quartz, which may mark the position of the eastern lode; but the work has ceased at this point. The lode formation shows a little fahl-ore, now much decomposed and discoloured.

The upper tunnel is driven eastwards on a bearing of 266°, and passes through slate and crushed grit. The total length of this crosscut is 234 feet.

At a distance of 126 feet from the mouth a drive runs due north on the first ore-body. A rise has been put up for 15 feet at a point 110 feet from the main crosscut, where a little metal was met with. Some 34 feet north of this point a winze has been put down. It was full of water at the time of my visit.

At a distance of 29 feet north from the winze a crosscut has been driven for 23 feet, where the second lode was encountered, and driven on for 20 feet northwards. This lode is 4 feet wide, and has well-defined walls. The lode-matter is graphitic slate, with numerous veinlets of carbonate of iron. The footwall is a hard siliceous slate.

The main drive was carried for 33 feet north, past the eastern crosscut, and still on the lode-channel, which shows quartz, siderite, and a little galena. The width of the zone of crushed graphitic slate carrying these minerals varies from a few inches up to 3 feet 6 inches.

The main crosscut did not meet with any ore after traversing the second lode.

The lower-level workings are 60 feet above the button-grass plain, and 50 feet below the upper workings. The adit level is driven for a total distance of 285 feet, and intersects both lodes.

The first was cut at a distance of 212 feet from the mouth of the adit, and there are 15 feet of country between it and the second lode.

The first lode was driven on northwards for 15 feet. The lode-formation appears to be about 4 feet in width, and similar to that on the upper level, but no galena was visible. The drive was abandoned here, and the lode driven on southwards for 73 feet. The formation is well defined all the way. It is about 4 feet wide, and has clean walls. Very little

metal is now visible, but a few splashes of coarse-grained galena occur near the south end on the back of the drive. None was showing in the face.

A drive was started on the eastern lode and carried 6 feet before being abandoned. The lode is well marked, and is in graphitic slate. The ore is accompanied by veins of quartz and siderite, and consists of galena, resin, or ruby blende, fahl-ore, and copper pyrites. The fahl-ore would account for the high assay values which have been recorded of the ore in this mine.

No work was being done on the section at the time of my visit, and the old workings were very much discoloured. The amount of ore in the mine could not be determined, nor the proportion of fahl-ore to the galena. The only spot where any appreciable amount of metallic minerals was visible was at the point where work has been done on the eastern lode on the lower level. There I saw a vein of an inch and a half of the fahl-ore at the sole of the face.

Some rich returns are said to have been obtained from the ore taken from the winze on the upper level. In all, about 120 feet of backs would be obtainable from the lower level to the highest point of the outcrop.

(4)—THE MURCHISON EXTENDED MINE (LATE NORTH MURCHISON).

The company holds one section (No. 1075-M), which is registered in the name of E. T. Midwood.

There is a fair amount of surface prospecting work done on this section, but no payable lode has yet been located.

Near the centre of the western boundary-line there has been some trenching along a creek which runs westwards, and a little galena has been disclosed. A main adit has been driven east on a bearing of 91° for a distance of 143 feet.

At 120 feet a lode was met with. This is a brecciated zone of black slate, in which much siderite is visible, and a little galena and fahl-ore. It seems highly probable that this ore-body is on the line of the Central Farrell fractures, but whether a second lode corresponding to that in the Central Farrell property exists I could not determine from the work which has been done.

A considerable amount of trenching has been done on the southern boundary of the section. Some carbonated black slate has been located which carries some pyrites and traces of galena.

Further east of this place trenches have been carried up the hill in steps to a height of 430 feet above the button-grass. The top few feet show a silicification of the country rock, and in the quartz veins a little chlorite and pyrites, but no galena. The occurrence seems similar to that in the South Murchison eastern tunnel. I could see no galena nor any siderite associated with the quartz. The occurrence does not seem to me likely to prove of commercial value. The bearing of this quartz zone is about 175°.

(5)—THE MACKINTOSH COPPER AND GOLD MINING COMPANY, NO LIABILITY.

The company holds two 80-acre sections, viz., Nos. 3221-93M and 3223-93M.

The workings on these sections have been carried out in both lead and copper-bearing lodes, which are situated along a line on the western portion of the two sections.

The most southerly workings are in the extreme south-west corner of the southern section, and within 150 feet of the most northerly workings of the North Mt. Farrell Mine. The ore-body is clearly a continuation of the North Mt. Farrell lodes, and it seems continuous right through this southern Mackintosh section and part of the northern.

The company has let several tributes, and the most southerly workings are being carried on by J. Geddes and party.

An adit is driven eastwards from the western boundary-line of the section on a bearing of 91°. The country traversed is all slate, and before meeting the main lode three minor lodes were cut and driven on for a short distance. All of these appear to be merely branches of the main lode, and their strike is N.W. and S.E. From one second branch-lode a rise has been put in to the surface. No work was being done on any of these occurrences at the time of my visit.

The main lode was driven upon southwards for 200 feet on a bearing of 9°. A rise has been put to the surface and a winze sunk on the ore. There are said to be from 1 to 6 inches of first-class ore here, and with it a few feet of seconds.

The dip is to the west, and the footwall is of quartz, and barren.

The width of the lode varies from 4 to 9 feet. Stopping is being carried on at a point 25 feet from the south

boundary. The formation is a brecciated zone of quartz and galena, and fragments of slate scattered through pug. Some first-class ore is found on the foot and hanging-wall side. The better ore is said to be on the hanging-wall. These veins of firsts are usually in short overlapping lenses.

The present stopes are 30 feet above the level, and there are another 100 feet of backs between the workings and the surface. The ore is partly bagged in the stopes, and the best seconds are hand-jigged.

Some second-class ore is left in the stopes for filling, and the remainder is stacked on the tip with the seconds from the jigs.

The following table compiled from the sale-notes of the tributors shows the grade of ore, and its value:—

Date	Net Weight of Ore.		Assay Value.		Total Value (per ton.)		Metal Quotations.					
			Lead.	Silver. (oz.)			Lead. (per ton.)	Silver. (per oz.)				
	tons.	cwt.	qrs.	per cent	per ton	£	s.	d.				
June 11, 1907 ..	10	1	1	53·0	54·3	20	7	2	20	15	0	32·00
July 23, 1907 ..	11	6	0	58·2	68·7	21	19	8	22	0	0	32·06
Aug. 19, 1907 ..	11	11	3	58·5	73·4	21	12	7	19	15	0	32·94
Sept. 20, 1907 ..	15	9	2	60·5	78·8	22	13	6	19	17	6	32·44

In this southern section of the Mackintosh property there are two other places where the creeks have exposed ore, and it is probable that they are on the same lode as that worked by J. Geddes and party.

In these, no work was being done at the time of my visit. Some good second-class ore was visible in the workings, but the lode is not suitable for a small tribute party, although it could doubtless be profitably worked on a larger scale. The lode-stuff in both of these workings is similar to the bulk of the good second-class ore in the North Mt. Farrell Mine.

In the south-western corner of the northern Mackintosh section two lodes have been located by trenching in a creek. A tunnel has been driven from a point a little further west. The bearing is 113°, and the country is clay schist for the first 52 feet. After traversing 81 feet of slate which lies east of the clay schist, this tunnel intersected the first lode. Here good ore is said to have been met with, and a few stopes have been carried almost to the surface, some 85 feet above the level. The first-class

ore was sold and the seconds stacked on the tip. The stopes are 40 feet long, and a rise from over the adit was taken right to the surface.

The drive on the ore-body has a bearing N. 10° E. It has been extended southwards for 20 feet, but northwards for 90 feet. The greater portion of this level is full of water dammed up by a heap of mullock, and consequently inaccessible. The lode-channel seems to be well marked, though the lode varies. The footwall is well defined, and on it the first-class ore is obtained. The hanging-wall is indefinite, and a shot put into the apparent country may at any time reveal ore.

At winze has been put down at a point a few feet north of the main crosscut to a depth of 26 feet.

The ore-body here dips more steeply. It is 8 feet in width, carrying about 6 inches of clean firsts on the footwall side and a band of some inches of pug, which contains brecciated steel-grained galena. This latter is hand-jigged.

During my visit some work was done by a tribute party on the ore in this winze, but the water could not be kept under and the party were compelled to abandon the tribute. Nothing could be done with the second-class ore, although it was of splendid grade. Of the hand-picked firsts and jigs some 3 tons of ore were sent away. The average value of this ore is said to have been £16 per ton.

Fahl-ore is mentioned as having been seen in small amount in the ore taken from this lode.

The main crosscut has been driven another 100 feet eastwards beyond the first lode. At 42 feet from the latter a second lode has been cut carrying second-class ore. This has been driven on for a short distance north and south. The lode here appears to be making towards the first lode, with which it would junction at a point further south. A shaft was started in this ore-body at the surface, and is said to be down some 36 feet. Some good second-class ore is tipped round the collar of the shaft.

The Mackintosh property, therefore, seems to carry a length of lode and lead ore of such grade that mining operations on a large scale would be highly profitable. It does not possess the topography that would make the mining on a large scale possible without the sinking of a shaft; yet the bulk of second-class ore and the readiness with which it could be concentrated are in favour of this treatment on an extensive scale. The ore is physically well adapted to concentration, and closely resembles the North Mt. Farrell second-class ore. The present inactivity on this property is deplorable.

At a point further north in the northern section of the Mackintosh lease, and 250 feet from the western boundary, two lodes have been exposed in the bed of a creek.

The country-rock is a pale clay schist, which has been silicified, and which carries also veins of quartz. There is a little carbonate of iron with the quartz, and the metallic minerals present are iron and copper pyrites. The ore is dense and hard, and the copper pyrites is found disseminated in fairly coarse blebs throughout a zone about 8 feet wide. The strike appears to be a few degrees west of north, but very little work has been done, and it is difficult to ascertain the strike and dip.

A shaft has been sunk at a distance of 25 feet from the creek on its northern bank to a depth of 35 feet. It was full of water when I visited the property. The country-rock is the same as that exposed in the creek, viz., clay schist.

The slate is 50 feet to the east of this shaft, and although a number of trenches have been cut in the creek bed on the east of the copper lode no trace of mineral has been found.

On the western side of the lode above mentioned, and distant about a chain, there is a second copper-bearing zone, of a similar character. It is some 3 feet wide, and carries both iron and copper pyrites.

This is the most southerly point at which copper is visible along this line, *i.e.*, in the absence of a much larger proportion of galena.

It does not appear from the work so far done at this point that the ore will give profitable returns as a copper proposition. The occurrence is, however, worthy of being further prospected.

(6)—THE FARRELL BLOCKS.

The company known as "The Farrell Blocks" holds two sections, which are registered in the name of E. Goldsmith, and are numbered 2397-m, 79 acres, and 2820-m, 80 acres.

On the western of these two sections (No. 2820) no work has been done. There does not seem much prospect of the Mackintosh lead lode passing into this ground at a reasonable depth. The dip is certainly to the westward, but the winze put down on the western Mackintosh lode shows that the tendency of the lode is to become more nearly vertical than it was between the adit level and the surface; and the lode is distant about 350 feet from the western boundary of the Mackintosh section.

The northern section, No. 2397, occupies a better position with regard to the lode system.

On the boundary-line between this section and the northern Mackintosh section there is a small quartz blow which may be connected with the outcrop cut by the creek a short distance northward; yet the whole area here is highly contorted, and the creek beds show quartz veinlets, which run in all directions, and many of these carry no trace of metal.

In the south-west corner of the section a lode-formation has been cut in a small creek. It is a zone of highly-contorted clay schist, which has been impregnated with silica, and which carries copper and iron pyrites. A little galena is visible in the lode.

On the northern bank of the creek, some 30 feet away, a shaft has been put down 30 feet. No metal was encountered in sinking. The rock penetrated was the clay schist very much contorted, and carrying a little carbonate of lime. The shaft is now full of water. Some 65 feet of backs could be obtained here by driving an adit from the west, but such work is not at present justified. A crosscut from the bottom of the shaft would also prove the lode. However, until the lode is proved to be continuous by other trenches at the surface, the exploitation at a depth should be held over.

Trenches have been cut in the bed of the creek which traverses the middle of the section for a distance of about 7 chains. The country rock exposed is for the most part slate, which is very much contorted. It is sometimes graphitic, and contains a little siderite and veins of quartz. The latter are flat veins dipping mostly to the east, or follow the contortions in the slate. No metallic mineral other than iron pyrites was visible in the main part of the trenches. However, in the southern end of the workings, near the junction of the slate and clay schist, some good galena was obtained. It cut out in the bottom of the trench, however.

The work done at this point has clearly been influenced by the idea that the galena can only be expected to be found within the slate boundaries. The trenching has here been carried out to the east of the proved line of fracturing of the area, and I should recommend that in future prospecting the trenches be continued for a short distance to the west of their present extent. It is possible to obtain 60 feet of backs at the point where the galena was met with in the trenching by 150 feet of driving from

a point a little lower down the creek. Still, the trenches might be extended westwards with much less expenditure.

(7)—THE SECTIONS ON THE NORTH-WESTERN FLANK OF
MT. FARRELL.

On Section No. 3010, which is registered in the name of D. Powell, some trenching has been carried on on both banks of a large creek which runs through the section, but without result. The section lies to the east of any lodes yet discovered.

On Section 2905, which adjoins the northern section of the Mackintosh property, a trench has been cut in the creek bed, but abandoned in river wash, which consists of fragments of conglomerate from the mountain.

In the south-eastern corner of Section 2909, on the eastern side of the Mackintosh River, some trenches have been cut in the bed of a small creek. The river bank is very steep at this point. The upper trenches expose a highly contorted graphitic slate, with irregularly distributed veins of quartz, siderite, and galena. Some of these veins dip west and others flatly to the south.

On the water's edge a few shots have been put into the bank, and show the same clay schist which is found in contact with the slate all along this line; and in the rock are a few scattered splashes of galena. No further work has been done on the section.

Passing northwards along the eastern bank of the Mackintosh River the next two sections are registered in the name of G. E. Butler, and are numbered 2796-M, 80 acres, and 2892-M, 40 acres.

On the 80-acre section some work has been done in the past near the northern boundary. At the time of my visit nothing was being done.

The fault-plane referred to above traverses this section, and a creek is situated on the line of the fault. Some trenching had been done in the slate near the track, but the sides had fallen in, and nothing was visible of the bottom. A tunnel has been started into the mountain and driven 30 feet in a direction bearing E. 16° S. The tunnel was begun in a coarse quartz grit, and was abandoned when the massive conglomerate of the mountain was encountered in the face. There are some quartz veins in the grit carrying iron pyrites, and in one place, near the entrance, some galena.

However, there does not seem to me much inducement to continue driving, in spite of the presence of a small

amount of galena; for what metal was discovered was enclosed within a member of the slate series, and it has not yet been proved that any of the lode-fissures are continuous into the massive conglomerate. This section was formerly known as the "Metropolitan."

At the extreme north end of the mountain, on Section 2873-M, registered in the name of C. R. Lynch, some work has been done to try and locate an ore-body said to be visible in the river at low-water. This latter was not to be seen during my visit. A short tunnel has been driven in the river bank with a bearing of S. 12° W. The work has revealed slate with quartz and iron carbonate veinlets, but no galena could be detected. The tunnel runs with the cleavage of the slate, and a crosscut has been put in towards the east for 14 feet. The slate here, too, carries quartz and siderite stringers.

A trench above the track on the Mt. Farrell side of this tunnel shows only slate.

On the eastern boundary of the section, near the cage crossing to the Tullibardine area, a short trench has been cut in a crushed grit carrying arsenical pyrites. The weathering of this mineral has produced some limonite at the surface; but no sign of a defined ore-channel was visible when I last saw the work.

The position of this section appears to be a little to the east of the line of fracturing of this area.

(8)—THE TULLIBARDINE COMPANY.

The company holds three 80-acre sections, all of which are registered in the name of J. McPhee, viz., Nos. 2058, 2592, and 2593.

The greater portion of these sections is covered by unconsolidated river wash, through which the main creeks have cut their way and exposed the underlying rocks.

The felspar porphyry forms a series of steep hills on the western boundary of the property, and the rock underlying the river alluvial is slate or pale clay schist. The strike of the belt of clay schist is, as far as could be determined, considerably east of north. Whether it is the northward continuation of the belt of similar rock which traverses the Mackintosh and Farrell Blocks sections, I could not on this visit definitely decide. However, I think it will prove to be portion of what was originally one continuous formation dislocated by the fault which traverses Section 2796. The fault-plane will, I think, be found to be the spot at which the strike changes. If so, the fracture system which has controlled the position of

the ore found on the Tullibardine is probably portion of the same fracture system as that which traverses the Mackintosh area and the Farrell Blocks, and which has been traced to the river bank in Section 2909. In other words, the lode channel, as well as the country rock, has probably been dislocated by the fault which cuts across the country on Section 2796.

In the Tullibardine area the slate occurs on the west as well as on the east of the clay schist. This was the case on the North Mt. Farrell lease (3262), but at the northern locality there is a much greater thickness of slate on the western side.

The main workings are situated in the south-eastern corner of the central Section, No. 2058, on the banks of the large creek which traverses the section. The creek takes a sharp bend from an easterly to a southerly course at this point, and a face has been broken down from the southern bank just at the turn. This cut is 25 feet in length, and exposes the country to a depth of from 5 to 12 feet below the surface-soil. The clay schist is very waxy in appearance, and carries numerous intersecting quartz veins, which carry copper pyrites and some secondary copper ores. The quartz veins vary from half an inch up to a foot in width, but they make and pinch within very short distances. The country rock contains greenish patches, the green colour being due, not to copper, but to a green sericitic mica.

In a complex lode-formation of this character the strike and dip are difficult to estimate. One very strong vein, which has been followed down in a winze, strikes N. 25° E., and dips east at 80°; but other veins dip towards the west.

The copper pyrites is very clean and free from iron pyrites, and is in places quite coarse and massive; and, resulting from its alteration, malachite and bornite are common in the lode-formation.

A winze has been put down on the eastern end of this face for 7 feet. The same types of country and mineral vein persist. In addition, the schist is thoroughly impregnated with very finely divided native copper where it is enclosed between a cupriferous quartz vein and a plane of separation along which surface waters have been circulating. The schist is at this place deeply stained with limonite.

A little further up the creek to the westward a couple of small cuts have been made in the bank, and show a little copper pyrites. One of these veins shows a fair

amount of ankerite* with the quartz, and serves to show the connection between the copper ores and the lead ores. At this place, 15 feet west of the main face, the clay schist has a belt of slate intercalated with it. The slate dips to the westward.

In all, the veins which show copper extend to a distance of 100 feet west of the main face exposed.

Across the creek from the main cut there are two trenches which show quartz veins or silicified schist carrying copper ore. These serve to indicate that the copper bearing zone is at least 150 feet in width.

Where the creek turns to run southwards there is a strong quartz vein carrying coarse copper pyrites. On this, Pearce, who first held the property as a reward claim, had sunk a shaft 20 feet, but the creek at the time of my visit made it impossible to investigate this work. Pearce had apparently turned the creek to the west, but the later work had thrown it over again, so that the water could not be baled out of the shaft.

Alongside this old shaft a tunnel has been driven eastwards on a bearing of 126° in slate, which here junctions with the clay schist. The cleavage-planes of the slate at the entrance of the tunnel dip at 60° to the east, but in the face they dip at 80° to the west. The slate, considered as a whole, will be found, I think, to dip to the west, as does the small band intercalated in the clay schist.

At 75 feet the tunnel cuts through a band of silica 2 or 3 inches wide, and striking N. 5° W.

Further in, 8 feet from the face, the country becomes fractured in all directions, and the fractures are filled with siderite. In the face, further veins of quartz appear striking from 30° to 40° east of north. These quartz veins carry copper pyrites and some odd splashes of galena. The tunnel was here abandoned.

Another tunnel was started, 100 feet south of the first, and across the creek. It was driven west on a bearing of 299° for 35 feet, the intention apparently being to prove the veins of cupriferous quartz exposed in the main cut on the creek bank. The only copper veins met with were some small ones in the approach. The country intersected by the tunnel is clay schist, much crushed and fractured. Some bands of the schist are a little darker than others, and resemble more closely an ordinary slate. Vertically above this tunnel a couple of trenches have

* Ankerite is a carbonate of lime, iron, and magnesia.

been cut in the creek bank, and show a few quartz veins carrying copper pyrites.

The tunnel should certainly be continued for another 100 feet to prove whether the veins of copper-bearing quartz exposed by the main face are continuous. So far only the width of the formation has been indicated by prospecting operations.

The creek turns again to the east a little way further south, and some trenching should be done here to prove whether the lodes cut by the eastern tunnel are of any horizontal extent.

In the south-western corner of the northern section, a trench one chain long has been cut, and a hole put down some 6 feet in the centre of it. The country rock is the clay schist in which green patches of sericite occur, and which is thoroughly impregnated with ankerite. A little quartz is present in veins and small lenses, but no copper accompanies it at this spot.

