TASMANIA

REPORT

OF THE

SECRETARY FOR MINES

FOR

YEAR ENDING DECEMBER 31

1909

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

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REPORT OF THE SECRETARY FOR MINES.

Mines Department,
Hobart, 14th June, 1910.

SIR,

I HAVE the honour to submit my Report upon the Mines Department and the Mining Industry for the year ending 31st December, 1909.

GENERAL REMARKS.

The aggregate value of the minerals raised during the year was £1,574,995, being a decrease of £75,030 on the value of the output of the preceding year, owing principally to the decrease in the output of gold, and to the decreased value of the silver-lead ores.

The value of the gold won was £52,481 less than the previous year. While the output of silver-lead ores was increased by 17,362 tons, the value was £33,127 less.

The average price of tin for the year was £134 17s. 8d., as compared with £133 2s. 6d. for the previous year. It started at £132 7s. 6d., receded to £125 15s. in February, and reached its highest—£154—in December.

The average price of fine silver for the year was 2s. 1·617d. per oz., as against 2s. 2·316d. last year. The highest monthly average was in June, when it reached 2s. $2\frac{1}{16}$d.

The average price of copper was £58 17s. 1·83d. per ton, as against £60 0s. 5·813d. last year.

Government Prospecting Parties.

The matter of sending out small prospecting parties in different directions under the control and supervision of the Department is one which has engaged my attention for some time past, and may be worthy of your consideration.

While the attention of prospecting companies and syndicates is centred upon paying properties or fields, there appears to be very little disposition on their part to send out prospecting parties in new or untried localities, and it often happens that it is only after the prospects of a mining field are declining, or the principal mine shuts down and causes an exodus of the miners, that fresh fields are sought and new and important discoveries are made.

The mining industry is the most important of our industries, and at present is of very slow growth, and therefore needs fostering and encouraging in every possible way, for it is to this industry, perhaps more than to any other, that the State looks for its prosperity in the future. With its vast areas of unexplored mineral country I feel that there is a great future before us, and that the industry is still in its infancy, and the more we can do to promote its welfare by encouraging and assisting prospectors to go out in search of minerals the better. What matters the expenditure of a few pounds now, if there is no immediate return? The establishment of one payable field will ultimately repay, a thousand-fold, any expense the Department may incur in sending two or three prospecting parties out.

A good selection of districts would have to be made, also a wise choice of men; and proper measures taken to protect the Government, and to see that due value was received for the assistance given. If the summer months are utilised (December, January, February), and good men are engaged, beneficial results ought to ensue. Some scheme might be devised by which the prospectors should receive some reward for discoveries made. Towards the end of the season their camps should be visited, and their work inspected by the Inspectors of Mines, the Geologists, or some other officer. The smaller each party the better—not more than two or three. Men could be advertised for, and a selection made from those offering. The districts would require careful consideration. Certain districts suggest themselves readily:—

1. The Mt. Ramsay district.
2. The Parson's Hood district.
3. Between Middlesex and Farrell.
4. South of Lyell and to the Frenchman's Cap.
5. South of Macquarie Harbour to Little Rocky Point.
6. Between Zeehan and the coast-line.
7. The Arthur River and north of the Savage River; and others might be added.

This is no doubt a new departure, but in these days new endeavours are expected, and a trial can but be made. The island is being prospected very slowly. Men do not possess the means for doing the work. The difficulties of procuring food and food-transport keep them back, and, indeed, practically put it out of their power to spend time in the remote bush; also when the uncertainty of a return for labour is considered there is little wonder that prospecting is not felt to be attractive.

The question of remuneration would require attention—whether to pay them an inclusive wage and leave them to arrange their own food-supply, or to provide them with food and transport. The Public Works Department would doubtless suggest something from its practice in somewhat similar circumstances.

These are some of the crude ideas which present themselves at present, but no doubt a scheme can be successfully devised later if the suggestion meets with your approval.

Sale of Land within Mining Areas.

I have already drawn attention in a former report to the sale of Crown lands within mining areas proclaimed under Part V. of "The Crown Lands Act, 1903." The Act provides for the sale of Crown lands within a proclaimed mining area, reserving all mining rights to the Crown; and any person may, upon obtaining permission to search or mine thereon from a Warden of Mines, apply for and obtain a mineral lease over such purchased land. The reserved right is looked upon as illusory and useless, and consequently the sale of such land is a hindrance to mining.

The prospector will never enter upon private or fenced land to search for minerals under the gaze of the owner or his neighbours. Anyone who knows anything about prospecting will admit this. The sale of the land stops prospecting absolutely.

Further, he cannot begin any mining operations in search of minerals until the whole series of formalities has been completed, and he has paid to the owner the assessed compensation for the damage which the owner is likely to sustain. This is another very effective obstacle. Some applicants for leases object to this, and prefer to withdraw their applications.

In some instances applicants have been prevented by the owners of such lands from applying for leases by absolutely refusing to consent to their prospecting on the land, although they are aware of the conditions under which they purchased. The applicants for leases are either not aware of the sale conditions, or do not care to incur the expense of employing a lawyer to compel them to submit to arbitration, and the land remains locked up.

Still, further, when any person's name appears on the chart as a purchaser, the miners do not know the conditions of the sale, and consequently are not aware that the mining rights are reserved to the Crown. Thus, when land is sold in a mining area, one may look upon all chances of future mineral discovery as having been bartered for a cash payment.

In some instances where I have objected to the sale of lands in mining areas, the applicants to purchase have offered to forego any right to compensation if allowed to purchase. This is in contravention of the Act, and it is not my duty to question the policy of such sales, but an objection to it would be that it would then be necessary to constantly advertise the varying conditions of sale of such lands, so that the miners might always be kept informed as to what properties they are entitled to enter without liability to pay compensation. Each district would then have two classes of allotments, and unless the miner knew where he stood, the sales of land would discourage mining. Further, in spite of the willingness of the owner to forego his rights, the prospector would be as unwilling as ever to trespass on private land. Such owners, too, often do not object to the prospector's tent, but will not have his dog (the guardian of his camp), and in other ways petty obstacles are liable to be interposed, causing friction and quarrels

"The Gold Act."

"The Gold Act" passed during 1908 to regulate the buying and selling of gold has been repealed and replaced by anotner, which came into operation on the 1st April, 1910, and so far appears to be giving satisfaction. Many complaints were made about the old Act pressing very hardly upon holders of miners' right claims and others, and they not only had very great difficulty in disposing of their gold, but often had to travel long distances to obtain assayers' certificates before they could sell, which sometimes cost more than the gold was worth.

Press Reports.

An unauthorised report, which appeared in the press recently, stated that the Government Geologist was, at the time, reporting on and sampling the mine known as the Great Pyramid, at Scamander. This is incorrect. The Geological Survey Branch is charged with the work of investigating the mineral resources of a district, and produces maps and bulletins embodying the results; but it is not its duty to undertake sampling, or to report on individual mines in any way calculated to encroach on the province of the professional mining engineer. What was happening in the instance referred to was that the Government Geologist, under instructions from the Department of Mines, was examining the Scamander mineral district, with a view to the preparation of a survey bulletin on the field in general, and that, in the course of this work, the Pyramid workings were inspected, to see what information they gave bearing on the structural and economic geology of the district, but not to gauge the commercial value of the venture.

Geological Surveys.

The Department has under consideration plans for extending the usefulness of the geological branch. At present two geologists are fully employed in different parts of the island investigating our mineral resources and examining the country in connection with indications and occurrences of ore-deposits, the Assistant Geologist being more particularly engaged on the West Coast mineral fields, while the Chief Geologist visits the northern and eastern parts of the island and attends to administration matters. It is highly desirable that the work of examination and survey should be proceeded with actively, and accelerated if possible, so that no part of the island may remain without a geological inspection. For financial reasons, any scheme for expanding this work must, if possible, be of a nature that will not involve an addition to the permanent staff. A method which has been adopted in other countries, and has answered well, may be mentioned as worthy of consideration for Tasmania. This is to enlist the temporary services of science students at the University by allotting to one or two students certain districts to be mapped and investigated during their vacations. A keen student might hail the opportunity of improving himself in field work, and prepare a thesis or report which could with advantage be issued by the Department as a geological survey bulletin. An arrangement might possibly be made for no salary to be paid, but only out-of-pocket expenses, and the only additional expense to the Government would be the cost of printing the memoirs. The districts to be allotted would be suggested by the Chief Geologist, who would also exercise a general supervision.

Assaying Ore for Prospectors.

It cannot be too widely known that the Mines Department is always ready to provide *bonâ fide* prospectors with assay returns from approved samples sent in, and without making any charge.

A few simple, and by no means onerous, conditions must be observed. The privilege of free assays can only be accorded to genuine prospectors, not to syndicates or share and metal brokers. It is, however, essential to inform the Department of the locality from which the samples have been obtained. This information is sometimes given with reluctance, but a little reflection will show how justifiable the demand for it is. Much of the material sent in for assay is economically valueless, and a record of these assays will assist both the State and individuals by preventing subsequent hopeless attempts to work the deposits. The record will prove useful also in registering the contents of low-grade or difficult ores which may be unworkable at present, but may be payable with improved methods or better prices in the future. Also if records of localities are kept duplication of assays will be avoided.

Previous assays of abandoned discoveries can be furnished to prospectors desirous of taking up old ground, and such information may often prove of great value.