Near the centre of the southern section, No. 2592, there is a short trench upon a quartz outcrop. The surface cover is considerable, and only a few irregular masses of quartz are visible. There is a small amount of ankerite and both copper and iron pyrites included in the quartz. I noticed also some fragments of included slate, like those in the quartz reef on the Mt. Farrell leases. The outcrop is poorer than that in the north-eastern corner of the section, but seems worth prospecting further.

A few chains to the south-east a trench, 40 feet in length, has been cut. It shows the usual alluvial cover resting upon a dark-coloured wavy slate. There is some quartz in the slate, and on the sides of the trench I saw some slate with veins of siderite and a little iron pyrites. This may come from the end of the trench now filled in by the fallen alluvial from the sides.

On the eastern bank of the creek, south of this latter place, a trench 8 feet long exposes a lode which differs from the copper formation in a striking way. The country rock is the same clay schist, with green sericitic mica on the divisional planes, and carrying a quantity of carbonates, but no silica. The metallic minerals are galena and blende.

The strike measured over the short length exposed is between 10° and 12° east of north. The dip is to the westward. No copper ore at all has been seen at this place.

The ore strikingly resembles that which comes from the vughs in the quartz reefs of the Mt. Farrell Mine.

There is a vein, about 10 inches wide, of ore which carries the metallic minerals (galena and blende) in bands up to an inch in width, and also scattered through the gangue.

A trench, 6 feet deep, was cut at a distance of 60 feet to the southward to test this lode. The sides had partly fallen in and were not visible. On the banks were some pieces of greenish schist carrying veins of quartz and carbonates, with iron and copper pyrites, but no galena.

There is little else done on this area. In the bend of the river, just south of the boundary-line of Section 2593, a trench has been cut in the clay schist, but no ore is visible.

The copper ore of the central section is in itself of very promising appearance; but the quantity available cannot be estimated even roughly until some further prospecting work is done, with a view to proving the length of the lode-formation. The amount of ore carrying native copper cannot be expected to be considerable.

(9)—THE WHITE HAWK DISTRICT.

(a)—*The White Hawk Mine.*

The White Hawk property includes the sections numbered 2330-M, 42 acres; 2331-M, 80 acres; and 2332-M, 47 acres. All of these are registered in the name of R. P. Symmons. The 80-acre section contains the workings.

At the centre of central block (No. 2331) is the lode, which was first located by Tom Farrell, and the section was his reward claim. His original workings have been almost completely obliterated by recent prospecting operations. The ore outcrops at the foot of a steep hill of limestone.

A short drive has been put in on a bearing N. 30° W. on the lode. A body of gossan carrying some galena and cerussite (lead carbonate) was met, and a winze put down to a depth of 5 feet on the lode a few feet from the entrance.

At this point the lode seemed to dip east at about 40°, and to strike about 30° west of north. However, very little information could be gathered from the amount of work done. The shape of the ore-body was not clear. On the northern wall of the winze there was a good seam of galena and blende, but metal was absent from the southern wall. The ore gave me the impression of following the joint-planes of the limestone, but no length of lode can be said to have been proved.

Work has been abandoned at this particular spot, and a crosscut has been driven westwards for 141 feet on a bearing of 265°, in the hope of cutting another ore-body.

The first discovered outcrop of ore is situated at the approach to this tunnel. No other metallic mineral than iron pyrites was visible to the west of the lode at the entrance. Galena is said to have been seen while work was proceeding, but I did not find any in the workings.

The drive cut across some cavities in the limestone, which are still visible in the back, and down which the surface drainage brings a quantity of mud.

On the steep hill side which forms the western bank of the White Hawk Creek south of the centre of the section, there are two places where a small amount of galena, associated with zinc-blende, is visible. One is near the top of the hill, and carries some coarse-grained galena with semi-oxidised blende. The strike and dip could not be ascertained. The other occurrence is some 10 feet above the creek level, and shows galena following the joint-planes; and dipping east.

The metal appearing here is, in my opinion, not connected with any other lode yet located in this area.

Near the south boundary-line of this central section a mass of gossan was discovered, which, on being broken into, was found to carry veins of galena. The dip and strike could not be determined accurately, and the possibility of the veins now visible being of a secondary nature is so strong that such observations could hardly be of any value.

A tunnel was started from the creek bank, which is here precipitous, to cut the lode at a depth of 85 feet below the outcrop. The tunnel is on the same level as the other tunnel in the centre of the section, but here the creek is about 25 feet lower. The bearing of the tunnel is 256°, and it has been driven westwards. The limestone traversed dips at 40° to the west. Joint-planes crossing the bedding-planes at the entrance to this tunnel are apt to give a false impression of the structure; but the joints become less pronounced as the surface-rock is left. The limestone shows numerous seams of calcite running with the bedding-planes, and opening out here and there into lenses from a quarter of an inch to half an inch wide, and from half to three-quarters of an inch long.

The tunnel at 40 feet from the entrance met with a body of semi-oxidised ore. There was some crystalline calcite and a mass of gossan carrying galena and cerussite. On the sole of the drive this ore looked very well. A

winze had been started during my visit to the district, and was down 9 feet on ore. A chamber was cut on the southern side of the crosscut, and the winze was following the ore, which at this place is dipping eastwards. The dip varies, becoming much flatter in the bottom of the winze. On both hanging-wall and footwall there is pug carrying fragments of limestone. The ore consists of gossan, carrying blende and galena in bunches through it, and at the bottom of the winze at the time of my visit there were 2 inches of clean galena in the gossanous material, which was dipping east at 35°. The amount of ore was increasing as the workings were carried down, and there appeared to be signs of the lode increasing in width on the southern side of the winze.

The adit was continued past this spot, and when I visited the mine the work of driving westwards was proceeding, at a distance of 123 feet from the entrance.

This tunnel at 80 feet passed through a slide-plane, dipping with the country, and carrying fragments of limestone set in a paste of soft, wet, yellow clay. Some cavities of solution were passed through, similar to those met with in the northern tunnel. Where the drive intersected one of these, at 103 feet from the adit entrance, a mass of gossanous material was met with, which carried galena. This fragment of ore may have been derived from the upper portion of the body of ore cut at 40 feet, and may have rolled down the open cavity to its present position.

Beyond this point the last 20 feet of the tunnel are in very dense limestone, in which the bedding-planes are not decipherable, but which is traversed by a number of very irregular joints. Veins of calcite were present, and in them a little iron pyrites.

The work done at this end of the section has given very inconclusive results. There are two bodies of ore—the surface gossan, some 85 feet above the tunnel; and the ore-body on which the winze is sunk. But the connection between the two, if any exists, has not been proved. The tunnel was being driven in country which, at the time of my visit, showed no indication of the presence of ore. It would therefore seem advisable to follow the surface gossan down, to try and determine the strike and dip. Until more is known about this surface ore it appears to be inadvisable to prospect for it by means of a tunnel.

On the northern boundary of the section in the creek bed a trench has been cut for a few feet. The massive limestone here contains some crystalline calcite, but I could see no trace of any lead ore.

The following assay returns will show that the metallic contents vary considerably. This is no doubt owing to the fact that the lodes are subject to the leaching action of surface waters.

Description of Ore.	Lead.	Silver (per ton).	Zinc.
	per cent.	ozs. dwts. grs.	per cent.
Mixed sulphides	41·8	12 5 0	20·5
Gossan	39·2	15 16 5	—
Galena (from gossan)	66·7	11 3 5	—
Galena (from gossan)	49·5	9 13 6	—
Galena (from winze)	39·1	8 15 0	—
Galena	77·2	53 1 16	—
Galena	50·51	27 17 8	—
Galena	60·6	6 7 9	—

(b)—Other Sections on the White Hawk Creek.

On the Section 3367-M, 72 acres, charted in the names of R. P. Symmons and C. R. Lynch, a gossanous cap on the limestone has been found. Some trenching has been done on this outcrop, starting from the small creek that runs southwards to join the main creek near at hand. The trenching shows a number of veinlets of calcite, carrying galena, blende, and copper pyrites. These dip to the west into the limestone, and with the bedding-planes. From the amount of work that had been done, these veinlets gave me the impression of being "droppers" from a lode crossing the bedding-planes. A trench across the formation in an east-and-west direction would afford valuable information.

There is no further work done on this or the other sections charted in the same names.

(10)—THE SOUTH MURCHISON SILVER AND LEAD MINING COMPANY, NO LIABILITY.

The company holds one section, No. 704-M, of 73 acres, upon which a considerable amount of prospecting has already been done, but hitherto without any successful issue. The object of the work done is to pick up the southward continuation of the Murchison lode. It has been already pointed out that the lode-channel after passing through the porphyroid in the Murchison low-level workings turns and follows a direction only a few degrees west of south. If this strike continues unchanged, the lode-channel should traverse the South Murchison ground,

provided that it is continuous for that distance. The surface cover of vegetation is extremely thick at this place, and the prospecting work has been considerably hampered by its presence.

A lode is said to have been discovered in the river bank just east of the crossing. This formation is said to have carried galena in a gangue of quartz and siderite. At the time of my visit the river was at first too high to see this lode, and later, when the water had subsided, it was deeply covered with silt.

Two lines of trenches are cut at a point near the south boundary-line of the Murchison section, but no definite lodes have so far been located. Some siderite is visible in dark graphitic slate, and with it a little quartz and iron pyrites. This spot is a little to the east of the upper tunnel, and is the strongest evidence I saw on the section of the proximity of a lode likely to contain lead.

The tunnel just mentioned was driven westwards on a bearing of 280°. The country penetrated is a dark-coloured slate, slightly contorted. The tunnel has been carried for a total distance of 107 feet. At 70 feet a drive north was put in some 27 feet, and a further cross-cut was driven north-west for 27 feet. The face of this crosscut showed massive quartz, with a little calcite and pyrites. The quartz contains some chlorite. No galena was found in these workings, and they have been abandoned. The company, at the time of my visit, was exploiting the more easterly portion of the section by a low-level tunnel. This starts from the river bank at a point 17 chains N.N.E. of the corner peg on the river bank.

The tunnel is driven west on a bearing of 270°, and had been extended some 160 feet when I visited the property. There is a dark slate at the approach, and then for 150 feet the adit is in a pale-coloured clay schist, not different from the slate except in colour. A few veins of quartz were intersected, carrying some chlorite and associated with calcite. Some of the veins showed a few splashes of blende and galena.

At 150 feet the tunnel passed into a belt of porphyroid, which continues up to the face of the drive.

The company expected to cut the lode by this tunnel with 100 feet of driving, but events have shown their estimate to be much too small. The width of the felsitic rock has not yet been proved at this point, and the surface vegetation is too dense to settle the matter till some further trenching is done. The lode for which the com-

pany is driving is said to be in slate where it was picked up on the river bank. Yet this does not necessarily mean that the lode will continue in slate. The felsitic rock may carry the lode if the fracture persists and crosses over into it from the slate. The upper-level tunnel would appear to be situated just to the westward of the belt of rock said to contain the lode. Had it been 100 feet further to the east much more information might have been obtained. The configuration of the country is less favourable at this point. Still, a site for the lower-level tunnel might well have been obtained further west than the one selected.

(11)—THE OTHER SECTIONS NORTH OF THE MURCHISON RIVER.

On the remaining sections charted on the map accompanying this report practically nothing has been done.

A few cuts have been made along the river bank on Section 2945, registered in the names of R. Green and A. King. Galena is showing in two places in a lode-formation which consists of slate cemented together with carbonate of iron and quartz. This latter occurrence of ore may have some connection with the western lode, which has been located across the river on Thomas' Blocks.

(12)—THE THOMAS' BLOCKS SILVER MINING COMPANY, NO LIABILITY.

This property consists of three sections, viz., 2808-m, 80 acres (lessee, C. W. Thomas); 2850-m, 80 acres (lessee, C. Thomas); and 2918-m, 20 acres (lessee, G. O. Smith).

The main portion of the leases is situated on typical schistose porphyroid, but the slate occupies a large area of the northern section (2808).

Work on the lodes found on these properties has only been in progress for a few months, and thus far nothing is known of the behaviour of the lodes in depth.

There are certainly two lodes on the property, of which the eastern one is the principal.

This main lode, at its outcrop near the northern boundary of Section 2808 in the bend of a creek, showed about 14 inches of banded ore, in which were 4 inches of clean steel-grained galena on the hanging-wall side. The metallic minerals occurring with the galena at the surface were blende, copper pyrites, and iron pyrites. The gangue minerals were quartz, ankerite, and fluorspar.

It was decided to exploit the lode at this spot, and with that object a shaft was sunk at the site of the outcrop first located. This shaft was only just started at the time of my visit, and some difficulty was experienced in keeping it clear of water. There were a few inches of very good ore, consisting of galena and copper pyrites, in the bottom of the shaft. The amount of copper pyrites was not large, but all the ore I examined carried blebs of it.

A point has been chosen about 250 feet further down the creek from which to drive for the lode. Near this approach there was a small vein of a quartzose character, which showed a little galena and blende. In cutting a magazine at this point, the ore was not found to make into body of any size. It is probably an off-shoot from the principal lode.

The first few feet of the tunnel are driven in a southward direction, and it then turns away with a south-westerly bearing to intersect the lode near the shaft sunk from the surface. The tunnel was begun in slate, which gave way within a few feet to a wavy porphyroid. Galena was visible here and there on parting-planes in this rock, which clearly shows the results of alteration by vein-forming solutions. The main lode-channel had not been reached at the time of my visit. When the lode is cut at this point much more information should be afforded. The ore at the surface seemed very free from oxidation on the whole, but a sample from greater depth is needed for comparison.

I have been shown since leaving the field some of the ore from the shaft, which contained a considerable proportion of fahl-ore. The assays made of samples taken from this place gave these returns:—

Silver (per ton).		Lead
ozs. dwts.	...	(per cent).
102 18	...	65.4
215 0	...	69.5
201 0	...	—

The discovery of the fahl-ore here seems an excellent sign, and if any quantity of this mineral is commonly associated with the galena of the lode, an ore with a silver content much above the average will result. The increase in the silver content with recent deeper development is notable, for earlier assays of material taken from the outcrop are said to have shown only from 27 to 50 ozs. of silver to the ton.

What would appear to be, in all probability, portions of the same lode as this main one just described outcrop at several points on the slopes which rise gradually from the river towards Mt. Murchison.

One of these outcrops is situated within the southern section (2850), and close to the south-eastern corner of Section 2808. Very little of the lode was visible at the time of my visit, and the character of the ore seemed a little different from that at the principal workings. It was dense and quartzose, but carrying two bands of galena, making in all about 6 inches of second-class ore. Trenches at intermediate points are necessary to prove definitely whether these southern outcrops are on one and the same line of lode. The trenches would also serve to locate the better shoots of ore for exploitation.

In the south-western corner of the northern section the "western lode" has been exploited by a trench. The lode runs N. 25° W., and is in the same country rock—porphyroid. A trench some 50 feet in length and 8 feet deep has been cut. The metal occurs on a good wall as a narrow seam 1 to 2 inches in width. It is free from non-metallic gangue minerals, but both iron pyrites and blende accompany the galena.

No height of backs can be obtained at this point by tunnelling, and it will be probably found more advantageous to carry a trench on the line of the lode as at present, and to sink on any good shoot of metal that may be met with.

In the north-west corner of the south section there is some gossanous material on the surface which may be derived from this western lode.

(13)—THE TULLAH SILVER AND LEAD MINING COMPANY,
NO LIABILITY.

The company is engaged in exploiting a lode which has been discovered on Section 2925-M, 80 acres, registered in the name of E. Pennefather.

The lode has been exposed by some 30 feet of trenching in the creek which traverses the southern portion of the section. At the surface it appears to be of a composite character, consisting of numerous short lenses and bands of galena, blende, and iron pyrites, in a zone of altered felspar porphyry. The width at the surface is about 15 feet, and the strike, as far as could be ascertained, N. 8° W. There is some good milling ore visible in the trenches,

but the lode would need some hand-picking, since the ore follows only certain irregular lines.

A tunnel has been driven, at a depth of 80 feet below this outcrop, in an easterly direction, the bearing being 76°. The country rock driven through is for the most part massive uncrushed felspar porphyry. At 15 feet from the entrance a former river-channel was intersected. The river wash which filled this channel, of which the width in the tunnel is 20 feet, contains boulders of granite, felsite, diabase, and some rounded fragments of lode-material similar to that found in the lode itself.

After passing through this old river bed, a reddish or greenish felspar porphyry was traversed by the adit till a point 210 feet from the entrance was reached. Then the lode-formation was encountered. The tunnel was continued for a total distance of 234 feet from the mouth.

The lode-formation is, in all, 23 feet in width, and dips to the westward at from 80° to 85°. It is a complex lode system, comprising numerous zones separated by divisional planes roughly parallel to the outer walls. The gangue is for the most part a greenish sericitic alteration product of the felspar porphyry. Some silica is present, especially on the footwall side. Much of this silica is of earlier date than the impregnation by the lead-bearing solutions.

The footwall country is a chloritized felsite, which is free from galena, but ribbed with vertical veinlets of quartz. Part of it, too, is hardened by an intimate infiltration of silica, till the rock becomes practically a jasper or chert. This phenomenon is merely a phase of the formation of the siliceous veinlets so common throughout the district, and with which no other metallic mineral than iron pyrites is associated.

The felspar porphyry, once fractured and cemented together with the silica veinlets, has been refractured, and the metallic contents have been introduced.

The metallic minerals present are galena, blende, and copper pyrites; and with them there is present a little siderite. This latter gangue mineral, so characteristic of the field generally, is present in appreciable amounts only where the larger pockets of ore are found. The zone of country which has been altered by the vein-forming solutions is notable for the development of sericitic mica rather than the carbonate minerals.

The galena and other metallic ores are found in bunches and pockets, and along all the cross-heads in this compound lode-formation. The zone which carries the most

ore is the central portion of the lode. This is also the softest, for the development of sericite and carbonates is most marked there. Some of the galena is in an extremely fine state of division, and the lode is so minutely impregnated with it in this central zone that any broken fragment of ore shows the fine-grained metal throughout.

With a view to proving the lode, there was started during my visit to the field a northward drive, which had been carried for some 28 feet along the footwall. The lode here was hard and poor. Since my return from Mt. Farrell the drive has been carried another 100 feet northwards, but the driving has been continued a little to the west in the central and softer portion of the lode-formation. The results are reported to be much more encouraging, and some ore carrying a fair proportion of fahl-ore has been obtained.

It will probably be wisest for the company to follow the lode on the present level and sink on the better shoots of metal met with, rather than to drive a low-level adit, which would need to be a very long one, in order to obtain any considerable height of backs. A survey made by the company shows that, with 925 feet of driving, some 320 feet of backs are obtainable.

The following are the results of assays made from ore from this mine since 6th January, 1908:—

Silver (per ton).		Lead
ozs.	dwt.	(per cent.).
13	4 14	77.1
32	0 6	77.6
47	17 3	73.0
305	16 0	77.6
222	10 0	74.7
429	18 16	74.5

The latter three samples contained fahl-ore. The variation in the silver content in the others is perhaps due to the proximity to the surface. Much water was encountered during the driving, when the lode-formation was met, and the circulation of surface waters may cause a partial leaching of the silver contents.

(14)—M. DONOGHUE'S SECTIONS, NOS. 2863 AND 2864.

These two sections are of 80 acres each, and are on the line of what is probably the major fracture in this area.

The main lode outcrop, now being prospected on Thomas' Blocks, is the most northerly outcrop on this line

of lode. As already stated, some further intermediate trenches are required before these different outcrops can be regarded with certainty as being on one continuous lode. Still, the probability that they are on the one lode is very great. The line of the lode seems on the map to bend away a little towards the east; but it is to be remembered that the country is rising here towards the heights of Mt. Murchison, and the dip of the lode at Thomas' Blocks has been shown to be to the westward.

Just outside the south-eastern corner of Section 2850, of the Thomas' Blocks lease, there is an outcrop of the lode. The country rock is still the schistose type of the porphyry. Galena is visible at the surface, and some iron pyrites in a siliceous lodé.

Still further south there is an outcrop in the creek, on which some work has been done, and in which a very promising lode has been disclosed. It is a complex formation, from 14 to 18 inches in width, consisting of second-class ore with narrow veins half an inch wide of clean galena on the walls. With the galena are its associates, characteristic of the lodes on the field, viz., blende and both copper and iron pyrites.

The country rock is here no longer schistose, but massive quartz-felspar-porphry. The hanging-wall is but little altered, and is pink; but the footwall is greenish, and carries streaks of metal in the sericitized zone. This occurrence is 720 feet, by aneroid measurement, above the river.

Still further south, and a chain inside the boundary of Section 2864, is an outcrop showing disseminated galena, blende, and iron pyrites over a lode 18 inches wide in the quartz-porphry. This spot is 875 feet above the river.

Further up the hill still, and 960 feet above the river, there is in the creek a greenish lode some 8 inches wide, carrying pyrites and galena.