The prospector should say whether his sample is considered to represent the bulk of a lode, or whether it is a picked specimen, or, if concentrated, to what extent. To avoid disappointment, he should also intimate for what mineral or minerals he wishes his sample to be assayed.

The Department in making this known is desirous of putting it in the power of prospectors to obtain an authoritative statement of the contents of any discoveries they may make. It has been the practice for the Department to have these assays made, but comparatively few applications are received, perhaps owing to it not being sufficiently known by those whom the matter immediately concerns.

Appendices.

Appended will be found the following reports and papers:—

- The 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.
- Paper by J. S. Purdy, Esq., M.D., D.P.H., on the Cause, Effect, Incidence, and Prevention of Pneumokoniosis of Quartzminers.
- The Geological Reports on the Gunn's Plains, Alma, and other Mining Fields on the North-West Coast, by W. H. Twelvetrees, Government Geologist.
- The Tinfield of North Dundas, by L. Keith Ward, B.A., B.E., Assistant Government Geologist.
- The Preliminary Report on the Zeehan field, by Messrs. W. H. Twelvetrees and L. Keith Ward.

Gold-mining.

The total quantity of fine gold won during the year was 44,777·366 oz., valued at £190,201; as against 57,085·124 oz., valued at £242,482; being a decrease in value of £52,481 on the previous year.

Beaconsfield.—The yield from this district was 22,032·30 oz. of gold. The Tasmania Mine was the chief producer, having won 21,812 oz., valued at £92,578, from 56,153 tons of quartz crushed, an average of 7 dwt. 18·413 gr. per ton. The total quantity of gold won by this company is 794,702 oz., from 813,928 tons of quartz. The total amount paid in dividends up to 1905 was £772,671 15s., since which date no dividends have been paid.

The chlorination plant has been replaced by a grinding plant, with subsequent cyanide treatment, and included in the gross output was 180 oz. of fine gold, from 801 tons treated in the new plant. The gross total also includes 1589 oz., obtained from the treatment of 32,188 tons of battery tailings. The average number of men employed was 525.

In June, 1909, an exceedingly heavy burst of water, amounting to between eight and nine million gallons, was cut in the 1250-feet level, and owing to the breakage of part of the pitwork of one of the pumps, this burst of water caused the battery to be closed down for nearly two months.

The coal strike in Newcastle and consequent shortage of coal supplies considerably delayed the developmental work.

Bonanza Proprietary Mine.—This company was engaged prospecting on the north and south lodes. The total distance driven was 854½ feet. The average number of men employed was 14. The company ceased operations in October, 1909, but recommenced work on 3rd January, 1910.

The Tasmania Tailings Syndicate obtained 784·97 oz. of gold, employing 14 men.

The Moonlight-cum-Wonder Gold Mining Company obtained 25 oz. Three men employed.

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

	oz.
New Pinafore Gold Mine	7·25
Creek Cyanide	682·5
Kitto's Chum Syndicate...	148
Gift Gold Mine	55
Others	40
Total	932·75

The New Pinafore Gold Mining Company early in the year discovered a very promising reef midway between the Native Youth and Morning Star reefs. A shaft was sunk to a depth of 70 feet, and the reef was driven on for a distance of 600 feet on its course without meeting anything sufficiently good to encourage the company to persevere, and the mine ceased work and was closed down after a life of 19 years.

The Gift Gold Mining Company was formed to work a small vein in close proximity to the Reward Claim on Specimen Hill. A crushing of 11 tons of stone taken from the surface down to about 100 feet gave an average of nearly 5 oz. per ton. The company erected a winding plant and unwatered the old Reward main shaft at the 260-feet level. The vein at this point, and for some distance west along its course, was of no value. A little prospecting by means of winze and rise was done upon it at the shallower levels, with but poor results. Some attention was paid to parallel lodes, none of which proved payable, and the mine closed down in March last.

The McIvor Mine is closed down, and the Kitto's Chum Mine has ceased work, having failed to discover anything payable at 200 feet from the surface.

The outlook is certainly very gloomy at present. Although the mines paid good dividends in the past, and business people generally benefited by the prosperity of the field, none now appear to be willing to help in giving it a further trial, and it must consequently soon become a deserted field.

Lisle and Golconda.—The total quantity of gold won was 207½ oz., 14 men being employed.

The Golden Pyramid Company, at Golconda, has been prospecting to try to discover the source from which the numerous specimens which have been found from time to time during the past 30 years have been shed. The company has been driving in a westerly direction towards the Sandstone Hill in the hope of meeting with payable stone at the contact of the granite and sandstone country. Owing to the decomposition of the granite and the water-soakage the work has been rather slow and expensive.