The south-western portion of the southern section contains two occurrences of ore, which have had a little trenching done on them. The western occurrence shows iron pyrites, blende, and galena, in a green lode-matter resulting from the alteration of the felspar-porphry, which is here schistose.

South-east of this occurrence is a somewhat similar one. The trench shows a greenish quartzose lode, of which the bearing is about N. 35° W. The lode carries galena, blende, and pyrites. The country is the massive type of felspar porphyry.

The lodes on this section are well worth further prospecting, especially the eastern one, which I think to be probably the southward continuation of the "main lode" on Thomas' Blocks. The prospecting now being carried out on the latter property will no doubt afford valuable information, which will be of benefit to the future prospecting of this lode. The surface configuration will enable the lode to be worked at several levels by means of short adits.

(15)—THE SECTIONS IN THE STERLING RIVER VALLEY.

To the west of the Thomas' Blocks and Donoghue's sections are a line of sections situated on the low ground leading down to the Sterling River. These sections—numbered 2861-M, 20 acres; 2837-M, 80 acres; and 2862-M, 68 acres—stand in the names of J. H. Finlay and M. Donoghue.

The western portion of the area consists mainly of slate, but in which there are some parallel narrow bands of porphyroid. The outcrops are few, and I could not determine whether the porphyroid was intrusive or whether thin sheets of lava were interbedded with the slates.

There is a long quartz reef traceable right through these sections from end to end, which has a trend slightly to the east of north.

The only work done on these sections has been carried out on this quartz body.

The outcrop of quartz has been cut through by a trench at a point just south of the boundary-line, between Sections 2837 and 2862. The quartz is some 15 feet across at this point, and has a westerly dip. There is a little iron pyrites present in the quartz, and with it some copper pyrites. On the hanging-wall side of the reef in the slate there is a vein of galena half an inch in width; and on the footwall side there is a gossanous admixture of quartz limonite and iron carbonate carrying a little galena.

An assay of the ore from this spot is said to have shown the presence of 11 ozs. of silver to the ton.

A few chains to the northward the quartz shows only iron pyrites, and no trace of lead ore.

Following the outcrop northward it disappears under the button-grass, but again reappears in the same line. Some trenches have been cut across it in Section 2861, and just outside the northern boundary of this section, but only iron pyrites was found in the quartz.

This quartz reef seems, therefore, barren, as far as galena contents go, and to resemble in many ways the quartz reef in the Mt. Farrell sections. The one spot at which the galena has been found appears to me a place where a later fracturing has in part coincided with the original fracture, enabling the galena to be introduced alongside the quartz.

(16)—OTHER SECTIONS SOUTH OF THE MURCHISON RIVER.

On the north side of the Tullah property, and between it and the river, lie two sections—No. 2830-M, 80 acres, registered in the name of C. A. J. Collins; and No. 2911-M, 79 acres, in the name of C. Thomas.

The former of these, No. 2830, carries only one trench in the centre of the section. The rock exposed is porphyroid, impregnated with galena, blende, and iron pyrites. Too little work has been done to form any estimate of the value of the lode.

On Section 2911 there is a little work done on the north-western corner, high on the slopes of Little Farrell. In the crushed conglomerate, 500 feet above the river, a small body of quartz has been disclosed, which carries some very coarse clean copper pyrites. The bulk of ore proved is so far very small, but it is so rich in copper pyrites that further work at the spot might well be carried on.

A little higher up the hill there is some massive haematite, which merges gradually into the crushed conglomerate, which it has in part quite replaced. I did not see any sign of any copper ores in association with the iron oxide.

On Section 2921-M, 37 acres, in the name of E. Goldsmith, no work at all has been done, and no lode discovered.

To the east of Donoghue's sections lies an 80-acre section, No. 2940, standing in the name of H. J. Kelly. The country rock is massive quartz porphyry on the western side, and this merges into a medium-grained granite on the east.

A trench has been cut in the granitic rock, and exposes a green, altered zone, which carries some iron pyrites.

The same zone has been cut by a trench a little further north, outside the section, and some veins of quartz, carrying iron pyrites, are exposed. I saw no indication of galena in this area.

(17)—THE SECTIONS ON THE NORTHERN SLOPES OF MT. MURCHISON.

(a)—*The Two 40-acre Sections, 2865 and 2866.*

These two sections are registered in the names of R. P. Symmons and J. J. Rice.

On the southern section, 2865, on the track running through the section, a small excavation has been made in the outcrop of a lead lode. The country rock is granitic but the galena occurs in a remarkable gangue of quartz, barytes, calcite, and actinolite. Reference has been made to this lode type in an earlier portion of this report.* Some coarse cubical galena was visible at the top of the cut, but the lode seems to pinch towards the bottom of the excavation, and the galena is largely replaced by iron pyrites. These workings are 1000 feet above the Murchison River.

On the adjoining section, 2866, a shot has been put in the rock over the track in the northern portion of the section. A chloritized lode-stuff is exposed, carrying a few splashes of copper pyrites. This ore resembles the copper ore visible at several points on the Osborne Blocks and other sections situated along the Murchison River.

The bulk of ore does not seem to be great, and the copper content too low at this place for the deposit to be of value, unless future operations produce a marked improvement.

(b)—*The Two 80-acre Sections, 3070 and 3071.*

These two sections, known as the "Sterling" sections, are registered in the name of W. Woolven. They are situated on the northern slopes of Mt. Murchison, and in altitude from 1300 feet above the river on the northern boundary, to 1440 feet on the eastern boundary of the southern section. The country rock is on the eastern side massive, uncrushed felspar porphyry, and on the western the typical crushed porphyroid.

Near the centre of the northern section there is an outcrop of massive hematite at the surface, and a tunnel has been driven some 30 feet below to cut the lode. The tunnel runs for 40 feet on a bearing of 124°, and cuts the body of hematite, but does not penetrate it. On the exposed face I saw a little copper carbonate and copper sulphate. Galena is said to have been seen while the tunnel was being driven, but I could not find any trace

* See p. 49.

of it remaining. It is said that the black gossanous material on the border of the mass contains native copper. No specimen which I examined carried the mineral. The country rock is porphyroid.

All the ironstone seen was apparently well above the water-level, and the workings are consequently too shallow to give an idea of the proportion of copper ore associated with the hematite. The configuration of the country is rather unfavourable for the driving of a lower-level tunnel. It would be better in future prospecting to sink on the lode.

On the southern section the porphyroid carries a few stains of copper carbonate, but outcrops of the rock are few, and no further signs of the presence of a lode were detected.

(c)—*The Barytes Lode.*

Situated between Section 2865 and the Murchison River, and at a height of from 600 to 700 feet above the river, there is a strong vein of barytes.

This is exposed at the surface for a length of 5 chains. Its width is at least 4 feet at the southern end of the outcrop, but no work has been done elsewhere, and I cannot say if this is the average width.

The barytes is crystalline, and white or transparent at first sight. Careful examination, however, shows that it is flecked throughout with minute specks of galena.

Several prospectors enquired of me whether the barytes cap might not be a sign of a massive galena lode in depth. They seemed to have the impression that there were known cases of the variation of lode contents of the type mentioned. If any such cases exist they are unknown to me.

It is true that in the case of barytic lead-veins* the progress of weathering may after a long interval of time produce a gossan relatively rich in barytes. This is because of the insolubility of barytes. But in the present case the vein is a solid one, consisting almost entirely of massive barytes, and not a honeycombed gossan; and there is no justification for the belief that the mineral character will alter materially.

If the occurrence is to prove of commercial value it will be as a source of the mineral barytes itself. Barytes is used mainly in the manufacture of paint as a substitute for white lead or zinc oxide, and to a less degree for

* Described on p. 49 of this report.

weighting paper and for the preparation of the oxide of barium.

For such purposes it is necessary to, first of all, free the barytes from its associated impurities. In this case no great difficulty would be encountered; for, apart from the small galena content, I did not observe any other mineral present, and the purity of the colour indicates its freedom from iron.

The price fluctuates slightly, but the average value for the crude product, delivered at a grinding-mill, may be reckoned at between 16 and 20 shillings per short ton.

When finished for the market, the mineral is worth as much as £4 per ton.

Until better facilities for the transport are available, I doubt if the value of the mineral is sufficient to justify the exploitation of the lode.

(18)—THE EASTERN SECTIONS ON THE MURCHISON RIVER.

(a)—*The Sections known as "The Osborne Copper Blocks."*

The track which follows the northern bank of the Murchison River towards the south-east traverses a number of sections, of which only two are at present taken up. These are Nos. 2144-m, 80 acres; and 2145-m, 80 acres—both of which stand in the name of C. Madden. The greater portion of both these sections consists at the surface of chloritized quartz felsite, but the conglomerate encroaches upon the borders of each section.

On the northern side of the river, near the centre of Section 2144, there is a massive outcrop of hematite. The schistose green quartz felsite has been, by silicification, converted into a grey quartzite in the immediate neighbourhood of the hematite.

A few distinct quartz veins are to be seen, and these carry both iron and copper pyrites; and besides these actual veins, the green quartz-felsite is irregularly impregnated with iron and copper pyrites and a little galena. Very little prospecting has been done on this outcrop, which certainly merits further attention. Two approaches of a few yards each have been cut from the west and north-west, as if to cut the hematite body; but in neither case has the work been carried far enough to afford much information.

Below this point, on the track, the quartz felsite again shows an impregnation with copper pyrites.

This section seems well worthy of more work being carried out upon it. Very little has ever been attempted, and the vegetation is so thick that prospecting cannot be carried out without trenching.

In the adjoining section (2145) at the southern corner of the portion which lies on the northern side of the Murchison River, and right on the water's edge, there is a further outcrop of metal. A zone of the quartz felsite about 30 feet in width is impregnated with copper pyrites and bornite. The occurrence has had very little done on it, and the surface only has been exposed here and there. As far as I could see, there are no definite walls to the deposit. Some joint-planes are visible, but these seem of later date than the impregnation with metal, for the ore does not follow the divisional planes at all.

This formation should certainly be vigorously prospected.

A very similar occurrence of quartz felsite which has been impregnated with copper pyrites is situated nearly a mile south of this spot, on Section 4440, where the track traverses the centre of the section. Here, too, only the surface has been broken from the outcrop.

On the southern side of the river, and in Section 2145, some further workings are situated. Some copper and iron pyrites are visible in the quartz felsite, and a short tunnel has been driven westwards at a point 75 feet above the river. The tunnel only runs in some 15 feet; and a short drive, 10 feet in length, runs southwards from the end.

About 20 feet higher up the hill the quartz felsite is replaced by actinolite rock. A trench shows a few colours of iron pyrites and hematite along joint-planes, and in thin seams in the rock. The prospects at this point do not seem very encouraging.

(b)—*Foy's Lode.*

During my visit to the field a discovery was made by R. Foy of a lode crossing the Murchison River in the north-western corner of Section No. 24-m.

There are two distinct veins on the eastern side of the river, separated by a distance of 5 feet. The eastern one carries some good coarse galena associated with blende, iron pyrites, and copper pyrites in a gangue, which is mainly silica. A few fragments of bleached and kaolinized country rock are included in the lode. This vein is about 8 inches wide where it was first picked up, at a

height of 25 feet above the river, and widens to a foot or more at the water's edge.

The eastern wall (footwall) is the green quartz-felsite which has been sericitized. The hanging-wall is impregnated with very finely divided galena and thin veinlets of quartz and pyrites. The dip is towards the west, at about 75° ; and the strike, measured across the river to the outcrop on the other side, is N. 21° W.

The western vein is smaller—4 inches wide—and dips to the west at angles which vary a good deal over the small length of lode visible. It carries a little less metal and more quartz. Blende and copper pyrites are present with the galena. Across the river at the water's edge both veins could be seen; but they are here hard and quartzose. The two veins unite about 12 feet from the water, and at the junction a pocket of good galena occurs. A little blende, copper pyrites, and fahl-ore accompany the galena at this point.

Traced beyond the intersection the ore becomes once more hard and dense, and narrows down to a width of 6 inches.

The pinching of the lode may be only a local feature, but the prospectors will probably find it more profitable to exploit, first of all, the main vein on the eastern bank of the river. As a preliminary to future operations, I should advise trenching on the eastern bank.

The lode being known to persist on the western bank, it should be eventually followed there; and the exploitation at this point will be easy, since the bank rises almost precipitously from the river.

The brecciated character of the lode-stuff indicates the fact that the lode is the result of the filling of a well-defined fissure, rather than an impregnation of the country rock.

(c)—*Kittson's Workings.*

Following the track southwards from Foy's lode a small outcrop of hematite is met at a point just outside the western boundary-line of Section 24-m. The country rock is quartz felsite, but no copper is found here in association with the iron.

The track follows the river bank, and no striking difference is noticeable between the country rock here and that further north until a belt of crushed conglomerate is met with, similar to that which forms the western slopes of Little Farrell, in Section 2911.

Beyond this the igneous rocks occur again, and in them the old workings of H. E. Kittson are situated. The section, No. 2829-m, 80 acres, is now registered in the name of L. Jolly.

The workings are in the northern portion of the section, and on the south side of the river close to the cage.

Close to the landing-place of the cage, and only just above the river level, an excavation has been made in the steep bank, which shows a band of quartz porphyry impregnated with iron pyrites, copper pyrites, native bismuth, and a complex mineral termed lillianite. Some oxidised copper ores are also present. Some very rich silver ores are said to have been derived from this locality; but in what form the silver existed I cannot say. The veins seemed to run in all directions, and all the mineral exposed was much weathered and discoloured by limonite.

About 150 feet to the south-east, and 80 feet above the river, another zone is opened up, some 20 feet wide, and through it a number of small veins run. The veins are vertical, but their strike is very variable. These veins carry a little iron and copper pyrites, together with some specular iron ore.

Below this outcrop, and 30 feet above the river, a tunnel was started in granite, but abandoned when 15 feet of driving had been done.

The mouth of the tunnel shows a greenish altered zone in the granite, which appears to dip northwards. If the work is persevered with, this tunnel should prove the lode-formation in depth. The surface workings are too much affected by weathering to give much information at the present time. I could find no sign on the surface of a main fissure, nor could I trace any connection between the ore exposed in the two sets of workings.

No work at all was being done at the time of my visit to the locality, and there were no signs of any recent attempt to prove the property.

(19)—THE SECTIONS ON THE PIEMAN RIVER.

The track to Rosebery from Mt. Farrell follows the Pieman River round the base of Mt. Black, and from the Murchison River on the western side of the Mt. Farrell township to the railway bridge over the Pieman the country rock traversed is wholly the felspar porphyry.

The river alluvial overlaps the base of the higher ground, and the present river has cut its way down through this gravel.

The felspar porphyry is very similar in appearance to the corresponding rocks further east. It is on the whole schistose, but the degree of schistosity varies between wide limits.

The region is traversed by a number of minor, and one major, fractures, at a distance of about $2\frac{1}{2}$ miles from the junction of the Mackintosh and Murchison Rivers.

Only one section on the area is at present taken up, viz., No. 2382, 40 acres, which is registered in the names of G. A. Gabbedy and W. M. Black. It is on this property that the mine known as the Langdon is situated.

The lode was first discovered at the point where Innes' track crosses it by a prospecting party, who worked northwards from Rosebery along the felspar porphyry belt. It exhibits a marked peculiarity of structure, in that the strike is due east-and-west. The dip is northward.

A tunnel has been driven southwards from a point 30 feet below the outcrop. The bearing is 147° , and at 30 feet it passed through the lode.

It is said to have been driven another 30 feet on the same bearing, but the portion of the drive past the lode was blocked by waste. The tunnel was carried past the lode, for the reason that the values had so materially decreased in depth that it was thought the lode was still ahead.

I am informed that the upper portion of the workings produced some very good galena, of which about 40 tons was taken to the smelters. At the time of my visit all this material had been stoped out right to the surface. A few specimens lying on the tip showed good coarse galena with resinous-looking blende.

There is a drive on the lode from the adit for 30 feet in an easterly direction. The back of the drive shows that the ore-body has pinched to a width of only a few inches, and, in fact, can hardly be traced at the intersection of the drive and tunnel. About 10 feet from the end of the drive there are 6 inches of ore, consisting of coarse galena mingled with resin blende. But on the whole the galena seems to have given place to resin and ruby blende.

The contraction of the ore-body and the impoverishment in the lead content have no doubt led to the abandonment of active work, and the mine has been idle for 12 months.

It is regrettable that while work was in progress no winze was put down on the lode to prospect it in depth. The pinching of the lode may be only a local feature, and

after such a promising outcrop it is a pity not to carry the work down beyond the very shallow-level tunnel.

There have been several trenches cut on the western continuation of the lode outcrop, but they show only zinc-blende with traces of galena in veins through a mineralized zone. These trenches extend to the western boundary of the section, and have not indicated sufficient values to justify further prospecting at a depth.

The country rock is a felspar porphyry, which is slightly altered near the lodes, probably by the development of sericite. Numerous veinlets of silica are to be seen in the country rock near the lode, and these veinlets seem to have a tendency to run in an east-and-west direction. The country rock is also indurated here and there by an intimate impregnation by silica, till it resembles a chert.

Higher up the hillside, some 250 feet along the track, there is a little work done on a gossanous capping. A few shots have been put in, and a complex lode-formation is disclosed. It is 6 or 7 feet in width, and carries a number of small veins up to 3 inches in width of zinc-blende, and very occasional splashes of galena. The blende has by weathering acquired a coating of limonite, but the undecomposed material is dull yellow, and has been mistaken for carbonate of iron.

Too little of the lode was exposed to determine the dip. The strike seemed to be a little north of east. The country rock is similar to that of the Langdon Mine.

There has been some trenching on the adjoining section, 2524, now vacant.

In one of the trenches below the track on the eastern boundary a small vein, some 4 to 6 inches in width, is exposed. It strikes N. 55° W., and dips to the north-east at from 80° to 85°. The lode contents are blende and a little galena in a band of silicified felspar porphyry.

A trench running a little east of north has been put down to cut the continuation of this lode, but without success.

There is also some trenching on the line of the Langdon lode, and in one trench a lode a foot wide, carrying some veins of tarnished blende and a little galena, is visible. A winze, full of water at the time of my visit, had been put down in the bottom of the trench, so I could not see the lode at that point.

The veins that have been located in this section seem to carry blende rather than galena, and work in the area has been altogether abandoned.

VII.—CONCLUSION.

Summing up, the writer may express the opinion that there is a well-assured future before the central area of the Mt. Farrell mining field.

The centre of future operations will, as far as can yet be foretold, be located round the North Mt. Farrell and Mackintosh leases. These appear to possess, in a greater measure than any others, the attributes which justify the outlay of capital for the development of the mines and the treatment of the ore.

One of these properties—the Mackintosh—is at present practically untouched. Yet the ore proved at the surface gives every indication of permanency in depth, and the length of the lode compares favourably with that of the lodes on any other lease in the field.

The ore-bodies on the two above mentioned properties contain a bulk of second-grade ore, which will, with efficient milling plants, ensure profitable returns for several years at least.

And there are several other properties to the southward which can show a fair amount of milling ore. No one of these, taken by itself, can yet be said to have justified the erection of a concentrating mill. Still, were a customs mill located in the district, there are several mines, now inactive, which would probably contribute second-class ore. The returns from this second-class ore would at all events assist financially towards the development of the properties; and during the mining of the second-class ore the contributing mines might well improve, or show an ever-increasing bulk of the milling ore.

The tendency has been thus far for the management of those mines which are in the earlier stages of development to expect highly payable lodes of first-class ore, rather than lodes of which the greater proportion, at least, is second-class ore. This being so, the work of development has in some cases been abandoned at once where first-class metal is not encountered. The lessons taught by the development of the North Mt. Farrell Mine should be remembered; for not only does the ore-body vary very considerably from point to point, but in one case the main lode (No. 3 lode) was passed through without being recognised.

The attitude assumed with regard to the presence of first-class ore has resulted in undue prominence being given to the assay returns from picked specimens of ore. Few, if any, assays of samples properly taken are obtainable; and the value of assays of specimens is, of course,

purely qualitative. The presence of fahl-ore with the galena, will, in the majority of cases, ensure a high return of silver. Yet, in the mines which have been opened up to any extent, the proportion of fahl-ore to galena is small.

The recent developments at the southern end of the field seem to point to its presence in larger proportions there, but this cannot be regarded as certain until the lodes are opened up more extensively.

The southern end of the field is undoubtedly expanding, and much will depend upon the work of the next few months on the Tullah Mine and Thomas' Blocks. Every successful development on these properties will stimulate further prospecting in this direction.

The northern end of the field has been seriously hampered by the difficulties of transport, and the lodes which have been located are almost entirely undeveloped, notwithstanding the fact that they were the first discovered in the district.

There is one strip of country which has thus far quite escaped the attention of prospectors—that between the Tullibardine lease and the Farrell Blocks, and lying on the western side of the Mackintosh River. It has been indicated in this report that it is probable that the Tullibardine lode lies on the main fracture-line of the central and northern part of the field, the strike-line of which has been bent a little to the eastward by the disturbance which produced the fault that traverses Section No. 2796.

The area on the Murchison River, eastward of the gorge cut through Mt. Farrell, is well worthy of more systematic prospecting. The recent discovery of a lead lode in that district should assist in stimulating prospecting activity.

This report embodies the field work which was carried out during the months of September, October, and November of 1907.

In conclusion, I wish to express my appreciation of the assistance afforded to me during my examination of the field and the preparation of this report by all those who are, in different capacities, interested in the field. The number of these to whom I am indebted is so large that I trust I may be permitted to make this general acknowledgment of thanks.

L. K. WARD,

Assistant Government Geologist.

Launceston, 15th February, 1908.

KEY TO PLATE II.

The Mineral Sections now taken up.

Number of Section.	Acres.	Lessee.
WHITE HAWK DISTRICT.		
2330-M	42	} R. P. Symmons. (The White Hawk.)
2331-M	80	
2332-M	47	
3367-M	72	} R. P. Symmons and C. R. Lynch.
3368-M	40	
3369-M	37	
THE AREA NORTH OF MT. FARRELL.		
2592-M	80	} J. McPhee. (The Tullibardine.)
2593-M	80	
2058-M	80	
THE AREA ON THE WESTERN SLOPES OF MT. FARRELL.		
2873-M	80	C. R. Lynch.
2892-M	40	G. E. Butler.
2796-M	80	G. E. Butler. (Formerly Metropolitan.)
2909-M	80	W. Innes.
2905-M	80	J. Geddes.
2397-M	79	E. Goldsmith.
2820-M	80	A. E. Goldsmith. } (Farrell Blocks.)
2983-M	80	A. E. Goldsmith.
3010-M	80	D. Powell.
3223-93M	80	} Macintosh Copper & Gold Mining Co., N.L.
3221-93M	80	
4116-93M	68	
3262-93M	76	
1867-93M	80	
2351-M	75	
2722-M	40	} North Mt. Farrell Mining Co., N.L.
1074-M	20	
292-W	10	
82-W	4	} Mt. Farrell Mining Co., N.L.
2409-93M	80	
2410-93M	80	
2656-W	10	} Murchison River Mining Association, N.L.
2815-M	80	
1980-M	80	
3263-93M	60	} E. T. Midwood (Murchison Extended). (Formerly North Murchison.)
1286-M	5	
1075-M	79	
2777-M	80	H. J. Kelly.

Number of Section.	Acres.	Lessee.
2891-M	40	M. J. Thornton.
2981-M	75	C. H. F. Shearn.
704-M	73	South Murchison Silver-Lead Mining Co., N.L.
2945-M	40	} R. Green and A. King.
2946-M	40	

THE SECTIONS SOUTH OF THE MURCHISON RIVER.

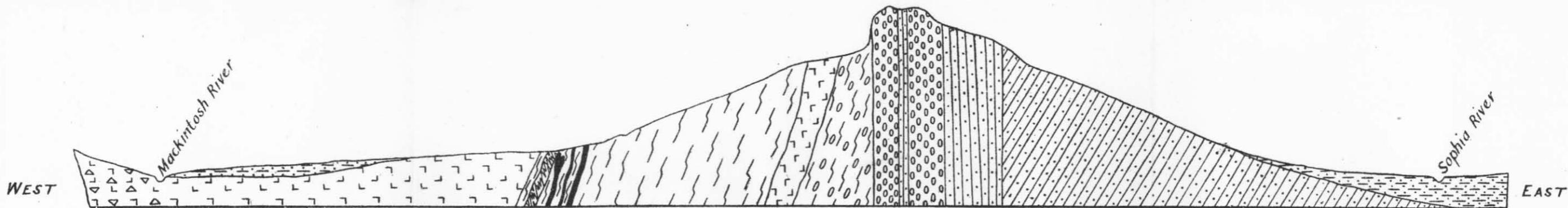
2921-M	37	E. Goldsmith.
2830-M	80	C. A. J. Collins.
2911-M	79	C. Thomas.
2808-M	80	C. W. Thomas. } (Thomas' Blocks.)
2850-M	80	C. Thomas. }
2918-M	20	G. O. Smith. }
2925-M	80	E. Pennefather. (Tullah Silver-Lead Mining Co., N.L.)
2863-M	80	} M. Donoghue.
2864-M	80	
2861-M	20	} J. H. Finlay and M. Donoghue.
2837-M	80	
2862-M	68	
2940-M	80	H. J. Kelly.
3-71-M	80	} W. Woolven. (Formerly Sterling.)
3070-M	80	
2865-M	40	} R. P. Symmons and J. J. Rice.
2866-M	40	

EASTERN SECTIONS ON THE MURCHISON RIVER.

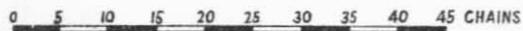
2144-M	80	} C. Madden.
2145-M	80	
2829-M	80	L. Jolly.

SECTIONS ON THE PIEMAN RIVER.

2382-M	40	W. M. Black and G. A. Gabbedy. (Formerly Langdon.)
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HORIZONTAL SCALE



VERTICAL SCALE

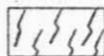


SECTION ACROSS MOUNT FARRELL

ON LINE S. S.

LEGEND

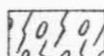
Slate



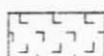
Conglomerate (massive)



Conglomerate (schistose)



Felspar Porphyry (schistose)



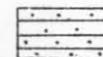
Lodes



Clay Schist



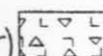
Sandstone



River Gravels



Felspar Porphyry (Tuff)



*Left Ward,
Assistant Government Geologist,
15.2.1908.*



5 cm

**GEOLOGICAL MAP
OF COUNTRY NEAR LISLE**

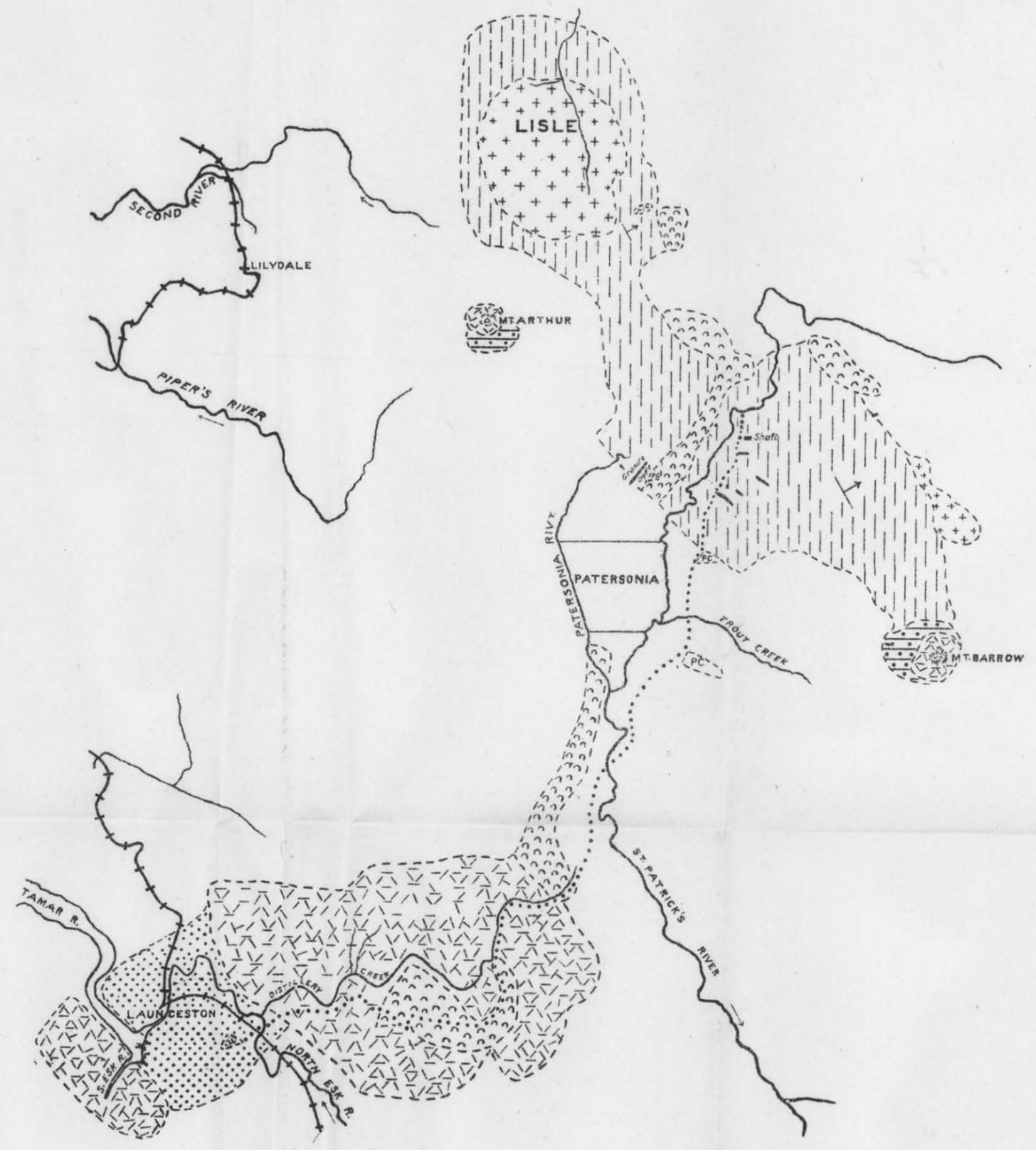


SCALE 0 1 2 3 4 Miles

INDEX

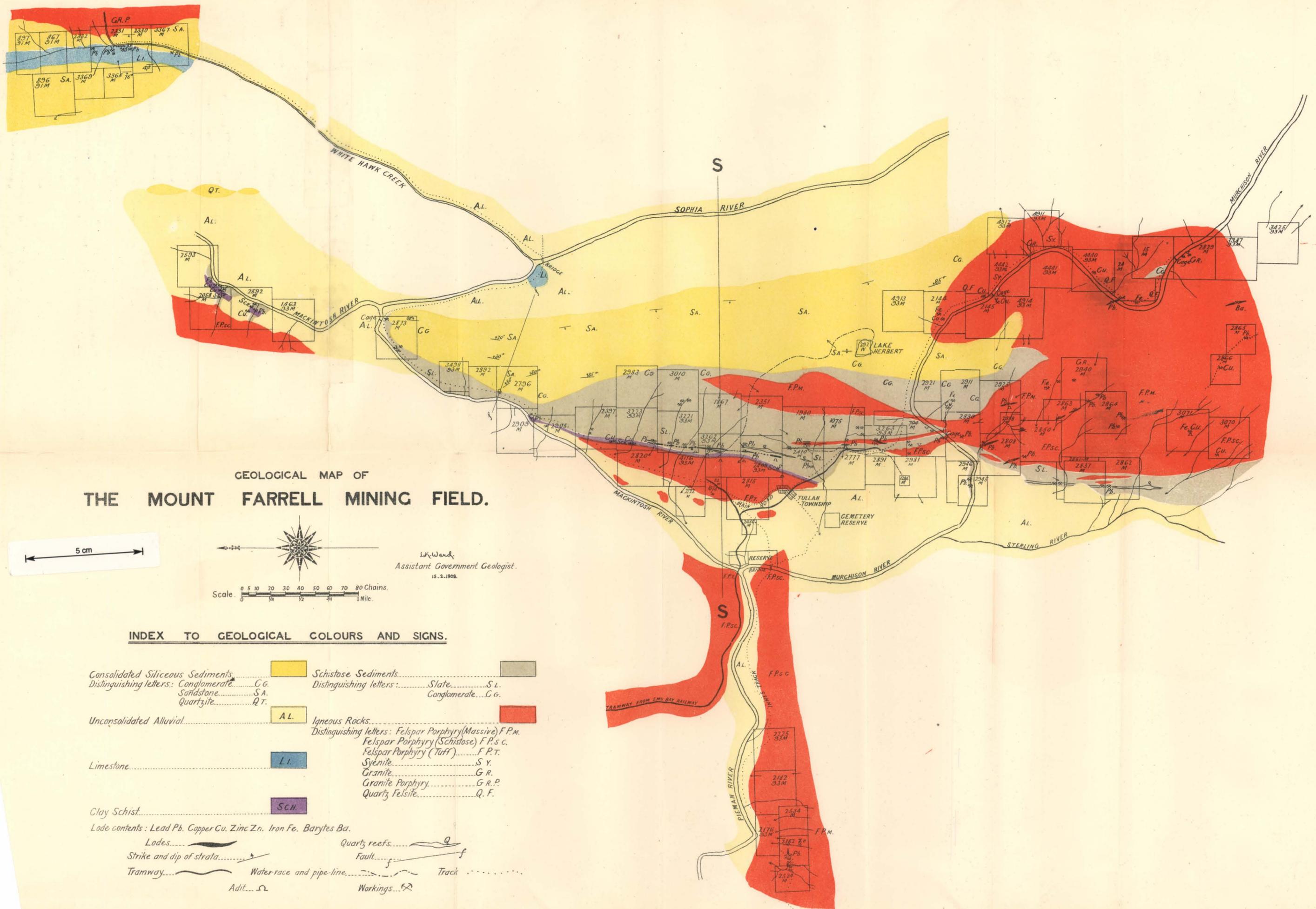
TERTIARY BEDS	
BASALT	
DIABASE	
PERMO-CARBONIFEROUS (PC)	
GRANITE	
ORDOVICIAN	

Dykes Strike and Dip of Strata
 Tracks Railways Geological Boundaries

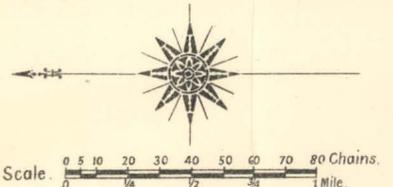
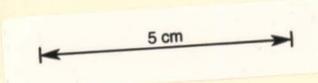


W. H. Finlayson
Government Geologist

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



**GEOLOGICAL MAP OF
THE MOUNT FARRELL MINING FIELD.**



Isk Ward,
Assistant Government Geologist.
15.2.1908.

INDEX TO GEOLOGICAL COLOURS AND SIGNS.

Consolidated Siliceous Sediments.....		Schistose Sediments.....	
Distinguishing letters: Conglomerate..... C.G.		Distinguishing letters: Slate..... S.L.	
Sandstone..... S.A.		Conglomerate..... C.G.	
Quartzite..... Q.T.			
Unconsolidated Alluvial.....		Igneous Rocks.....	
	AL.	Distinguishing letters: Felspar Porphyry (Massive) F.P.M.	
		Felspar Porphyry (Schistose) F.P.S.C.	
		Felspar Porphyry (Tuff)..... F.P.T.	
Limestone.....		Syenite..... S.Y.	
	LI.	Granite..... G.R.	
		Granite Porphyry..... G.R.P.	
		Quartz Felsite..... Q.F.	
Clay Schist.....			
	SCH.		
Lode contents: Lead Pb. Copper Cu. Zinc Zn. Iron Fe. Barytes Ba.			
Lodes.....		Quartz reefs.....	
Strike and dip of strata.....		Fault.....	
Tramway.....		Water-race and pipe-line.....	
Adit.....		Workings.....	

THE LISLE GOLDFIELD.

[Five Plates.]

I.—INTRODUCTION.

THE small township of Lisle is situate by road 7 miles south-west of the Lisle-road station on the Launceston to Scottsdale railway, and 8 miles due north from Patersonia. Cart traffic is mostly by way of Lisle-road, but the mail-horse route is *via* Patersonia. The few homesteads and surviving cottages are on the floor and basal slopes of a broad valley, about 2 miles in length, running in a north and south direction, and forming a triangular or sub-elliptical area between the Main and Bessell's Creeks. The confluence of these two creeks takes place at the northern end of the valley, where the hills close and a rocky gorge is formed through which the Lisle Creek flows northward to join the Little Forester River.

About a couple of dozen men are now occupied in sluicing the gravels for gold. The sawmill, which supplies timber for the builders' use in town, gives employment to several men. These, with the inhabitants of a few homesteads, make up the present population of the valley. Scrub has grown up again on the flat land which many years ago was cleared when mining was in full swing in the valley. Some of the purchased land in the centre of the valley and on the eastern slopes is cleared, but the rest is closely timbered for the most part. Tall gum forest clothes the hill sides, with a thick undergrowth of dogwood, musk, and cathead fern. The soil in the valley and on the lower slopes is clayey with a granitic bottom, and the land is well suited for grazing purposes. Fruit also does well. Mr. Furlonge has an orchard which produces apples admired in the London market.

The goldfield and the land surrounding it have been withdrawn from selection for many years, but 1400 acres in the south-western portion of the reserve have recently been proclaimed available for purchase, though in deference to indications of renewed mining activity on the field no sales have as yet been sanctioned.

II.—PREVIOUS LITERATURE.

The Government has caused two official examinations of the Lisle field to be made previously to the present one. The first report was by Mr. G. Thureau, Geologist to the Government of Tasmania, and was published as a House of Assembly Paper (No. 46), in 1882. The following extract will serve to show the conclusions then arrived at:—

“At the junction of the metamorphic schists with the syenitic granites, not only are there narrow quartz veins accompanied by granitoid vein matter, mica, hornblende, &c., but distinct, though small, veins of this granitoid rock protrude and traverse the schists for a considerable distance from the main body

“Bearing in mind that the whole of the granitoid formations are traversed by attenuated quartz veins charged with very fine gold, it may be inferred that if any vein matrices with coarse gold exist the probability is that they occur at or near the points of contact of the granitoid with the metamorphic or other schists on the Lisle Divide and in the eastern foothills of Mt. Arthur.”

The second Government inspection was by Mr. A. Montgomery, M.A., who reported on certain portions of the Lisle goldfield, on 13th September, 1894. This report was not printed. The following is extracted from it:—

“The Lisle workings lie in a somewhat wide valley, which contracts to a gorge lower down the creek. The bottom of the valley has been worked for some 500 or 600 feet in width, from which it would appear that the auriferous material could not have been confined to one narrow lead, but must have spread over some distance. Round the edges of the flatter ground at the foot of the slopes of the surrounding hills there are large terraces of alluvial material, some of which has been successfully worked. It seems rather likely that at one time the detritus from the surrounding slopes was brought down into the flat part of the valley faster than it could be discharged through the gorge at the outlet, and consequently large accumulations took place, especially at the bottom of the hill slopes. In one claim I noticed traces of the former presence of still water, there being a layer of finely laminated clay and sand lying horizontally upon the bottom gravel, and in the clay were numerous lignitic impressions of leaves The gold from this field is very fine in grain, nuggets

being quite rare, and is said to be very seldom found with quartz attached to it. The wash is of a clayey nature in the terraces, with not a great deal of stone through it. The stones are but little waterworn, and consist of metamorphic sandstones from the surrounding hills, chalcedony from veins in the granite, and only a little quartz that seems likely to have been derived from reefs. In parts we find veins and patches of quartz wash, but on the whole it does not seem very plentiful. In some of the claims towards the head of the valley there is much less clay than in the terraces near the township, and faces of 6 to 15 feet in depth of coarse sandstone gravel are seen in the workings. In these the stones are more waterworn, and the wash appears to be richer in gold. . . . The veins on Titmus and Dodgshun's sections are said by some to be the only ones yet found carrying gold on the Lisle field, but I have also been informed that similar ones were not infrequently met with in the bedrock by the alluvial diggers. It seems very possible that much of the gold in the valley has been derived from similar veins, but I am more inclined to think that the sandstone country, and particularly the belt along the contact between the granite and the sandstone, will in time prove to be the source of the gold.”