The New Panama Company, prior to the 26th June, was costeening on its section adjoining its consolidated lease, but since that date has been engaged driving a low-level tunnel on the consolidated lease.

Mt. Victoria.—One hundred and eleven oz. of gold were obtained, about seven men being employed. Sixty-one oz. were obtained by the Mercury Gold Mine, and 170 oz. by the New River Freehold Company. Three prospectors obtained 35 oz.

Alluvial and Gold-dredging Companies.

Gold was obtained by the following companies in streaming their tin drifts:—

	oz.
Ringarooma Bucket Dredging Company ...	119·50
Dorset Bucket Dredging Company...	111·60
South Mt. Cameron Tin Mining Company	40·65
Briseis Tin and General Mining Company	54·23
New Brothers' Home Tin Mining Company	21·11
Total	347·09

Mathinna.—The New Golden Gate Gold Mining Company, employing an average of 42 men, crushed 2828 tons of quartz, and treated 3445 tons of sand, and obtained 2258 oz. of gold. The total quantity of quartz now obtained from this mine is 276,079 tons, which has yielded 231,248 oz. of gold, an average of 16 dwt. 18·048 gr. per ton, and has realised £878,742.

The total amount paid in dividends is £355,200, or £11 2s. per share; and the total amount paid in dividend tax is £16,638 10s. No dividends have been paid since 1905.

Work in the old mine has been confined almost entirely to stoping, principally from small blocks of quartz remaining in various parts, from the 800-feet level up. The water has been allowed to rise up to the 1000-feet level. Large bodies of quartz were exposed in the lower levels, but sampling, assaying, and battery tests proved these to be quite unprofitable to work, the best returns from the battery tests being under 3 dwt. per ton. A large block of stone has been stoped from under the 316-feet level, yielding 2365 tons of quartz, of an average value of 14 dwt. per ton. This block was originally left as a support to the shaft whilst stoping at below that level. After the filling and levels settled the company was enabled to recover the block without injury to the main shaft.

In October, 1908, the company secured three leases east of the old mine, and decided to prospect them. A main shaft was sunk 200 feet. Crosscuts were driven east and west, passing through three reef-channels, two of which were north-west and south-west, and the other east and west. One of the north and south reefs carried up to 10 inches of solid quartz, giving fair prospects of free gold. The other parallel reefs consisted of a formation of quartz and rotten slates. The east and west lode gave small prospects of free gold. The main shaft was continued to a depth of 316 feet from the surface, and a level was driven from 308 feet. All three channels were again cut, and proved to be valueless, and prospecting operations were consequently ceased. Including the 316 feet of main shaft, a little over 1000 feet of sinking and driving was done on this section, at a cost of £2624. It is the intention of the company to take up other sections and prospect them.

Eldorado Mine.—The old Eldorado adit has been cleaned out, and a tramway has been laid down for a distance of 319 feet. About 300 feet from the mouth of the adit the drive, on a lode-channel, was extended in a westerly direction for a distance of 62 feet, and the winze was sunk below the floor of the drive to a depth of 22 feet. The eastern drive off the old adit was cleaned out and repaired for a distance of 95 feet, and a drive off a formation trending south-east for a distance of 50 feet was put in. Six tons of stone were crushed, and yielded 13½ oz. of smelted gold. On an average 3 men were employed.

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. 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 64 oz. 10 dwt. 20 gr. The Davie Prospecting Association at Lynchford has continued its prospecting drive for about 500 feet, and very favourable prospects have been obtained from its quartz reef.

SILVER-LEAD MINING.

The quantity of silver-lead ore produced was 80,378·35 tons, valued at £298,880, being an increase in quantity of 17,261·43 tons, but a decrease in value of £23,127.

The principal producers were:—

	Tons.	Value.
Zeehan Mines.		£
Mt. Zeehan (Tas.)	1647	14,936
Zeehan-Montana...	7423·59	55,425
Zeehan-Western	2925·88	6400
Silver Queen Extended	50·70	404
Oonah	6601	19,777
Zeehan Queen	1210	1392
Florence	262	1475
New Mt. Zeehan	139·60	547

	Tons.	Value. £
Zeehan Mines—continued.		
Tasmanian Smelting Company's Sections	278·31	458
Colonel North	251·47	2393
Section 1914-M	85	728
Nubeena	13	86
S. Nubeena	10	64
Section 1816	153	38
T.L.E.	10	101
Oceana	22·5	158
Austral Valley	800·35	252
Balstrup's	60	494
Venezia Tribute	36	216
Dundas Mines.		
Comet	17,579·96	14,161
Hercules	17,878·47	55,734
Adelaide	1655	14,766
Jupiter	108	422
West Comet	968	945
Mariposa	51	66
Anderson's Tribute	105	1580
Mt. Farrell Mines.		
Mt. Farrell	39·4	538
North Mt. Farrell	3219	26,429
Mackintosh	105	1317
Murchison River	150·95	2130
Others	28	230
Rosebery Mines.		
Tasmanian Copper	3865·5	14,896
Primrose	3641·5	9440
North Pieman.		
Chester Mine	1514·9	1514
Mt. Lyell.		
Tasman and Crown Lyell Extended	917	4409

Zeehan District.—The district has recovered somewhat from the period of great depression caused by the temporary closing down of the Tasmanian Smelting Company's works and the Hercules Mine during the previous year.

The Zeehan-Montana Mine, Limited.—During the year the exploratory work has been confined to Nos. 1, 3, 4, 5, and 6 levels, and practically the whole of the work has been carried on north of the shaft through and north of the main slide. This slide in all previous workings cut oft and faulted the whole of the lodes known to exist on the property, and although several attempts have been made to discover ore beyond the disturbed country they have not been successful. The company has got into more settled country north of the slide, and has found payable ore at Nos. 3, 4, and 5 levels. The finding of ore north of the big slide has given new life to the mine.

The exploratory work has been kept well forward.

The following represents the developmental work done during the year:—

	ft.	in.
Shafts	86	6
Winzes	193	0
Rises	809	0
Crosscuts	467	0
Drives	2378	0
Total	3933	6

Stopes.—Twenty-two thousand four hundred and eighty-seven lineal feet have been stoped. This produced 20,000 tons of lode-stuff, which, after concentration, produced 3435·41 tons of marketable galena ore, containing 223,097 units of lead and 249,618 oz. of silver, of a gross value of £56,000 approximately.

The company has suffered considerably owing to the low price ruling for silver. The price obtained for lead early in the year was also very low, consequently the value of the output has fallen considerably, and the profits have been practically nil.

The prospects of the mine are better than at the commencement of the year, and should the developments now showing north of No. 1 shaft continue, there is every reason for believing that the company will again return to prosperous times.

The Mt. Zeehan (Tas.) Silver-lead Mines.—On account of the depreciated value of metals, work at the company's Spray Mine and No. 2 shaft was suspended, and these workings were closed.

Mining work has been concentrated at No. 5 shaft, and four lodes have been developed therefrom, but the shoots of ore discovered were too short and too far apart to make this working profitable, and as no new discoveries were made by croscutting west the mine was closed down. A small prospecting shaft sunk to a depth of 60 feet in a lode 600 feet west of No. 5 shaft did not disclose anything of value.

At the Spray Mine an adit level was driven 600 feet north on the main lode, but nothing new was discovered.

On what was known as Sheargold's section a lode was discovered by a party of tributors, and the company to test it further sunk a prospecting shaft 50 feet. The water was very heavy, and the lode proved to be valueless. A large number of tributers are engaged on the property working small bunches of ore occurring near the surface. Their net returns give them good wages.

Oonah Mines, Limited.—The development of the stannite ore-bodies has been proceeding. The work has been directed mainly to the north end of the workings, and has revealed the continuance of the ore-shoots in that direc tion, the present faces showing good ore over a fair width, which has materially added to the ore reserves. During the latter half of the year stoping on the lower levels was in full swing, producing ore for the company's smelters, situated on the Silver King lease near Silver Bell. A railway, with two gauges, connecting the smelters with the Silver Bell siding, was completed in June, 1909, thus permitting the ore from the mine, and other supplies, being delivered at the smelters without transhipment. The smelting works comprises dry crushing mill, two mechanical calcining furnaces, reverberatory furnace with all appurtenances thereto, and provision for alternative electric motor and steam driving. The installation of a blast furnace with 72-inch by 42-inch water-jacketted furnace, boiler, combined engine and blower, belt-driven hoist, water storage and sump, service pump, &c., was completed in August. This plant has been in more or less experimental operation during the period under review, which has gone to show that the stannite ore can be treated successfully.

Many hitches incidental to new plants occurred, and slight alterations were found to be necessary to ensure smooth running.

Towards the end of the year several parcels of matte were shipped to England and found a ready market. Early in December, owing to the coal strike in New South Wales, the smelters had to be closed down owing to the failure of coal supplies, and the work at the mine had, in consequence, to be very much curtailed.

Zeehan-Queen, Limited.—The mine has been worked solely by tributers. A deal of prospecting has been done, and small bunches of payable ore have been worked out above water-level, but no new discoveries have been made.

On Section 1641 drives have been sent out southerly from the Zeehan-Montana Company's No. 2 shaft at the various levels on their Nos. 1 and 2 lodes, and a quantity of ore has been extracted.

Florence Silver-lead Mine.—The old poppet-heads, engines, and boilers have been dismantled and replaced by new ones. Two large Cornish boilers, 28 feet by 17 feet, and large compound condensing engine have been erected.