Mr. Charles Bessell (the Bessell Bros. were the discoverers of Lisle) wrote a report for a proposed hydraulic company in 1894, and the following extracts are taken from it:—

“Payable Ground Available.—This, I may say, is practically unlimited. In my opinion there are three distinct deposits of gold in the field, and it is also my opinion the sources are all within the Lisle valley, and have yet to be found. However, I can, I think, safely state that there are 500 acres averaging 12 feet in depth. This ground may be equally divided into old ground or ground that has been worked in the early days, and new or sound ground; part of this is not rich enough to pay by the slow process of pick and shovel. As to the old ground, in my opinion this would pay well, for personally I prefer to work good old ground than new poor ground. As to the probable yield per cubic yard, this is rather a difficult question to deal with, as in some places the gold is distributed through the ground from the surface to the bottom, while in others it is confined to the wash on the bottom, which varies from 1 foot to 5 or 6 feet. I have worked ground here with a payable prospect from the

surface to the bottom 15 feet in depth. I have also worked ground the same depth with no gold except in the bottom 2 feet with equally payable results. However, I believe I shall be well within the mark if I say the whole of the ground referred to will average from 4 to 6 grs. to the cubic yard—this is independent of rich patches, which will probably go several pennyweights to the yard, and I feel quite confident that many of these will be met with as work proceeds. I may state that there are many indications of false bottoms existing on the terraces; in fact, Cashman and party are at present working under 2 feet of false bottom, and again, it can be seen where I am now working at the camp, but how far it extends into the hill has to be proved. With reference to the quantity of gold obtained here I have heard many estimates, but being connected with its discovery 15 years ago, and having an object in endeavouring to ascertain the yield for the first years, as the Government of the day offered great inducement to prospectors in the shape of a large reward for the discovery of a payable goldfield, during the first year I obtained certificates from some of the gold-buyers that they had bought about 15,000 ozs. This, however, does not represent the total yield, and I have heard that Mr. Bernard Shaw, who was then Commissioner of Mines, estimated that not one-third of the gold won was sold in the country. In this I quite agree with him, as a very large number of the 2500 miners then on the field came from Victoria, and I know many of them took the gold there periodically. It must also be remembered that during the first year the men had all their dead work to do in opening up their claims, consequently were not getting gold the whole time, and one of the buyers referred to told me he had bought more gold the first half of the third year than he did during the whole of the first year. Taking all this into consideration, I believe I shall be near the mark by estimating the total yield to be 250,000 ozs., or in round numbers £1,000,000 worth; but I have heard some estimate the yield to be considerably over that amount. With reference to the yield of individual claims, this is a difficult matter to get at, as miners are generally very reticent on this subject. However, I have heard the yield of some of the claims from reliable authority. The best yield I have heard of was from Clare Brothers, who obtained over 1000 ozs. from two men's ground. This claim was on Bessell's Creek, and may be taken as an average. Donnelly and party, I am told, got consider-

ably over 1000 ozs. from their claim. There were several good claims on the terraces, the wash-dirt varying in thickness from 1 foot to 4 feet., and yielding from 5 dwts. to over an ounce to the load. The first claim in which I was interested yielded nearly 500 ozs. from four men's ground. This claim was on Bessell's Creek*, and may be taken as an average of all the claims on it for a distance of nearly 2 miles in length. Shillady and party have, I believe, won over 2000 ozs. from their claims. Cashman and party are reported to have had very good results all through, and I am informed that the last six months' washing resulted in nearly £200 per man."

In 1899 the Lisle Dredging Company was formed to work the deposits in the Main Creek, and published some reports with its prospectus. One of these reports was by Mr. Thomas Kelly, who has worked on the field for many years, and the following is a copy of same, omitting purely commercial references:—

"I here submit my 20 years' practical knowledge of the field. The ground held by your syndicate is known as the Main Creek, embracing some 2 miles of the same; also some terrace ground at the head of the creek which is supposed to be the source of the shed of the gold into the valley of the Lisle. I have not the slightest doubt of the 2 miles of creek being payable; that is, by treating it on a large scale. There have been several syndicates formed, and the required capital subscribed, to work this same ground. They estimated that the tail-race would cost £5000, but when levels were taken they could not obtain sufficient fall to sluice the washaway. In my opinion the only way the ground can be treated is by dredging it. The richest of the veins were on the course of this Main Creek, and therefore wet claims to work, and when they are wet there is always a loss of gold. For instance, myself and party worked ground known as Donnelly and party's. We worked the claim out for a yield of over 2000 ozs. It being situated on the terrace we brought water on to it, and it was ground-slucied away for a return of over 700 ozs. of gold; that made the yield of gold from four men's ground over 3000 ozs. As to the probable loss of gold in the Main Creek, there is no doubt they were mostly all rich claims, and I can safely put the loss down at one half of the return we obtained by ground-slucing Donnelly and party's claim, say, 350 ozs.

* The present Main Creek used to be called Bessell's Creek.

to the acre. Your syndicate holds, say, 2 miles of the creek, and without a doubt there must be in the old ground alone, to say nothing of the solid blocks that have not been worked, some thousands of ounces of gold, as the diggers in the early days looked for 2 or 3 grains to the dish, and anything less was thrown away. Regarding the upper portion of your ground—that is what is known as the deep ground, which is supposed by many practical miners to contain the source of the gold which was worked in the Main Creek—there have been many parties formed to test it, but owing to the ground being too deep and wet they had to abandon it, so I cannot say much about it, only that the ground was payable up to it. This field was the richest alluvial field opened in Tasmania; the yield of gold settles that point. The return from here is roughly estimated at 300,000 ozs., and the greatest portion of it was obtained in the main creek and terraces on each side of the creek. The dirt is of a friable nature, easily treated; and the bottom is a decomposed or soft granite. The water the creek carries in the summer season is about 4 sluiceways, in the winter months from 20 to 25 heads.”

III.—PHYSIOGRAPHY.

Enclosed by high hills, Lisle is an upland valley, the floor of which is from a mile to a mile and a half in width. Its approximate height, according to aneroid readings, is between 700 and 800 feet above sea-level. The railway-station at Lisle-road is 341 feet above the sea, so that the Lisle township is about 400 feet above the railway line. For notes on the determination of heights, see appendix to this report.

The crests of the hill ranges on either side of the valley are about 3 miles apart east to west, and the valley is closed in at its head to the south by a broad divide 1200 feet above the township. On the southern side of this divide is the fall to the Scottsdale-road, and a couple of miles south-easterly the high land rises to the summit of Mt. Arthur, formerly called Row Tor, 3895 feet above sea-level. The two sides of the horseshoe thus formed flank the Lisle Valley as high narrow ridges, 800 to 1000 feet above the township. The eastern ridge separates the Lisle Valley from the deep basin of the Little Forester River, and the western ridge overlooks on the west the valley of the Lone Star Creek, and the head of the eastern branch of the Denison River.

The configuration of the valley shows that its age is considerable. The flat floor has been gradually widened and the steep sides pushed further and further apart. The north-easterly dip of the strata has contributed powerfully to the downward creep of the hill debris, which everywhere thickly covers the surface of the bed-rock and accumulates towards the foot of the hills on the east side of the basin in large terraces of angular stones. On the west side the terraces are not so numerous, owing to the different conditions caused by the dip there. The Main Creek hugs the base of the range on the eastern side, and Bessell's Creek does the same on the western side. Stony Creek and Thomas' Creek, which flow down from the western mountains, add to the volume of water carried off through the gorge. The ground is flat, and possibly at one time the rainfall was such that there was more water than could get away easily through the narrow outlet at the gorge. At present, notwithstanding the steep grade of the hills, floods are not complained of, and though the encircling ranges are chiefly narrow divides with small catchment areas, the rainfall as a rule is sufficient, though last summer, as elsewhere, was dry. There is no meteorological station here. The nearest are Scottsdale and Patersonia. The rainfall at Scottsdale, from 1st October, 1906, to 30th September, 1907, was 47.25 inches on 155 wet days. At Lisle it is probably in the neighbourhood of 40 inches. The clouds often pass over, following the mountain crests. Although, owing to the high hills surrounding Lisle, the winters are cold, the climate is milder than that prevailing on the south side of the divide, where the influence of Mt. Arthur and Mt. Barrow is more distinctly felt. Snow falls in the valley very seldom.

The prospector for reefs experiences great difficulty from the heavy overburden of surface debris which has slowly accumulated on the mountain slopes. I was shown one place up the hill where the granite bed-rock had been exposed in 3 feet of sinking, but a few chains away no bottom had been reached in 70 feet. This gradual uninterrupted process of accumulation interposes a serious bar to costeaning. That reefs of some sort are present in these hills is evident from the profusion of stones of quartz present in the terraces, which have been worked by the miners, and here and there barren veins are known, but the reefs which have shed the bulk of the unproductive stone found in the workings have not been uncovered

owing to the thickness of loose stony débris or clayey soil covering the surface.

The main reefing lines in the sandstone strata are likely to run more or less parallel with the north-westerly strike of the strata, consequently, roughly parallel with the long axis of the valley. The little creeks which flow into the Main Creek from the eastern side of the valley run over the granite zone, taking their rise for the most part near the junction of the granite and sandstone. Hence their value for intersecting reefs in the sandstone country is nil.

IV.—GEOLOGY.

The rocks which occur in the district fall into the two divisions of eruptives and sedimentaries.

(1.)—THE ERUPTIVE ROCKS.

There are three groups or varieties of these, viz., granite, diabase, and basalt. Of these, the granite is the most important in every way, as the diabase and basalt have never been found in Tasmania to bear any relation to the process of deposition of the more valuable metalliferous ores or metals.

A.—*The Granite of the Lisle Valley.*

Below the alluvial of the creeks and the surface deposit of clay which covers the valley plain is the granite bed-rock. This is very generally concealed by the waste from the hills, but undoubtedly forms the solid floor of the valley and rises up the flanks of the mountains to a height of between 400 and 500 feet, when it junctions with Ordovician sandstone and slate. The exact line of the junction is hidden by the hill waste, but it is roughly traceable on the eastern side by the top of the granite forming a fringing shelf from which the sedimentary strata rise at a steeper angle of slope. The granite rises towards the south till it attains a height of about 700 feet, when it apparently passes under the divide in a south-easterly direction, reappearing, I am told, on one of Millwood's sections, and certainly exposed again beyond St. Patrick's River at Diddleum. The same belt comes to view again in Lone Star Creek and at Panama.

In the Lisle workings the granite is soft and decayed. At three places in the lower part of Main Creek loose boulders of the hard unaltered rock are seen in positions

which indicate the rising to surface of the solid granite mass. The rock itself is not dyke rock, but the normal granite of the belt. Higher up, at the head of the valley, on W. Kerr's land, is a knob of hard granite of the same type. At the north end of the valley, at the gorge, the granite sinks to the level of the creek, and disappears below the micaceous sandstone which forms the hill to the west.

To the naked eye it is of a finer grain than the familiar granite of the North-East Coast, and has a characteristic appearance, owing to dark magnesian mica (biotite) with some hornblende being present in great abundance. Quartz, though present, is subordinate. The type is the well known one of hornblende granitite. Rosenbusch defines granitite as follows:—*

"It is distinguished from granite, not only by the absence of muscovite, but is nearly always richer in lime-soda felspars, coloured constituents, and iron oxides, though on the other hand poorer in quartz than granite proper, in the restricted sense of the word The normal type of granitite takes up hornblende readily, and in this way the variety of hornblende granitite is formed (in petrographical literature often called syenite-granitite)."

This rather basic, or, more strictly speaking, less acid variety of granite appears to be characteristically associated with gold rather than tin ore. The same type prevails all along the gold belt, at Diddleum, Lisle, Golconda, and where it is dominant it is safe to say that gold, and not tin, will be the metal that should be sought, as far as this part of the island is concerned. This is not affected by the circumstance that a little tin has been reported as found with the gold at Lisle.

B.—*Diabase.*

On the south divide, on T. Faulkner's (now A. Dean) 100 acres purchased land, and about 5 chains south of the north boundary, is a line of boulders indicating an outcrop of this rock running towards the west. It is the same rock as that which forms the summit of Mt. Arthur, consisting of a mixture of felspar and augite. The felspar is labradorite. The rock is of medium texture. It is too well known to need here a recapitulation of its microscopic characters. It intruded in the older sandstones and

* Mikroskopische Physiographie der massigen Gesteine, 1907, I. pp. 61-62.

the overlying Permo-Carboniferous strata, which latter have since been denuded, resulting in the exposure of the intrusive rock. Its age is approximately that of the close of the Mesozoic, consequently younger than the granite and older than the basalt. It is not connected in any way with the deposition of ore, and the only use apparently to which it can be put is in making foundations for buildings and bridges and metalling roads. For the former, it is strong and durable, but does not dress easily; and for the latter purpose it is not quite an ideal stone, being too tough to powder sufficiently to supply its own binding, and rather hard for horses' feet.

c.—*Basalt.*

In the eastern part of the preceding section and the one adjoining it on the south the rich soil of the farm land proclaims the presence of the basaltic lava sheet, 1800 feet above sea-level. This volcanic sheet is pretty well continuous to the south-east as far as and beyond St. Patrick's River, but it is often reduced to a thin covering of decayed rock or is even completely broken down into its characteristic soil. The ash cones of the Tertiary volcanoes have long since disappeared, and the former vents have not been located.

There are grounds for believing that in early Tertiary times the land in Northern Tasmania was even higher than it is now, but that a period of subsidence set in, which came to an end with the outpouring of the basalt lavas in the Middle Tertiary, since when an elevatory movement has taken place and the present Lisle Valley and gorge have been excavated.

The rock is the olivine-basalt, of which there appear to have been numerous outpourings in Tasmania at the close of the Lower Tertiary or Palaeogene period.

(2.)—THE SEDIMENTARY ROCKS.

(1.) These consist of slate and sandstone strata, which have a very regular strike of N. 30° W., and a north-easterly dip. They are traceable without interruption to south-east of St. Patrick's River, and the prolongation of their bearing in a north-westerly direction would approximately follow the course of the Little Piper River. The same strike and dip continue as far as to the west of the Piper River and Back Creek, but there is a change of dip to the south-west within a few miles of Lefroy. As

a north-easterly dip prevails on the west side of the Tamar at Beaconsfield, that river is apparently either in a synclinal valley or, as is more probable, on the line of a fault which affects the older strata. In support of the latter theory is the negative fact of non-discovery on the east side of the river of any exposure of the Beaconsfield series.

The sandstone and slate strata form a belt on the east side of the Lisle Valley, while slate also skirts the west side. Another belt of slate comes in on the east on descending the range into the basin of the Little Forester. The sandstone and slate on the eastern ridge are metamorphosed to a hard, dark, bluish rock, with splintery and conchoidal fracture, and have been frequently mistaken for basalt. The rock has no doubt suffered from the granite contact. Where not altered, the sandstone is a soft brown micaceous rock. Another phase of alteration is also shown by the sandstone, which is slightly argillaceous, and under the microscope shows nodular segregations approaching the nature of incipient chistolites.

Some obscure nodular forms are seen in sandstone to the west of the track on the top of the hill south of Lisle. It is rather doubtful whether these are organic.*

These stratified formations are with probable correctness placed in the Ordovician system. This conclusion is reached partly by the application of negative criteria and partly by connecting the stratigraphy with that of neighbouring belts of country. It has not been possible in Tasmania as yet to divide the Ordovician into Lower and Upper divisions.

(2.) Apart from the consolidated rocks is the heavy covering of hill débris and clay which clothes the hill slopes and is spread over the floor of the valley. This débris consists of angular and subangular stones of white quartz, sandstone, granite, chalcedony (from veins in the granite), and quartzite. The creeks contain waterworn stones of the same nature. There is some evidence of alluvial ground along the course of an older stream to the east of the present Main Creek on a higher parallel; † but there is no evidence of there ever having been any other drainage outlet to the valley than at the gorge end. There is a theory which is entertained by some on the

* The earlier reference to graptolites, found at Lisle by Mr. Thureau, may be disregarded as based on a misapprehension.

† This was in all likelihood the ancient bed of the present Main Creek.

field that a stream once passed north-west over or through the hill into the Lone Star Valley. I examined this divide, and came to the conclusion that no outlet could have existed in this direction. The dividing crest is solid sandstone, rising to 800 feet above the valley, and shows no indications of any alluvial covering which could mark a former channel.*

It is this unconsolidated mantle which has yielded all the gold which has been won from the field.

(2.)—*The Geological Sequence.*

This arranges itself as follows, reckoning from the earliest to the most recent places of the succession:—

- (1) The deposition of the Ordovician sediments.
- (2) The folding of these strata.
- (3) The eruptions and consolidation of the granite.
- (4) The period of the deposition of gold.
- (5) The intrusion of the diabase.
- (6) The outpouring of the basalt lava.
- (7) Late Tertiary and recent sedimentation.

These periods cover the events which make up the geological history of Lisle so far as it can be deciphered from the rocks.

(1.)—*The Deposition of the Ordovician Sediments.*—

This is the oldest geological process which we can here recognise. The more ancient rocks upon which these strata were laid down are nowhere exposed in the neighbourhood. The nearest reported occurrence of the older platform is near Glengarry, west of the Tamar, where crystalline mica schist indicates one of the Pre-Cambrian groups. The changes from sandstone to slate, and *vice versa*, indicate frequent alternations of sediment from sand to clay when the Lisle beds were being formed.

The coast-line of this ancient sea is necessarily conjectural, but it may well have run along the Pre-Cambrian axis of what is now called the Asbestos Range, which stretches west of the Tamar all the way to Badger Head. How uncertain, nevertheless, such speculations are is exemplified by the microscopical examination of Ordovician slate at Mathinna, revealing, as it does, as constituents of the rock, minute fragments of granitic felspar,

* The comparatively recent cutting of the channel through the Gorge leads one to search for another outlet, and a north-westerly one is the only other direction which is reasonable. If any convincing evidence could be obtained, one would have to resort to this supposition.

evidently derived from the waste of granite ranges long since vanished without leaving a trace behind.

The Lisle belt of slate and sandstone continues south to the North Esk River (near which it encloses the Burns Creek reef), and beyond till it is interrupted by the Ben Lomond massif.

The Lefroy-Lisle Ordovicians differ in appearance from the Beaconsfield strata, which are perhaps somewhat older and do not seem to be represented to the east of the Tamar.

(2.)—*The Folding of the Ordovician Strata.*—The alternations of slate and sandstone in meridional belts and in directions parallel to the general laminations of the strata indicate that these partings as a rule conform with bedding-planes. Indications, however, are occasionally to be found showing the latter to be discordant and rather flat in places. These may be seen on the St. Patrick's River-road, past the post office, where the coarse partings of the slate, dipping steeply to the north-east, intersect almost horizontal bedding-lines. But whether the bedding is horizontal or inclined, the cleavage dips throughout are always at high angles. The change of dip between Lisle and the Tamar points to a great fold having occurred, and the anticlinal axis of this seems to be a little east of Lefroy. This is very likely responsible for the development of quartz reefs at that township.

The slaty cleavage is a regional feature, and results from the constituents of the original rock having been rearranged by earth-pressure. The period when this pressure was applied and the folding of the strata also took place has not been defined, but must have been between the close of the Ordovician and the beginning of the Permo-Carboniferous. As in other parts of the island rocks of Silurian age were involved in the process. The time was probably late Silurian or Devonian.

(3.)—*Irruption and Consolidation of the Granite.*—

As has been remarked over and over again in our geological reports from Mr. A. Montgomery's time onwards, the granitic intrusions in Tasmania occurred between late Silurian and Permo-Carboniferous, and have generally been referred to the Devonian. Reference to this age will explain its presence in the Ordovician strata. It has invaded these in an axial line N.W.-S.E., through Panama and Golconda, Lisle, Diddleum, and so on, towards the North Esk. This line of outcrop lies several miles

west of the large granite mass in the Scottsdale district, of which it is probably a differentiated marginal portion. The two outcrops are of different types of granite, but are doubtless connected in depth. It is to be noted that the main mass consists of granite of medium acidity, while the outlying Lisle-Golconda exposure is distinctly more basic.*

After the invasion of the ancient sediments by the granitic magma at an undetermined but great depth, the elevation of the land, throughout a long period resulted in the erosion and removal of the superincumbent strata, exposing the underlying granite. In some parts of the country, e.g., on the Blue Tier, Ben Lomond, and in the St. Paul's Valley, the granite was exposed already in Permo-Carboniferous times, for sediments of that system are noticed reposing on the granitic platform. At Lisle the wearing down of the overlying strata to granite level apparently took longer time.

The intrusion of the granite produced profound effects upon the surrounding strata—effects which are noticeable to a distance of several hundred feet from the known contact line. The adjoining slate has been silicified, and a good deal of mica has been developed in it, with a production of incipient chistolitisation. The sandstone, too, has been converted into a highly micaceous quartzite. These metamorphosed rocks form an aureole surrounding the intrusive granite mass. Their alteration has proceeded so far as to effectually mask their real nature and to deceive the casual observer as to their original character.

(4.)—*The Period of the Deposition of Gold.*—Under this head I do not refer to the redistribution of gold which has taken place in the present Lisle Valley, but to the deposition or precipitation of the metal in the veins or other sources which have supplied the alluvial or quasi-alluvial of the diggings.

There is nothing to urge in favour of a theory that the present alluvial gold is a concentration of older alluvial gold belonging to the Ordovician sandstone. The fact

* See E. Weinschenk. Grundzüge der Gesteinskunde, 1907, II. p. 40.—“Granitic stocks often show that the core of the massif is composed of a two-mica granite, which gradually loses its muscovite contents in an outward direction. Biotite granite is thus formed, and to this hornblende is added: the plagioclase contents become more and more important and finally genuine plagioclase rocks, diorites, even gabbro, represent present facies of the granite.”

that here and there some gold has been found in quartz veins shows that the Lisle gold must be referred to the granite magma. Consequently, wherever the gold appears along this line—Diddleum, Lisle, Golconda—granite appears also. There is a genetic relationship between the two. The formation of the one has been accompanied by the birth of the other. Whether, therefore, the gold was a primary constituent of the consolidated granite (of which there is no proof) or was deposited in veins either through the granite, or proceeding from it, or in solutions expelled from the granite magma, its approximate age is that of the granite, i.e., Devonian. Its distribution through the unconsolidated formations which have been worked by the miners was effected long subsequently—in late Tertiary and Quaternary times.

(5.)—*The Intrusion of the Diabase.*—Although a few stones of diabase may be gathered in the soil of the valley, it is, strictly speaking, an outside rock, and certainly had nothing to do with the deposition of gold. Mt. Arthur and Mt. Barrow are crowned with it, and on their flanks are the Permo-Carboniferous fossil-bearing strata, which it has pierced, or between the beds of which it has forced its way. In either case the gradual erosion of the overlying measures has exposed the igneous rock on the present summits. The Mesozoic sandstones in this district seem to have been completely denuded, and thus proof is wanting here of the uppermost limit of the diabase, but elsewhere, wherever the upper coal measures survive, there is decided evidence of their penetration or disturbance by this igneous rock. Its intrusive character explains the widely different positions which it occupies in relation to the sedimentary strata in various parts of the island. In the south, section after section may be seen, showing it capped by the Permo-Carboniferous mudstones, while in the north, the relative position is reversed, and the summits of the mountains are occupied by the diabase.

As might be expected, its contact effects on contiguous strata are never extensive. A development of iron ore, calcite, or chalcidony in the strata passed through is frequently observed for a few feet from the contact. Shales at the contact are hardened into chert or adinole, and it is not certain that the opal occurrences at Bothwell are not due to the influence of this intrusive rock.

(6.)—*The Outpouring of the Basalt Lava.*—Although the basalt on the farms overlooking the Lisle Valley

reaches a height of 1800 feet above sea-level, it was probably much lower when it first flowed over the land. We know that at that time (Middle Tertiary) Northern Tasmania was undergoing a movement of slow subsidence, during which the Launceston Tertiary basin was filled with clay and sand sediment to the depth of 1000 feet, so that most likely the basalt which is now on the high divide was then flowing at somewhere near the level of the present Lisle township, or not far above it, for the subsequent elevation was perhaps not quite so great as the previous subsidence. There is no clear evidence that the basalt ever flowed over the ground which has been removed to form the Lisle Valley. It seems rather to have followed some depression of the surface towards the north-east in the direction of the Little Forester River.

(7.)—*Late Tertiary and Recent Sedimentation.*—With the rising movement of the land after the lava flows alluded to above, the process of valley excavation at Lisle began, and has continued to the present day. The principal water-channel, with its tributary creeks, carved its channel deeper and deeper, cutting down through the sandstone and slate strata which once stretched right across the valley, and eventually laying bare and entering the granite foundation. This slow, resistless process has been at work for ages, assisted by rains and weather, breaking up the solid rock, releasing the quartz from veins, pounding it unceasingly to sand, draining off sand and water to the sea, collecting the residual gold. After Nature's slow, tireless toil, man appears on the scene, an army of miners descends upon the valley with box and cradle, and after a short period of feverish industry depletes the accumulated store of metallic residues and departs. The history of the invasion may be told in a few words.

V.—HISTORY.

The brothers Bessell discovered the field at the end of 1878, but it was not until January, 1879, that the rush took place. On the 11th January 14 ozs. of gold were brought to Launceston, and by the end of the month there were a hundred diggers on Main (then called Bessell's) Creek, working ground 4 to 10 feet deep, with 15 to 18 inches of wash-dirt. On the 12th of March His Excellency Governor Weld visited the spot and named the



LISLE VALLEY.

[Twelve trees.



LISLE VALLEY.

[Twelve trees.

township Lisle, in memory of the name of Mrs. Weld's family, which was De Lisle. By the end of that month a thousand men were working on claims extending for over a mile, and bringing in from £2 10s. to £15 per week per man. The reports of that year show that the population increased to 2500. The yields seem to have ranged from £4 to £12 per week per man for the most part. In some cases the highest figure exceeded this, while many only earned a living. By the end of 1879 the place had settled down to steady work. The reported yield of the field was then about 400 ozs. per week. The field was a very active one for three or four years, but after a rush which took place to Temora, N.S.W., work fell off considerably.

Mr. Charles Bessell has furnished me with much interesting information relating to the produce of the field in the early days. The best shows were:—(1) Donnelly's terrace (at these workings 1000 ozs. were got from 1000 loads). (2) Lockwood's terrace, where 600 ozs. were got in one year. (3) The Main Creek, all along which from £4 to £10 or £12 per week per man used to be made. The sides would yield an ounce per man, while the centre was much richer. A little to the west of the creek one man cleared £2500. In the creek opposite the post office 550 ozs. were won; and higher up the creek, at the Red Cliff, a couple of hundred ounces have been won from less than $\frac{1}{4}$ -acre; and below this, 600 ozs. came from ground not exceeding $\frac{1}{2}$ -acre in extent.

The terraces were very rich in patches, Donnelly's being remarkably rich, but the creek was good all the way up, with hardly a "duffer" claim on it.

The total output of the field cannot be stated precisely, as only a small proportion of the gold won was sold in Tasmania. The Government returns show about 84,000 ozs., but there is reason to suppose that this is less than one-half of the real produce. Mr. C. Bessell, who took the trouble to obtain as many certificates from buyers as he could, and made numerous enquiries in reliable quarters, with a view of getting as near to the true yield as possible, is of opinion that it is in the neighbourhood of 250,000 ozs. Some have named still higher figures.

The present output as reported to the Mines Department is from 30 to 40 ozs. per month, but there is reason to believe that it is actually slightly in excess of this.

VI.—MINING.

The ground which has been worked, and some of it reworked, forms a belt of 500 or 600 feet in width along the Main Creek, and also a belt on the western side of the valley along Bessell's Creek. The tributary creeks have also been sluiced. The large terraces at the foot of the hills on each side of the valley have likewise been worked with great success. The occurrence of the gold seems to follow no regular rule, being sometimes distributed irregularly through the deposit from top to bottom, and in other places being won from a foot to 6 feet of wash lying on the soft granite bottom. The deepest ground on the creek is perhaps that near Langley's—16 feet. The ground forming the terraces is now spread out fan-like at the foot of the hills, and the small creeks have intersected it. Displacements of it have apparently occurred, and any tunnelling into the made ground is uncertain. Tertiary faulting is supposed to have taken place, disturbing the clay deposits, and interfering with some of the mining operations. The terrace stones are distinctly angular, and waterworn only in the bottom wash, while in the creeks they are rounded. A low ridge of soft granite separates the gold-bearing ground on the east side from that on the west side, and the miners say that they recognise differences in the appearance of the gold won from the different sides of the valley, and that the western gold realises about 10d. per ounce less than that from the eastern part of the field. The mint value of Lisle bullion is about £3 18s. per ounce.

The claims at present being worked on the field are as follows:—

- (1) W. Kerr, in the upper part of Main Creek.
- (2) Bailey's claim, also up the creek.
- (3) Watts and Langley, under the cliff.
- (4) Marshall and Faulkner, a little lower down.
- (5) Marshall, also in the creek below the preceding.
- (6) C. Bessell, in Main Creek.
- (7) E. Bessell, in Main Creek.
- (8) Jno. Kerr, in Main Creek.
- (9) Watts' claim, in Donnelly's Creek.
- (10) Watts Bros., in Main Creek (lower part).
- (11) Schlobohm, up Bessell's Creek.

(12) Lockwood's terrace, Harmansen's claim.

(13) H. Faulkner and Marshall, on Thomas' Creek.

These give employment to 23 men, all of whom are making a living, so that the field cannot be properly described as worked out.

Red Cliff.—The Cliff workings are in the part of the field where the old Mt. Arthur P.A. carried on exploratory work. It drove three tunnels into the eastern hill, where deep alluvial ground exists under a spur between two small creeks. Soft granite was driven through, and an east and west alluvial channel met with, filled with boulders and stones of quartz and sandstone. A little gold-bearing gravel was struck, but this cut out, and only broken barren material was passed through after this. The gold which was found is stated to have been angular, and with occasional pieces of quartz attached to it. The lead is supposed to have been dislocated and broken up by faults. However, this may be, extensive landslips have taken place on this slope of the range, and it is now difficult to locate the exact position of the original channel. This point is about $1\frac{1}{2}$ mile up the creek from the gorge, and not much gold has been obtained higher up. The source of the Main Creek gold is therefore practically restricted to the eastern side of the Lisle Valley for $1\frac{1}{2}$ mile in length.

At present the Cliff, or Red Face, is being worked by Watts and party, where there are about 10 feet of overburden overlying 4 feet of wash, which rests on the soft granite. The gold is not much water-worn, and is rather a coarse variety for Lisle. A flat piece, weighing 1 dwt., has been found recently, and several pieces weighing 6, 8, and 10 grains have been obtained. The ground is clean—not scaly; and has the reputation of being the best on the field. A few small sapphires and rubies have been found in the wash.

The most frequent stones in the dirt consist of the dark metamorphic and brown sandstone. Stones of chalcedony are fairly common, some of them containing pyrite. I was informed that a seam of pyrites was once found in the granite bottom; otherwise pyrites is absent. The iron-magnesia spinel (pleonaste), known on the field as black-jack, occurs in the wash, occasionally in large sizes. I saw a crystal of this embedded in vein quartz in Marshall and Faulkner's workings on the western side of the

valley. The gold obtained is free, but 2 or 3 grains have been found adherent to pieces of quartz of equal size.

J. Faulkner and Marshall.

A gully just north of the Red Face is being worked by Marshall and Faulkner. The ground consists of alluvial matter with stones of bluish and reddish sandstone. Large boulders of the bluish sandstone are scattered about the wash. Few stones of quartz occur. The wash of water-worn stones rests upon an irregular surface of granite, and has probably been the bed of the old Main Creek, which has gradually worked its way down to its present channel in the flat.

The ground has been worked up towards the head of the gully just below the track, where the last work done was four loads for 11 ozs., and then both gold and wash gave out. Towards the hill among the ferns there is deeper ground, 40 feet, and no bottom. Under Mr. A. Bessell's house the granite is even 70 feet below the surface. It is noteworthy that gold is obtainable here in the surface soil. Up the hill it can be got in the grass over a loose stratum of sand and stones 40 feet deep.

Callaghan's Creek.

The creek called Callaghan's flows into the Main Creek on this side of the valley, and has been worked for gold, but was not considered good ground. It was the highest payable alluvial at Lisle, and the best part of it was up near C. Bessell's house. The knob of ground there has gold at the surface, but this seems to cut out at that spot. Mr. C. Bessell states that it is the only place where he obtained some specimens of gold and quartz. The largest piece of quartz was the size of a pea, and had half a dozen little specks of gold in it.

Kelly's Creek.

Near the post office is another small creek, Kelly's by name, which has also been worked a little. It heads from a little distance up the hill, still in the granite zone.

C. Bessell.

A claim on the Main Creek opposite the township houses is worked by Mr. C. Bessell with fair results.

Cox's Creek.

Near the schoolhouse, Cox's, or Slaughteryard, Creek flows into the Main Creek. Its source is near the contact of the granite with the sandstone. Fairly good gold was won from its lower part, but the creek became poorer higher up. All round the valley is a kind of ledge which marks the upward limit of the granite. The drainage of the hill sinks through to this floor, and from it issue the head waters of the various creeks.

Donnelly's "Terrace."

Further north are Donnelly's Creek and Terrace workings. Close to the road is the rising granite bottom, a point of soft bed-rock on which T. Clare worked 4 feet of terrace for 1000 ozs. per 1000 loads. The old paddocks of terrace stone stretch up the hill to the east on the gently sloping granite floor to the 15 feet of standing terrace face, which has been tunnelled into at the base on the bed-rock. The top part of the terrace for 10 or 11 feet consists of clay and angular stones of reddish sandstone, highly micaceous and ferruginous. These have evidently crept down the hill as superficial detritus, and from their shape it is clear that they have not been moulded by river action. At the same time a certain linear arrangement of the stones seems to suggest that they formed part of shore-beds—perhaps on a lake beach. This rubble-bed passes downwards at one part of the face into a bottom layer of yellowish drift sand and clay 4 feet thick. This layer contains some rounded pebbles, and yielded the heaviest gold. At the same time prospects were obtained from the upper beds, and nearer the road gold was won from all through the deposit, which there consisted nearly entirely of surface clay, with scarcely any stone. I am informed that Donnelly's workings contained a good deal of chalcedony and quartz. The wash evidently had a distinctive character of its own.

Titmus Upper Tunnel.

The highest mining work on the field is that which was done at the Titmus upper tunnel above the Police Reserve and not very far below the crest of the hill. A shaft was sunk on a small leader in soft granite for 60 feet, and afterwards a tunnel was put in a little higher up, apparently on the same vein in sandstone. A good distance was driven without a trace of gold, and work was finally

suspended and the drive caved in. I picked up specimens of quartz at the approach, but these on crushing and washing proved to be quite barren. This tunnel is in sandstone country above the granite contact.

Titmus and Dodgshun's Tunnel.

A little lower down the hill Titmus and Dodgshun drove a tunnel 80 feet or thereabouts in soft granite. Mr. Montgomery reported in 1894 that there were five or six small auriferous veins, $\frac{1}{4}$ to $\frac{1}{2}$ inch thick, of quartz and kaolin in the granite, coursing in a direction N. 76° E. Some of the quartz was sent to Launceston to be tested, and returned 3 dwts.

Lisle Dredging Company.

In the latter part of 1901 a Launceston company (the Lisle Dredging Company), commenced working the alluvial gravel in the Main Creek with a suction plant. The ground was estimated as worth 1s. per cubic yard, and the working costs as not over 6d. per yard. It was considered that as the old miners left all ground which yielded less than 5s. a yard, there would be ample margin for profit. However, the buried timber proved a great obstruction, and the number of times that the dredge had to be moved militated against cheap working. The ground, too, turned out to be nothing like so rich as was anticipated, and after three years' struggling with various hindrances—shortage of water, &c.—operations were suspended. The quantity of gold reported to the Government as won amounted to 1605 ozs.

Bessell's Creek.

At the north end of the field Mr. Schlobohm is working up Bessell's Creek. At this end the western and the eastern runs of gold-bearing drift seem to junction. Where Bessell's Creek joins the Main Creek a bar of granite crosses, and the best nuggets found in Lisle came from this locality. The largest one was discovered by T. Bessell, and weighed 15 dwts. The first one found is in the possession of Mr. W. F. Petterd, and weighs 1 dwt. 2½ grs. Several have been found weighing from 1 to 2 dwts.

Thomas' Creek.

Marshall and Faulkner have a 5-acre section (714G) in the western part of the field on Thomas' Creek, where

they are working a face by hydraulic sluicing. This terrace shows bedding lines and carries waterworn stones, suggesting former river action. Below the surface is red ironstone gravel for 4 feet, resting on 4 feet of sandy silt. Below this is a stratum of stones of quartz and grey sandstone for a foot in thickness, which rests upon 6 feet of clay and stones of slate. The whole deposit lies on granite bed-rock. In each bed there is gold, but the heaviest gold is on the bottom. The bottom wash contains pieces of granite and purple slate, and granitic mica is a constituent of the sand between the pebbles. The stones of blue metamorphic sandstone, so frequent in the deposits on the eastern side of the valley, are rarely found here. The extent of the auriferous ground has not been proved yet, but apparently its channel has proceeded from the hill to the south-west.

Further south a few colours are found in Stony Creek, and this does not suggest that there is much worth speaking of south of that creek.

Lockwood's Terrace.

North-west of Marshall and Faulkner's workings is the extensive patch of deep ground known by the name of Lockwood's Terrace. This is on a ridge which forms the end of a spur coming down from the western hills, and was worked in a good many places at one time, as many as 500 men being on the ground at one place or another. The deepest ground which has been bottomed is 60 feet. A shaft 60 feet deep was sunk, and 2 grains to the dish stated to have been prospected from the bottom. One, Currie, had a claim and puddled his dirt for 160 ozs., according to report. Lockwood's dirt, too, lower down, used to go 1 oz. to the load. Harmensen's face is 19 or 20 feet deep, with 4 feet of subsoil resting on 3 feet of horizontally bedded clay, which in its turn covers 12 feet of wash on granite bottom.

The drawback to the work on this terrace was want of water, and it is very probable that if water could be brought to it, the ground would still pay to work. The best gold, as usual, was found in the wash at the bottom; still, a little was obtained all through the deposit. Very little of the bluish metamorphic sandstone and slate is found here; the stones of quartz belong to a more kindly variety than that on the east side of the valley, and the gold apparently has not been derived from that side.

Mt. Arthur Properties, Ltd.

In this part of the valley several sections have been taken up by the Tasmanian Consols, Limited, on behalf of the new company, the Mt. Arthur Properties, Ltd., recently registered in London, with a capital of £65,000. A few preliminary bores have been put down in this ground to depths varying from 9 to 26 feet. Layers of heavy wash and boulders made it very awkward ground to test by boring. The holes were deflected, and in most instances the pump could not follow the auger. Notwithstanding this, gold was got in five out of the seven holes. Two holes gave 0.57 and 1.323 grains gold per cubic yard; two gave 1.728 and 2.16 grains; and one gave 8.748 grains per cubic yard. The testing work will shortly be resumed. The company contemplates working this flat, and as it is mostly virgin ground, the difficulties experienced by the Lisle Dredging Company in the worked ground along the Main Creek will probably not recur.

OBSIDIANITES.

Several of those interesting objects known as obsidianites (Australites) have been found in the wash at Lisle associated with the gold. Some recovered by Mr. Bessell were lying together on the granite bottom 17 feet from the surface. The forms known here are the circular button shapes, the dumb-bell shapes, and the beetle shapes. Some of these have been obtained from the gravel below the Red Face workings, so that we can say positively that they could not have travelled far; in fact, it would be possible to circumscribe an area a few hundred feet square within which they must have fallen. The proof of age is not precise, but it would certainly be Late Tertiary or Recent—not pre-basaltic. These obsidianites consist of acid or sub-acid volcanic glass, and not of such glass as would result from the emissions of any Tasmanian volcanoes. The proximity of the basalt sheet at Lisle is an accidental feature which is unrelated to the occurrence of these objects. It is sufficient to call to mind that they have also been found at Cox's Bight in the tin-bearing gravel in the extreme south-west of Tasmania, where there is no basalt whatever, the nearest being in the Huon basin. Their real origin is still a matter of debate, the theory which meets with most favour at present being that the glass is meteoritic.

VII.—THE DERIVATION OF THE GOLD.

Whence all the gold has been derived which has been won in the form of alluvial has long been a mystifying puzzle, baffling the prospector and the visiting expert alike. A quarter of a million ounces have been obtained from a mere fractional portion of an area not exceeding a mile and a half square. The bulk of this has been sluiced from the bed and banks of the Main Creek and from terraces sloping down to it on the eastern side of the valley; the remainder has been won from small creeks on the opposite side of the basin and from terraces above them.

The remarkable feature of the field is that no reefs have been found either in the valley itself or on the surrounding hills. Certainly some quartz veins must exist concealed beneath the mantle of overburden which clothes the hill-sides, because numerous stones of quartz occur in the drift; but this quartz is barren. No gold-bearing quartz has ever been seen in the workings, beyond a minute specimen here and there. Yet nearly everyone who works on the field or who prospects it has in his mind the eventual discovery of a parent reef or reefs which have shed the gold. A little reflection will show how unreasonable such a notion is. Anyone standing on the floor of the valley finds himself in a locked basin, walled all round by hills 800 feet to 1000 feet high, and cannot escape the conviction that whatever may be the source of the gold, the whole of it has been derived from points within the area upon which he gazes. The auriferous overburden which covers the bed-rock has not been brought by torrents from afar. The gold has not travelled. The terraces consist of hill detritus—not of shingly-beds. Apart from the bottom wash of the terraces, the only shingle in the valley is that of the creeks or of their ancient beds. The creeks themselves are contained within the valley walls. With these conditions one cannot escape from the conclusion that if the gold has been shed from quartz reefs specimens of auriferous quartz will be found in the workings. But such quartz is absent, and the inference therefore is irresistible that the gold won must have been derived from some other source. This is the starting point from which any intelligent investigation of the phenomena must begin. There may possibly be a few gold-bearing veins in the surrounding hills, but any gold which they may have contributed must have been inconsiderable in amount, and they may certainly be neglected in this inquiry. A useful preliminary in the investigation will be to scrutinise closely

the nature of the stones with which the gold in the alluvial workings is associated, as from such scrutiny some definite information will certainly emerge.

I confine my remarks first of all to the eastern side of the valley, as the bulk of the gold has come from the Main Creek and the eastern terraces.

1. The stones in the alluvial and terrace ground are mainly metamorphosed sandstone and slate from the hill-side above the granite contact. The most abundant are bluish stones which bear a superficial resemblance to basalt.

Some of them are quartzite or metamorphic sandstone; others, more compact in structure and of argillaceous nature, are altered slates. The rock has undergone intense metamorphism by reason of the influence of the intrusion of the granite. These stones contain a good deal of iron, and have a habit of crustal weathering which proceeds inwards till often only a kernel of the hard blue rock remains in the centre. The miners call this becoming coated with sandstone, and significantly state that it is characteristic of the deposits where gold is found. The importance of this statement will appear later.