The New Mt. Zeehan Mine.—Work has been continuously carried on by tribute parties with but poor results.

Dundas District.—The Comet Tribute Company drove 300 feet to cut the lode. This will give an extra 60 feet of stoping. The lode was cut at 300 feet, and proved to be 30 feet wide. From this point a drive was advanced 200 feet south on payable ironstone. The drive is under the open-cut workings, and will open up a large reserve of flux. The overburden in the large open-cut became so heavy and expensive to remove, it was decided to remove it by hydraulicking, and a race was cut from the top of the lode to Maestries Creek, a distance of 61 chains, and a hydraulic plant was installed. It proved very advantageous in removing the overburden, and it has opened up large quantities of good ironstone flux.

The West Comet has been closed down during the year.

The Hercules Gold and Silver Mining Company, employing and average of 90 men, has broken out and sold 12,812 tons of sulphide ore, and 4066 tons of zinc-blende ore, valued at £55,734. The ore has been obtained at Nos. 3 and 4 levels, principally from the "B" and "E" ore-bodies, where extensive stoping has been completed. The development work has been chiefly the extension of the main crosscuts, drives, and rises in the various ore-bodies to further open up and prove their size and continuity. Rises have been put up to connect the levels, and to provide for travelling-ways and ore-passes. In addition, the main workings have been connected to the northern end of the mine, thus providing a new outlet and connection to the haulage tramway. To accomplish this, connecting and deviating drives of 125 feet in length were made, and a main chamber for the gathering of the trucks, 66 by 13 feet, cut out. The extension of the eastern crosscut in 5B level (50 feet below the main working level) was taken in hand, and the "B" ore-body was intersected at 98 feet, and has been found to be of a width of 37 feet. Further extension of this crosscut is in progress to prove the existence of the "B" lode at this depth. All surface works have been well maintained, and are in good order. The haulage tramway is in daily operation, and the whole plant is working satisfactorily.

Mt. Lyell District.—The Tasman and Crown Lyell Extended Mines.—The output from the mine was 544 tons of galena, valued at £3100. The ore was forwarded to the Tasmanian Smelting Company's Works at Zeehan for treatment. The company has employed an average of 24 men, and has expended £4665 4s. 3d. The work done during the year was—shaft-sinking, 100 feet; driving, 273 feet 7 inches; and rises, 150 feet. A tramline 3 miles in length has been completed.

North-East Dundas.—A new field is opening up at the 5-mile upon a galena lode discovered a short time ago by the Wallace Brothers, and which has been purchased by Mr. T. Vincent, manager of the Mt. Zeehan (Tas.) Silver-lead Mines. A main shaft has been started, and a small temporary plant has been erected to enable sinking operations to be carried on without delay. When the tramway from the mine to the North-East Dundas Railway-line is completed Mr. Vincent will be able to put his pumping plant in position.

Mt. Read District.—Mt. Read Mine.—Work was discontinued in the 600-feet crosscut on the 30th September last. Total length of same is 1654 feet; distance driven from January to October by two men being 107 feet. The usual mineralised schist carrying small blebs of zinc sulphides is still showing in the face, but nothing of a payable character was disclosed up to the time work was discontinued. On December 11 a winze was started in the crosscut of the 300-feet level. The ore-body is being followed down on the footwall side of the lode. The width of the ore-body in the crosscut is 50 feet.

Mt. Farrell District.—The operations of the North Mt. Farrell Company have been conducted on the usual lines at the four main adit levels. Owing to the exhaustion of the larger ore-bodies a reduced tonnage of ore was won compared with that of the previous term. A slight depreciation in the "values" of the ore mined, and the decline in prices of silver and lead, materially affected profits, but at the same time these latter were more than sufficient to provide for capital expended in shaft-sinking, plant, and development, and also for meeting all financial obligations.

A considerable amount of exploratory and developmental work has been carried out in the upper levels, but results have been disappointing, and no material additions have been made to the rapidly-diminishing ore reserves.

Circumstances compelled the adoption of the scheme of sinking a shaft inside the mine. From a central site in the bottom of No. 4 adit a "blind shaft" has been sunk 70 feet, and a crosscut driven from it 60 feet below the No. 4 level cut the No. 3 lode at 90 feet east from the shaft. Two winzes have been sunk 50 feet on this lode from the No. 4 level, and as each went down in payable ore the prospects of development work at the new level being attended with satisfactory results are encouraging. All present demands for power for hoisting and pumping purposes are met by the small compressed-air plant recently installed. On the surface many improvements have been made, providing for the more economical and expeditious handling of the ore, and also affording much-needed facilities for the conducting of the necessary surface operations. The company's steam tramway from the Emu Bay Railway Company's line to Mt. Farrell was completed and opened for traffic in the early part of the year.