Some reddish brown micaceous sandstone also appears in the detritus, and at Donnelly's terrace this is the almost exclusive component of the drift, the dark bluish variety being almost absent there. This is explained by the brown sandstone being *in situ* on the hill above the terrace. The stones there are highly ferruginous and micaceous. Their mica may be considered as a result of the granite contact and the iron as derived from the decomposition of the ferro-magnesian mica.

The stones, therefore, which form the bulk of the gold-bearing drift have been derived, not from unaltered strata, but from rock which has been strongly modified by contact with intrusive granite.

2. Stones of chalcedony are frequent in the terraces, especially at certain points. A few of these stones picked up in the old workings under the Red Face contained disseminations of cubical white iron pyrites.* The stones have probably been released from veins in the granite and along the granite contact line. Mr. C. Bessell many years ago drove a tunnel in the western hill to the contact line, which he found marked by a vein of chalcedony.

Many of these stones look as if they had been cut or chopped with a chisel on each side, while their substance

* These assayed in the Government Laboratories by Mr. G. Oliver Smith, Government Analyst, yielded a trace of gold.

was in a soft condition. The Germans call this "chopped quartz."* Such stones are common in the tin drifts in granite areas on the East Coast, and have given rise to a good deal of speculation as to their mode of origin. They probably represent veins in the granite, and the gashes are the moulds of crystals of felspar projecting inwards from the vein-walls.

No gold has ever been noticed in any of the stones of chalcedony met with in the workings.

3. The stones of granite which appear in the drift are infrequent. The granite bottom is invariably soft, and consequently it can hardly be expected that the alluvial will contain pieces of the hard rock. No reefs have ever been seen in the granite floor.

4. In places there are large stones of white barren quartz in the wash and detritus. These have not been traced to the veins from which they must have proceeded. It is surmised that such veins must exist in the sandstone. Small veins of quartz have been noticed here and there in the stratified rock, *e.g.*, at Titmus' upper tunnel, and on the western range, but these are unimportant and have no real bearing on the question.

The terraces on the western side of the field have evidently derived their gold from the hill on that side. The blue sandstone is not so common on that range, and the wash contains more slate. The same contact conditions prevail there, the granite bed-rock rising up the hill-side to junction with slate and sandstone.

Coming to the consideration of the derivation of the gold, it is quite possible that some of it may have come from soft pyritous or micaceous veins in the granite bottom, which have gradually worn away with progressive denudation. This, however, is pure hypothesis, and no proof is available. Some source, however, other than hard quartz veins must have existed.

An important clue to the solution of the problem is furnished by the discovery of visible gold in the dark metamorphic sandstone frequently referred to in this report. One of the rock specimens which I brought home showed distinct specks of gold free from gold or pyrite. Unfortunately, I have not been able to observe this in any other specimens, though I have broken hundreds of stones. However, the fact that gold is present in the sandstone is undoubted, and is sufficient to outweigh innumerable negative results.

* Zerhackter Quarz.

The suggestion which I advance is that the bulk of the Lisle alluvial gold has been derived from the wasting away of the impregnated stratified rock near its contact with the granite.

Until we know more about the occurrence it is premature to attempt to range it definitely with other deposits, with which it may eventually prove to have little in common. We do not know yet whether the impregnations in the sandstone are connected with reefs proceeding from the granite, or whether a promiscuous deposition took place from siliceous solutions expelled from the granite during cooling, or some subsequent action took place along the contact line, distributing the gold in the adjoining rock.

In various parts of the world impregnations of gold in stratified rock have been recorded, but these seem always to be connected with quartz veins. One can only surmise that at Lisle the sandstone near its contact with the granite has been saturated with silica from the plutonic mass, and that the gold-bearing siliceous solution has deposited its precious freight in the interstices of the sandstone. The gradual weathering of the rock has liberated the gold, which, together with the detritus and wash (eluvial and alluvial) has found its way down hill to the terraces and creeks. All the facts and features of the field are in harmony with this view.

The impregnation may be irregular, and if so, it will not be easy to find the metalliferous patches. Even when found it does not follow that they will prove payable. The only way to test the occurrence is to remove the overburden on the hill-side and lay bare the bed-rock at the contact. The contact line from Donnelly's to behind Bessell's would be the most likely locality for this work. The task is not easy, as the overburden is heavy, and the position of the hidden line of junction has to be guessed at.

I took grab samples freely from the dark sandstone left in the paddocks from dredging and sluicing along the Main Creek, and these, assayed in the Government Laboratories by Mr. G. Oliver Smith, Government Analyst, yielded a trace of gold. Samples of the red ferruginous sandstone in Donnelly's terrace yielded nil.

VIII.—COUNTRY NORTH OF LISLE.

The Ordovician slate and sandstone continue north of the township to within a mile of the railway, when they are interrupted by granite. On the road opposite the Falls, in the Lisle Creek gorge, the dark metamorphosed

sandstone crops out, and on the west side of the gorge near the bar the brown sandstone is extremely micaceous, and has a microscopical structure resembling that of some of the crystalline schists—a structure which has been imposed upon it by the intrusion of the granite.

The general strike of the strata continues throughout the whole of this area, being for the most part about N. 30° W., though in some places up to N. 50° W., and the dip is uniformly in a north-easterly direction. In the bend of the road opposite F. Witte's house the bedding lines can be seen to be horizontal or slightly undulating.

Valentine Creek, which flows into the Little Forester River a mile south of the Lisle-road station, marks the junction of the slate and granite. On the north bank of the creek a surviving fragment of the ancient Little Forester River bed shows itself resting on granite at a good height above the existing river. On this granite ridge the schoolhouse is built, and it trends from that spot in a westerly direction. Northwards it sinks below alluvial gravels, which extend to the railway-line.

The granite is biotite-granite, of much the same type as that at Golconda and Lisle, and as it has also a mantle of slate and sandstone of similar age, its contact line ought to show indications of reefs or mineral deposits. I have not heard that it has been prospected very thoroughly.

Tobacco and Cradle Creeks.

Two miles north-west of Lisle, and on the southern boundary line of the Parish of Shaw, are some mining sections in which Tobacco and Cradle Creeks take their rise. These creeks flow north-east for nearly a mile and then unite, subsequently junctioning with the Lisle Creek. The sections can be reached from Golconda; they are not more than a mile south-east of the New Enterprise Mine. I visited them from Lisle, joining the Lone Star track on the crest of the hill west of Lisle Creek. Stringy-gum and sassafras clothe the side of the range, but at the top stringy-bark country is entered. Near the sections Middle Creek is crossed, a small stream flowing into Tobacco Creek and usually carrying about a sluiceway of water. No gold has been found in this creek.

Mr. C. Bessell discovered Tobacco Creek and gave it its name 18 months before he discovered Lisle. Cradle Creek owes its name to the work which was carried on in it. From these two creeks about 2000 ozs. of gold have been won.

I found an old prospector (Manson) in Tobacco Creek reworking old ground, with about 10 feet of clay overburden and 6 to 18 inches of wash resting on slate bottom. The stones of slate in the wash are angular, and the gold is not waterworn. When pieces of any size are found the gold is usually attached to quartz. The run of gold extends for nearly 20 chains, and has been worked up to the brow of the hill. It keeps at first to the creek, but finally leaves it and turns north-west up the hill. The gold in this creek is coarser than at Lisle, and nuggets up to 15 dwts have been found. The ground has been worked over three or four times, the workings widening each time. At the top of the hill which is between the two creeks a good deal of trenching has been done and some quartz veins have been found, one of which carried gold. A shaft was sunk on it for 25 feet, but the metal died out. A long tunnel was put in from the Cradle Creek side of the divide, but nothing was found past the entrance. On the summit of the ridge is an ironstone reef with a little quartz in it, very similar to many of those which occur near Lefroy. It appears to be conformable with the slate, and is not very promising to look at.

In the lower end of Cradle Creek the gold is extremely fine, and the wash is all quartz.

There seems to be no doubt that the gold won in the two creeks has been derived from the hill which divides them, and has been contained in quartz reefs. There was a rush here of 50 or 60 men some three or four years after work at Lisle began, and it is strange that the veins which shed the alluvial gold were not discovered. The area within which search has to be made is small, and it would seem that there is here a field in which a little capital might be usefully expended in exploration.

IX.—COUNTRY SOUTH OF LISLE.

The Ordovician strata of Lisle are prolonged south-east to Mt. Barrow and the North Esk River. Once removed from the immediate influence of the granite the slate becomes normally a grey greenish and purplish rock, with cleavage-planes having the usual north-westerly strike and north-easterly dip. Already at the head of the Lisle Valley the dark metamorphic slate and sandstone give way to purplish slate. From Faulkner's farm south-east to St. Patrick's River the stratified rocks are covered by a narrow strip of basalt and basaltic soil, which follows the

river down to Patersonia and further south to Mt. Edgecumbe and along Distillery Creek.

Several quartz reefs are known between Lisle and St. Patrick's River, but they are white and barren, and have been little prospected.

In the road below the St. Patrick's River post office a reef is exposed striking south-east and dipping north-east. It transgresses the country, and consists of seams of quartz alternating with chloritic and felspathic bands for a width of $1\frac{1}{2}$ feet. It is a persistent reef, for it runs south a good distance on R. Wilson's land. On Warren's land are reefs or dykes of somewhat similar nature. Microscopical examination shows these decomposed greenish formations to be hornblende-granite dykes, and they no doubt have some connection with the hornblende granite of Diddieum and Camden Plains.

Some boulders of granite porphyry apparently mark the line of a dyke or other granitic intrusion running north-east on J. Millwood's section, north-west of J. M. Peck's 100½ acres, across the river due west of the reefs just mentioned. These boulders are in slate country, but 10 chains south of them some Permo-Carboniferous mudstone with casts of spirifers is exposed on the road.

On Hart's 228 acres, on the road towards Sullivan's Bridge, is a wide red formation containing decomposed syenitic dyke-rock. The adjoining purple slate has here produced much red soil. No quartz is visible in the formation, but it is stained with manganese.

A little north is Brook's shaft, by the roadside. This was sunk 50 feet by a Launceston syndicate 10 years ago. Rumour says that assays of lead, gold, and silver were obtained. At present nothing can be seen beyond the grey slate thrown out of the shaft and a few stones of dirt white vitreous-looking quartz mottled with specks of greenish slate and manganese oxide.

At Irishman's Gully, running into the basalt zone west of the St. Patrick's River, a little sluicing has been done and some gold obtained, but the quantity is not known. Above the junction of Patersonia Rivulet with the river, where the basalt crosses the former, some paddocks of dirt were opened out and some gold won. It is reported that some precious stones were found here. These were probably sapphires, as some have also been got at Camden Plains.

I did not go on to Camden Plains, which have long been known as a gold-bearing field. I am informed that there 9 to 10 feet of wash rests on the granite bottom. The

granite is hornblendic. The gold is excessively fine, and no nuggets are found.

Looking upon this district as a whole I do not anticipate that payable reefs will be found. I suspect that, as a rule, the gold which has been won in small quantities at different places has been shed from the lines of contact of the granite with the stratified rocks, and that though in the aggregate a fair quantity may have been liberated by denudation, it has been distributed by the drainage system over so wide an area that the concentrations of metal at the different points are not likely to be very remunerative.

There is, however, just a chance that some deposit a little above the average may be met with.

Mt. Barrow (4644 feet) is crowned with columnar diabase, and several hundred feet from its summit is fringed with sandstone and Permo-Carboniferous mudstone. The upper beds of the fringe consist of calceous mudstone charged with fossils, and the lower beds comprise sandstone and boulder conglomerate, also fossiliferous. These are about 1100 feet in thickness. They repose in horizontal layers upon the steeply inclined slate strata of the Ordovician system. Down in the St. Patrick's River Valley, at Mac-laren's Turn-off, soft Permo-Carboniferous mudstone is again to be seen in the road drain.

A mile and a half further south, east of the main-road, is Bourke's sandstone quarry, with a cliff of freestone several chains long and 30 feet high. The stone is of even quality and grain, and free from iron. It looks as if it would make an excellent building stone. Samples may be seen at Mr. Silvanus Wilmot's stone-cutting yard, Brisbane-road, Launceston.

The diabase which surrounds Launceston plunges beneath the alluvial of the North Esk Valley and crops out in Mr. Fry's paddock on the Elphin-road. It passes below the Tertiary sandstone of the Windmill Hill and below the flat land at the junction of the North and South Esk Rivers. It has been found by boring at the Tamar-street Bridge 55 feet down. Processes of denudation have therefore in the course of ages removed the overlying Tertiary and Permo-Carboniferous strata, and have eaten into the diabase floor itself to a considerable extent. The thickness of the Launceston Tertiary beds may be gauged by the depth of the bore which was put down at Carr Villa—570 feet—before touching the diabase rock below. The old alluvial bottom began already to rise in later Tertiary times and with the new land configuration the North Esk River selected its present channel. The result

has been the formation of the Cataract Gorge, certainly not, as is often imagined, a display of volcanic energy, and probably not due to any disruptive force, but simply the carving out of a channel by the ceaseless but irresistible action of running water, assisted by a gradual elevation of the land.

W. H. TWELVETREES, Government Geologist.

Launceston, 10th October, 1908.

X.—APPENDIX.

ON THE DETERMINATION OF HEIGHTS.

The heights on this journey were taken with a 4-inch aneroid and a Casella's hypsometer, and to ensure an approximation to accuracy the calculations are based on readings taken during the last days of the period. It is now well known that aneroids give higher readings during the first few weeks of their stay at upper stations than they do subsequently. After a few weeks, if not used in further ascents, they recover and behave normally, probably increasing their index error in the process.

The results obtained with both of these instruments are inferior to observations taken with a mercurial barometer, but the transport of the latter is extremely inconvenient, requiring, as it does, continual attention and care. In fact, one man ought to be detailed to carry the barometer alone. The least inconvenient form is the portable mountain barometer made by several firms especially for explorers. For transport the cistern screw must be turned sufficiently to force the column of mercury to the top of the tube, and the instrument must then be carried upside down. While in this position loosen the screw half a turn so as to afford a little play to the mercury. If these precautions are not observed the instrument will come to grief. One cause of annoyance is that on mountain tops in a strong breeze the slender tripods supplied with the barometer vibrate unpleasantly and cause unsteadiness.

My boiling-point apparatus on this trip persisted in reading higher than the aneroid by 50 to 100 feet. I have generally used this method as a check on the aneroid with tolerably fair results. Of course it has been proved to be inferior in point of accuracy to the mercurial barometer, but nevertheless, on account of its convenience, it is much used by travellers. In using it, it should be borne in mind

that isolated observations are not of much value. At least three observations should be taken with different thermometers and the mean adopted. Thermometers, even by good makers, are not infallible, and as they increase in age they are apt to give too high temperatures, and consequently the calculated height is lower than the actual height. The value of one degree Fahrenheit on the thermometer tube in making the first ascent from sea-level is about 519 feet. It can therefore be readily seen what accuracy is requisite if fractional readings are to be reliable. Moreover, the value of the degree increases with the height above sea-level, so that instrumental errors and errors of observation ought to diminish as the ascent is made, which is not the case. Further, on looking through the literature of the subject, it does not appear at all certain that the barometric pressure corresponding with the various boiling-points has been accurately ascertained, and this adds a new source of possible error. In the earlier forms of the apparatus the purity or impurity of the water boiled affected the results, but in the hypsometers now obtainable, the thermometer, both stem and bulb, is immersed in pure vapour, so that the kind of water used is immaterial. For travellers' use, Casella publishes a set of tables, from which the following figures are taken:—

Boiling point temperature.	Approximate height above sea-level.	Difference for each degree.	Corresponding height of barometer.
degrees.	feet.	feet.	inches.
212	—	—	29·922
211	519*	519	29·335
210	1041	522	28·756
209	1566	525	28·185
208	2094	527	27·623
207	2623	529	27·070
206	3154	531	26·527
205	3686	533	25·993
204	4221	535	25·468
203	4757	536	24·952
202	5295	538	24·445
201	5834	540	23·946
200	6376	542	23·456

* Multipliers for the temperature of intermediate air and corrections for decrease of gravity as per tables given later in these notes must be used when the difference of height between two stations has to be calculated.

Aneroids.

There are many aneroids scattered about the country, and their possessors often suffer illusions in respect of their value for giving heights, and are, besides, inexperienced in their use for that purpose. The aneroid barometer cannot be called a tool of precision, notwithstanding various refinements of scale, verniers, &c. It is unreliable for contours of, say, less than 30 feet. Several unsatisfactory features are attached to its use, and great care has to be taken when employing it for the determination of heights. It is usual to hear travellers justify their determinations of mountain heights by laying emphasis on the fact that their aneroid needle has returned to its original base reading on the completion of their descent. This very fact would furnish grounds for suspicion, because the natural tendency of an aneroid in normal working order is during the ascent to lose or read higher than the true height, and in descending the opposite tendency or one towards recovery prevails. The two tendencies, as Mr. Whymper has shown, counteract each other, and the result is a retarded recovery, so that if a reading is taken immediately on completing the descent it will show less difference of air pressure than was shown by the ascent. Whymper states a rule: "All aneroids without exception lose upon the mercurial barometer when submitted to diminished pressure, and recover a portion of the previous loss when pressure is restored." He adds, that it is exceptional to find the loss exactly balanced by the recovery. The recovery is gradual, and sometimes exceeds the loss. Thus various index errors are acquired. A touching confidence is sometimes reposed in the Kew certificate when this is supplied with an instrument, but this is nothing more than a verification of the behaviour of the aneroid when under specific reductions of pressure in the maker's workshop. It is no guarantee of its behaviour during sustained fluctuations of pressure in the field. The certificate shows that care was taken in the manufacture, but the intrinsic foibles of ordinary aneroids remain unaffected. A clever and effective way of overcoming these disadvantages has been devised in the shape of the Watkin mountain aneroid, in which, by turning a screw at the back of the instrument, the pressure on the vacuum-box is exerted only at the time of taking the reading, and is relieved immediately afterwards.

Observers are advised not to rely upon readings at heights which are at all near the upward limit of the scale. Thus,

an aneroid graduated up to 5000 feet cannot be used with safety to determine heights above 4000 feet.

A gentle tap applied to the instrument is often of use in starting the needle, though the motion in walking or riding is usually sufficient to keep it acting freely.

It should be always read in one position, as the indicator will read differently according as the aneroid is held vertically or horizontally. The vertical position is preferable, as it can be suspended freely from the hand by the ring only, and exactly on a level with the eye.

In mountain climbing the pressure in inches should be noted, and not only the mere elevation scale, as the barometrical pressure will have to be used in the subsequent calculations. The scale of feet, too, may be taken as being less accurate than the divisions for pressure.

Mr. Whymper prefers aneroids of large diameter to those of watch size. On the other hand, the topographers of the United States Geological Survey use instruments 2 inches to 2½ inches in diameter. My own experience has been favourable to the use of the smaller size, if of the best construction.

The reading should be taken immediately on reaching the summit of a mountain. The height observed will usually exceed the true height by a little. The excess will be found to have increased if another reading be taken a little later. The later reading should be neglected, for it is not the result of sluggish action of the needle, as has been supposed, but is due to the continued low pressure, as mentioned above.

The usual and proper use of the aneroid is in determining relative, not absolute, heights. If heights above sea-level are desired, it is necessary to select a base, or lower station, the height of which is known from other sources. A railway-station, or some point the height of which above the rails have been ascertained, may be chosen as a base. Every opportunity of checking readings by repeated observations should be taken advantage of, for aneroids often behave in an erratic manner, and single observations are unreliable.

If a second aneroid is not kept in camp and read throughout the day by a second observer, it will be necessary to obtain the 9 a.m. and 3 p.m. atmospheric pressure from Hobart or Launceston, and deduct or add the mean of the daily variation. Thus, if at Launceston the barometer reads at 9 a.m. 30·20, and at 3 p.m. 30·10, the mean variation will be ·05. Therefore, deduct ·05 from

the reading at field base in order to correct it for comparisons, say, at noon with the reading at the upper station.

To obtain correct temperature at upper and lower stations, use a standard mercurial thermometer made by a good firm. Shade temperature must be observed, and the thermometer should be suspended at least 10 feet away from any vertical rock face or cliff.

Some aneroids are furnished with attached thermometers which are supposed to show the temperature of the instrument, but good aneroids are commonly compensated for this, and the appendage is unnecessary.

In determining heights by aneroid in Tasmania two corrections must be applied to the reading, viz:—

Corrections—

1. Correction for difference of temperature between the lower and upper stations (See Table II.).
2. Correction for decrease of gravity due to height (See Table III.).

The use of these tables may be illustrated by the following example:—

	Launceston.	Lisle.	Launceston.	Lisle.
9 a.m.	Inches.	Inches.	Thermom.	
July 15.	Barom. 30·48	29·60	+ 39°	+ 32°
20.	" 29·50	28·75	" + 51°	+ 38°
21.	" 29·70	28·80	" + 46°	+ 34°
23.	" 30·08	29·15	" + 46°	+ 33°
25.	" 30·15	29·25	" + 33°	+ 28°
Average	29·11	29·98	+ 33°	+ 43°
			} 38°	

Lisle.....	29·11 in.	Table I.	27,916·1 ft.
Launceston	29·98 in.	"	28,685·5 ft.

$$\text{Table II. Mean temperature } 38^\circ = \frac{769 \cdot 4 \text{ ft.}}{1 \cdot 0132 \text{ multiplied.}}$$

$$769 \cdot 4 \times 1 \cdot 0132 = 779 \text{ ft.}$$

$$\text{Table III. Decrease of gravity..... } 1 \cdot 94 \text{ ft.}$$

$$\text{Altitude of Lisle } 780 \cdot 94 \text{ ft.}$$

Table I. must be used by extracting from it the difference of elevation in feet which it shows between the readings at the upper and lower stations.

If the precautions detailed in these notes are observed, aneroids, if of the best construction, will, subject to their natural limitations, give fairly satisfactory results.

TABLE I.—Guyot's Reductions of Barometric Readings to Feet. (From Smithsonian Miscellaneous Contributions.)

Barometer in inches.	Hundredths of an inch.										Barometer in inches.
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
24.0	22873.0	22883.9	22894.7	22905.6	22916.5	22927.4	22938.2	22949.1	22960.0	22970.8	24.0
24.1	22981.7	22992.5	23003.3	23014.2	23025.0	23035.8	23046.6	23057.5	23068.3	23079.1	24.1
24.2	23089.9	23100.7	23111.4	23122.2	23133.0	23143.8	23154.5	23165.3	23176.1	23186.8	24.2
24.3	23197.6	23208.3	23219.1	23229.8	23240.5	23251.3	23262.0	23272.7	23283.4	23294.2	24.3
24.4	23304.9	23315.6	23326.3	23337.0	23347.6	23358.3	23369.0	23379.7	23390.3	23401.0	24.4
24.5	23411.7	23422.3	23433.0	23443.7	23454.3	23464.9	23475.6	23486.2	23496.8	23507.4	24.5
24.6	23518.1	23528.7	23539.3	23549.9	23560.5	23571.1	23581.7	23592.3	23602.9	23613.5	24.6
24.7	23624.1	23634.6	23645.2	23655.8	23666.3	23676.9	23687.5	23698.0	23708.6	23719.1	24.7
24.8	23729.7	23740.2	23750.7	23761.2	23771.7	23782.3	23792.8	23803.3	23813.8	23824.3	24.8
24.9	23834.8	23845.3	23855.7	23866.2	23876.7	23887.2	23897.7	23908.2	23918.6	23929.1	24.9
25.0	23939.5	23949.9	23960.4	23970.8	23981.3	23991.7	24002.1	24012.5	24023.0	24033.4	25.0
25.1	24043.8	24054.2	24064.6	24075.0	24085.4	24095.7	24106.1	24116.5	24126.9	24137.2	25.1
25.2	24147.6	24158.0	24168.3	24178.7	24189.0	24199.4	24209.7	24220.1	24230.4	24240.8	25.2
25.3	24251.1	24261.4	24271.8	24282.1	24292.4	24302.7	24313.0	24323.3	24333.6	24343.9	25.3
25.4	24354.2	24364.5	24374.7	24385.0	24395.3	24405.5	24415.8	24426.1	24436.3	24446.6	25.4
25.5	24456.8	24467.0	24477.3	24487.5	24497.8	24508.0	24518.2	24528.4	24538.7	24548.9	25.5
25.6	24559.1	24569.3	24579.5	24589.7	24599.9	24610.0	24620.2	24630.4	24640.6	24650.7	25.6
25.7	24660.9	24671.1	24681.2	24691.4	24701.5	24711.7	24721.8	24732.0	24742.1	24752.3	25.7
25.8	24762.4	24772.5	24782.6	24792.8	24802.9	24813.0	24823.1	24833.2	24843.3	24853.4	25.8
25.9	24863.5	24873.6	24883.7	24893.7	24903.8	24913.9	24924.0	24934.0	24944.1	24954.1	25.9
26.0	24964.2	24974.2	24984.3	24994.3	25004.4	25014.4	25024.4	25034.4	25044.5	25054.5	26.0
26.1	25064.5	25074.5	25084.5	25094.5	25104.5	25114.5	25124.5	25134.5	25144.4	25154.4	26.1
26.2	25164.4	25174.4	25184.3	25194.3	25204.2	25214.2	25224.1	25234.1	25244.0	25254.0	26.2
26.3	25263.9	25273.8	25283.8	25293.7	25303.6	25313.5	25323.4	25333.3	25343.2	25353.1	26.3
26.4	25363.0	25372.9	25382.8	25392.7	25402.6	25412.4	25422.3	25432.2	25442.1	25451.9	26.4
26.5	25461.8	25471.7	25481.5	25491.4	25501.2	25511.0	25520.9	25530.7	25540.5	25550.4	26.5
26.6	25560.2	25570.0	25579.8	25589.7	25599.5	25609.3	25619.1	25628.9	25638.7	25648.5	26.6
26.7	25658.3	25668.1	25677.8	25687.6	25697.4	25707.1	25716.9	25726.7	25736.4	25746.2	26.7
26.8	25755.0	25764.6	25774.3	25784.0	25793.7	25803.4	25813.1	25822.8	25832.5	25842.2	26.8
26.9	25853.2	25862.9	25872.6	25882.2	25892.0	25901.7	25911.4	25921.1	25930.8	25940.5	26.9
27.0	25950.2	25959.9	25969.6	25979.2	25988.9	25998.6	26008.2	26017.9	26027.5	26037.2	27.0
27.1	26046.8	26056.5	26066.1	26075.7	26085.3	26095.0	26104.6	26114.2	26123.8	26133.4	27.1
27.2	26143.0	26152.6	26162.2	26171.8	26181.4	26191.0	26200.6	26210.2	26219.8	26229.3	27.2
27.3	26238.9	26248.0	26258.0	26267.6	26277.2	26286.7	26296.3	26305.8	26315.3	26324.9	27.3
27.4	26334.4	26344.0	26353.5	26363.0	26372.4	26382.1	26391.6	26401.1	26410.6	26420.1	27.4
27.5	26429.6	26439.1	26448.6	26458.1	26467.6	26477.1	26486.5	26496.0	26505.5	26514.9	27.5
27.6	26524.4	26533.9	26543.3	26552.8	26562.3	26571.7	26581.2	26590.6	26600.0	26609.5	27.6
27.7	26618.9	26628.4	26637.8	26647.2	26656.7	26666.1	26675.5	26684.9	26694.3	26703.7	27.7
27.8	26713.1	26722.5	26731.9	26741.3	26750.7	26760.1	26769.5	26778.8	26788.2	26797.6	27.8
27.9	26806.9	26816.3	26825.6	26835.0	26844.3	26853.7	26863.0	26872.3	26881.7	26891.0	27.9
28.0	26900.4	26909.7	26919.0	26928.4	26937.7	26947.0	26956.3	26965.6	26975.0	26984.3	28.0
28.1	26993.6	27002.9	27012.2	27021.5	27030.7	27040.0	27049.3	27058.6	27067.8	27077.1	28.1
28.2	27086.4	27095.6	27104.9	27114.2	27123.4	27132.7	27141.9	27151.2	27160.4	27169.6	28.2
28.3	27178.9	27188.1	27197.3	27206.5	27215.7	27225.0	27234.2	27243.4	27252.6	27261.8	28.3
28.4	27271.0	27280.2	27289.4	27298.6	27307.8	27317.0	27326.2	27335.3	27344.5	27353.7	28.4
28.5	27362.0	27372.0	27381.2	27390.4	27399.5	27408.7	27417.8	27427.0	27436.1	27445.2	28.5
28.6	27454.4	27463.5	27472.6	27481.8	27490.9	27500.0	27509.1	27518.2	27527.4	27536.5	28.6
28.7	27545.4	27554.7	27563.8	27572.9	27582.7	27591.1	27600.2	27609.3	27618.3	27627.4	28.7
28.8	27636.5	27645.5	27654.6	27663.7	27672.7	27681.8	27690.8	27699.9	27708.9	27717.9	28.8
28.9	27727.0	27736.0	27745.1	27754.1	27763.1	27772.2	27781.2	27790.2	27799.2	27808.3	28.9

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TABLE I.—Guyot's Reductions of Barometric Readings to Feet—continued.

Barometer in inches.	Hundredths of an inch.										Barometer in inches.
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
29 0	27817.2	27826.2	27835.2	27844.2	27853.2	27862.2	27871.2	27880.2	27889.1	27898.1	29 0
29 1	27907.1	27916.1	27925.0	27934.0	27943.0	27951.9	27960.9	27969.8	27978.8	27987.7	29 1
29 2	27996.7	28005.6	28014.6	28023.5	28032.4	28041.4	28050.3	28059.2	28068.2	28077.1	29 2
29 3	28086.0	28094.9	28103.8	28112.8	28121.7	28130.6	28139.5	28148.4	28157.3	28166.2	29 3
29 4	28175.1	28184.0	28192.9	28201.7	28210.6	28219.5	28228.4	28237.2	28246.1	28254.9	29 4
29 5	28263.8	28272.6	28281.5	28290.3	28299.2	28308.0	28316.9	28325.7	28334.5	28343.4	29 5
29 6	28352.2	28361.0	28369.8	28378.7	28387.5	28396.3	28405.1	28413.9	28422.7	28431.5	29 6
29 7	28440.3	28449.1	28457.9	28466.7	28475.4	28484.2	28493.0	28501.8	28510.6	28519.3	29 7
29 8	28528.1	28536.9	28545.6	28544.4	28563.2	28571.9	28580.7	28589.4	28598.2	28606.9	29 8
29 9	28615.7	28624.4	28633.2	28641.9	28650.6	28659.3	28668.1	28676.8	28685.2	28694.2	29 9
30 0	28702.9	28711.6	28720.3	28729.0	28837.7	28746.4	28755.1	28763.8	28772.5	28781.1	30 0
30 1	28789.8	28798.5	28807.2	28815.9	28824.5	28833.2	28841.9	28850.5	28859.2	28867.9	30 1
30 2	28876.5	28885.2	28893.8	28902.5	28911.1	28919.8	28928.4	28937.0	28945.7	28954.3	30 2
30 3	28962.9	28971.5	28980.1	28988.8	28997.4	29006.0	29014.6	29023.2	29031.7	29040.3	30 3
30 4	29048.9	29057.5	29066.1	29074.7	29083.3	29091.8	29100.4	29109.0	29117.6	29126.2	30 4
30 5	29134.7	29143.3	29151.9	29160.4	29169.0	29177.6	29186.1	29194.7	29203.2	29211.8	30 5
30 6	29220.3	29228.9	29237.4	29245.9	29254.4	29262.9	29271.5	29280.0	29288.5	29297.0	30 6
30 7	29305.5	29314.0	29322.5	29331.1	29339.6	29348.1	29356.6	29365.1	29373.5	29382.0	30 7
30 8	29390.5	29399.0	29407.5	29416.0	29424.4	29432.9	29441.4	29449.8	29458.3	29466.8	30 8
30 9	29475.2	29483.7	29492.1	29500.6	29509.0	29517.5	29525.9	29534.3	29542.8	29551.2	30 9

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Mean Temperature of Intermediate Air.	Multiplier	Mean Temperature of Intermediate Air.	Multiplier.	Mean Temperature of Intermediate Air.	Multiplier.
32°	1.0000	55°	1.0511	78°	1.1022
33°	1.0022	56°	1.0533	79°	1.1044
34°	1.0044	57°	1.0555	80°	1.1066
35°	1.0066	58°	1.0577	81°	1.1088
36°	1.0088	59°	1.0599	82°	1.1111
37°	1.0110	60°	1.0622	83°	1.1133
38°	1.0133	61°	1.0644	84°	1.1155
39°	1.0155	62°	1.0666	85°	1.1177
40°	1.0177	63°	1.0688	86°	1.1199
41°	1.0199	64°	1.0711	87°	1.1222
42°	1.0222	65°	1.0733	88°	1.1244
43°	1.0244	66°	1.0755	89°	1.1266
44°	1.0266	67°	1.0777	90°	1.1288
45°	1.0288	68°	1.0799	91°	1.1311
46°	1.0311	69°	1.0822	92°	1.1333
47°	1.0333	70°	1.0844	93°	1.1355
48°	1.0355	71°	1.0866	94°	1.1377
49°	1.0377	72°	1.0888	95°	1.1399
50°	1.0399	73°	1.0911	96°	1.1422
51°	1.0422	74°	1.0933	97°	1.1444
52°	1.0444	75°	1.0955	98°	1.1466
53°	1.0466	76°	1.0977	99°	1.1488
54°	1.0488	77°	1.0999	100°	1.1511

TABLE II.—Multipliers for Temperature of Intermediate Air.

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TABLE III.—Correction for the Decrease of Gravity on a Vertical acting on the Density of the Air. This correction must be added:—

(From Smithsonian Miscellaneous Contributions.)

Approximate Difference of Level.				Decrease of Gravity.	
				Positive.	
				0	+ 500
Feet.				Feet.	Feet.
1000	...	...	...	2·5	3·9
2000	...	...	...	5·2	6·6
3000	...	...	...	7·9	9·3
4000	...	...	...	10·8	12·2
5000	...	...	...	13·7	15·2
6000	...	...	...	16·7	18·3
7000	...	...	...	19·9	21·5
8000	...	...	...	23·1	24·7
9000	...	...	...	26·4	28·1
10,000	...	...	...	29·8	31·5

4116
93M

Boundary line of section

PROSPECTING TUNNEL

Nº 3. TUNNEL

Nº 2 LODE

OPEN CUT

Nº 2 LEVEL

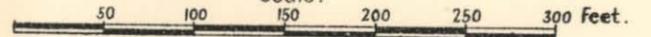
Nº 1 LEVEL

3262
93M

REFERENCE

- Nº 1. LEVEL
- Nº 2. LEVEL
- Nº 3. LEVEL
- Nº 4. LEVEL

Scale.

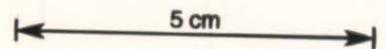


L. K. Ward,

Assistant Government Geologist.

15.2.1908.

Photographed by John Steel Government Printer Albert Tomkinson



Nº 4. LEVEL

Nº 1 LODE

WINZE

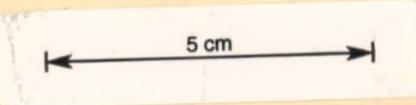
Nº 3 LODE

NORTH MT FARRELL MINING CO. NO LIABILITY.

PLAN OF MINE WORKINGS OCT. 31ST 1907.

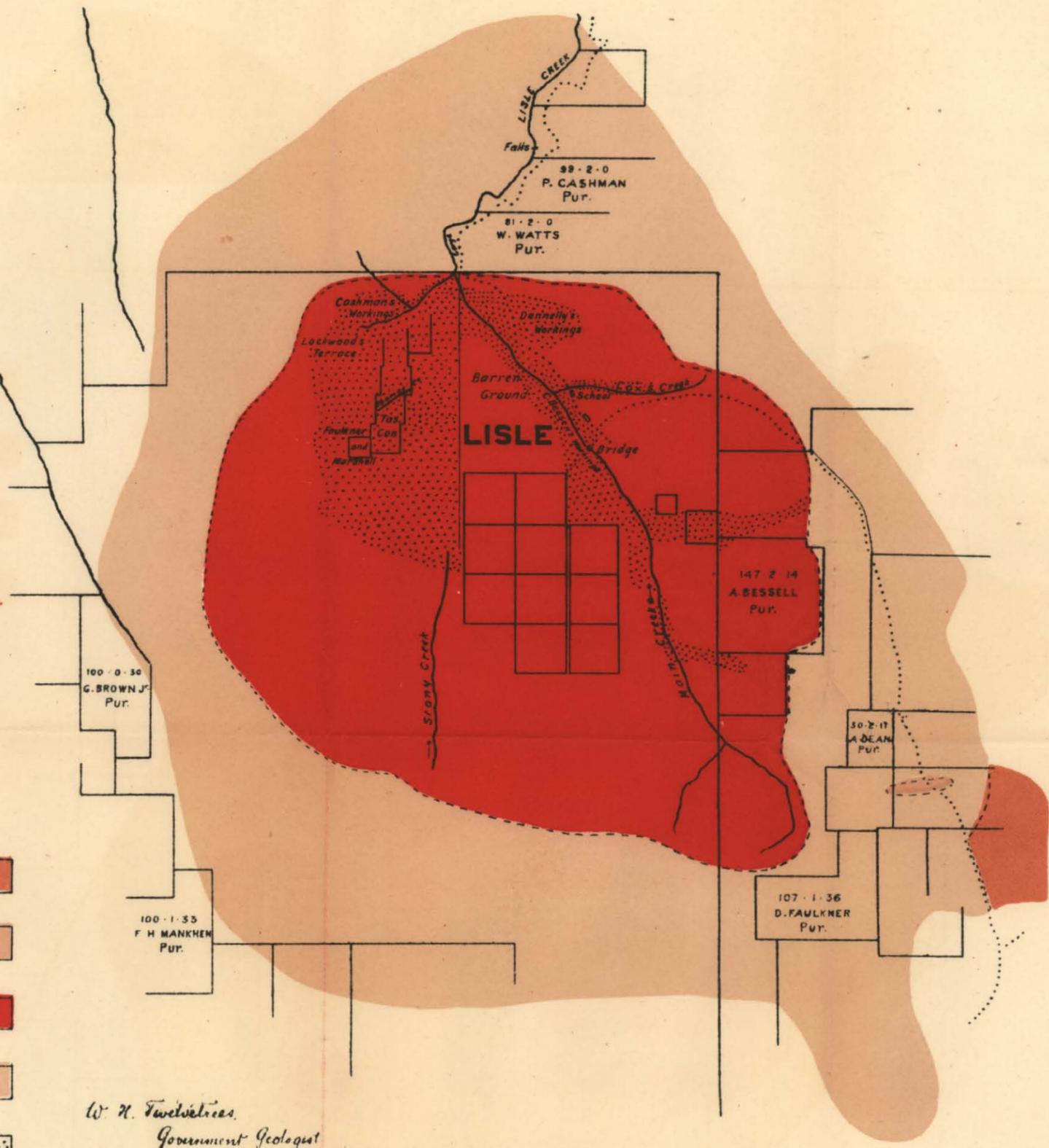
From the Company's plan.

GEOLOGICAL MAP OF THE LISLE GOLD FIELD



INDEX

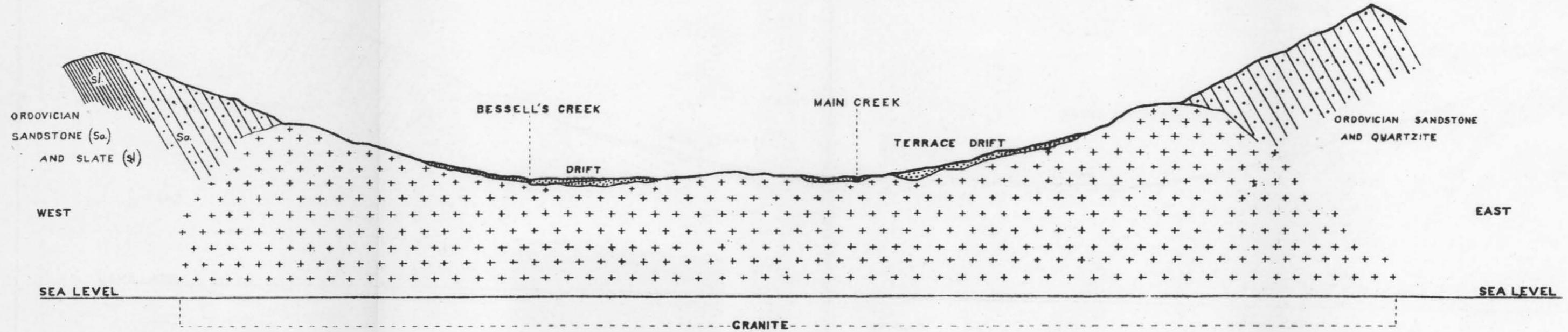
TERTIARY BASALT.....	
MESOZOIC DIABASE.....	
GRANITE.....	
ORDOVICIAN SANDSTONE AND SLATE.....	
AURIFEROUS DRIFT.....	



W. H. Twilveltes,
Government Geologist

Photo Aligned by John Hill Government Printer Robert Trueman

GEOLOGICAL SECTION OF THE LISLE VALLEY



WEST

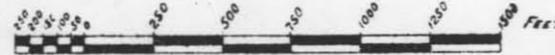
EAST

SEA LEVEL

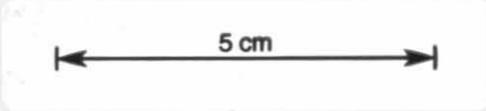
SEA LEVEL

GRANITE

VERTICAL SCALE



HORIZONTAL SCALE



W. H. Fyfe
Government Geologist.