The Tullah Silver and Lead Mine has cut the lode in No. 2 level at a distance of 390 feet from the approach, and 80 feet lower than No. 1 level. The lode was driven on south for a distance of 100 feet, and showed ore in bunches. About 20 tons of ore were stoped out from the No. 1 level and sent to the Zeehan Smelters, which assayed 60 per cent. lead and 32 oz. of silver per ton, but on account of the heavy train freights, &c., the mine had to be closed down.

North-Western District.—The Magnet Silver Mine.—The majority of the underground work has been confined to Nos. 7 and 8 levels. Preparations are being made for sinking to No. 9 level. In No. 8 level the lode averages 45 feet wide for a length of 400 feet.

The mill reduces all tailings to sand and sluices before dumping them, and treated 27,318 tons of seconds. Five thousand three hundred and seventy-four tons of crude ore were sent to Newcastle, assaying 12·4 per cent. lead and 39 oz. of silver. The concentrates sent to Europe assayed 41·8 per cent. lead and 133·4 oz. silver. The cost of winning ore and development was 8s. 9d. per ton; and the cost of milling, 2s. 11d. per ton. An average of 125 men were employed, including those on the railway-line.

New Magnet Silver Mining Company.—The company has extended its prospecting drive 803 feet west.

Northern and Southern Division.—The Round Hill Silver-lead Mining Company in October closed down for a time, and the mine was put in charge of a caretaker pending the appointment of a mine manager. The ore is of low grade, and the cost of carting and packing the ore makes the mine a difficult one to manage economically.

The Devon Mining Company.—On an average 5 men have been employed. One hundred and ten feet of cross-cutting and 49 feet of winze-sinking has been done. Sixty-three tons 12 cwt. of silver-lead ore were obtained.

Copper-mining.

The quantity of blister copper and copper ore produced was 10,225·8 tons, valued at £608,038; being an increase of 207·65 tons on the previous year.

The Mt. Lyell Mining and Railway Company, Limited.—The ores and metal-bearing fluxes treated by the company were as follow:—

Dry Weight.

	tons.	cwt.	qr.	lb.
Mt. Lyell Mine ore	252,440	0	3	19
North Lyell Mine ore	131,633	4	2	6
Purchased ore	270	2	3	2
	384,343	8	0	27

Metal-bearing Fluxes.

North Lyell Mine	364	1	0	6
Lyell Tharsis Mine	427	6	1	0
Total	385,134	15	2	5

Quantity and value of metal produced:—

Blister copper, 8638 tons, containing—

	£	s.	d.
Copper, 8534 tons, valued at ...	516,682	8	7
Silver, fine, 706·011 oz., valued at	69,735	11	1
Gold, fine, 13,400 oz., valued at	56,992	10	0
Total	£643,410	9	8

The average number of men employed was 1909. The amount paid in dividends was £315,000.

The Crown Lyell Extended Proprietary Company.—No work has been done by this company beyond repairing the ladder-way in the shaft and boring about 410 feet.

Mt. Lyell Comstock Mine.—The low-level tunnel has been extended from 477 feet 6 inches to 768 feet 6 inches. From 665 feet to 718 feet, a width of 63 feet, the average of all assays gave 3·7 per cent. copper. From 705 feet to 710 feet drives were put in north 18 feet and south

133 feet. The average of all assays gave 4·6 per cent. copper. The south drive is still being continued. A shaft is being sunk, and at the end of the year was down 30 feet 6 inches. The total driving and sinking for the year was 502 feet 6 inches, with an average number of 13 men employed.

The Mt. Lyell Blocks Mining Company.—Since restarting the mine on the 29th August the work done has been cleaning out and repairing the Consols tunnel for a distance of 1600 feet; and the Office tunnel, for a distance of 551 feet. These are the old workings. Two compressors and boilers have been erected. The average number of men employed was 18.

Heazlewood.—The old Heazlewood Silver-lead Mine and the Wealth of Tasmania Mine have been taken up by a new company called the Jasper Copper Mines, No Liability. The company was only formed in November, but immediately set to work to clean up the accumulated debris from the old workings to enable a thorough examination to be made in preparation for systematic development to be commenced.

Mt. Balfour.—A great deal of attention has been attracted to this field during the year, and about 3500 acres of land have been applied for under lease. The Assistant Government Geologist is now on the field making an extensive geological examination of the country. The only mine from which any ore has been won is that of the Murray Bros., who raised 1607 tons of copper ore, valued at £21,052, between 1st February, 1907, and the 31st December, 1909, and shipped it to New South Wales for treatment. The other mines working in the vicinity are as yet only in the prospecting stage.

Mr. Inspector Harrison, who returned from a visit to the field in March last, reported:—

"The Central Balfour Company has completed the erection of a small winding plant, and sunk a good main shaft to a depth of about 150 feet. At this level it is intended to put in an opening set and sink same to a depth of 300 feet, if possible. The country met with is soft schist. As the shaft is some distance away from the line of lodes the water is very light. Considerable interest is centred on the result of this work by the mining people on the field, as it will be the first shaft to prove if the lodes live to a depth or otherwise. On the northern end of the property a diamond-drill is at work, but I understand the directors do not wish results to be made public at present. The foreman of the drill is meeting with the usual difficulties that have to be encountered in drilling through soft stratas of schists.

"Balfour Blocks Mine.—This claim has been prospected as deep as the water difficulty would allow, from 30 to 40 feet. This mine requires machinery.

"Further north, Mr. Knox is prospecting, with favourable results.

"The next mine working is the Mt. Balfour (Mr. Langford, manager). A considerable amount of driving has been done at a depth of about 80 feet on a large formation, through which runs branches of good ore. A deeper adit is to be started by 1100 feet of driving, which will give another hundred feet of backs.

"The next is the North Balfour, where the manager is driving an adit to strike the lode. This is the furthest point north at which active work is being carried on. About half a mile east of the Balfour Mine some prospectors found a lode showing good ore just below the surface, and the usual amount of pegging is going on in that direction.

"From the Norfolk Ranges to the northern end of the field there is a continuous line of copper-bearing country, a distance of fully 18 miles."

Tin-mining.

The quantity of tin ore raised was 4511·2 tons, valued at £418,165, an average value of £92 13s. 11d. per ton.

This shows a decrease of only 9·60 tons on the previous year.

The statistics for the year are:—

	Ore Won.	Miners Employed.	
	Tons.	Europeans.	Chinese.
Northern and Southern Division	83·80	41	—
North-Eastern Division...	2414·65	619	75
Eastern Division	408·25	242	29
North-Western Division...	1324·23	425	—
Western Division	280·27	135	—
	4511·20	1462	104

Northern and Southern Division.—The only tin mine working in this division is the Shepherd and Murphy Mine, near Middlesex; 83·80 tons of tin ore were obtained, 41 men being employed.

North-Eastern Division.—The Briseis Tin and General Mining Company, Limited, has been the largest producer in this division, having raised 966 tons of tin ore, with an average of 134 men. A 24-inch belt-conveyor, driven by a Pelton wheel, has been put in at the Ringarooma overburden. The overburden races are now all lined with steel plates. Through one of these races stones weighing nearly half a ton have been transported by water. The southern end of the mine, which supplied half the output, is now worked out. However, bores put down below Krushka's old workings in the flat known as Krushka's Flat show encouraging prospects. This ground lies between the Briseis Northern workings and the river. It will be worked this winter. It is estimated there are 700 tons of black tin in the block bored.

Arba Tin Mine.—During the first two months of the year work was hampered owing to the very dry season and shortage of water, but after the 2nd March the dry weather broke up and work was carried on continuously. The total quantity of overburden and tin drifts removed was

197,516 cubic yards, at a cost of 6·05d. per cubic yard. The total output was 175 tons 6 cwt. of tin ore; the average number of men employed being 37.

Pioneer Tin Mining Company, Limited.—Four hundred and forty tons of stream tin have been won from 523,200 cubic yards of drift sluiced. During March the company's hydro-electric scheme was completed, and since then four sluicing plants, working as two units, have been at work on the drift, two of these being plants driven by electricity. The hydro-electric scheme comprised building a large dam on the Frome River, with a capacity of 420,000,000 gallons; construction of about 5 miles of head-race of large section; the building and equipment of generating station, with an output of 1100 kilowatts; erection of a 4-mile transmission-line; and the conversion of the mine plant to an electric drive, as well as the installation of a 36-inch diameter power-pipe line. The power is generated at 6500 volts, and is transmitted direct to the motors on the barges without transforming.

Pioneer Extended Tin Mine.—Sluicing operations were carried on from 1st January, 1909, until the first week in July, when the mine was closed down. The number of men employed for the six months, including woodcutters, was 28. The tin ore obtained amounted to 26·85 tons.

South Mt. Cameron Tin Mine.—One hundred and forty-five thousand four hundred and twenty cubic yards of wash, and 19,160 yards of pug, were treated. Seventy-two tons of tin oxide and 4 oz. 7 dwt. of gold were obtained. The average number of men employed was 35.

Garribaldi Tin Mine.—The principal work done during the year has been the building and repairing of dams, new flumings on head-race, and repairing and cleaning head-race. The quantity of tin ore raised was 28¼ tons. The average number of men employed was 24.

The Aberroe Tin Mining Company.—On the old Mussel Roe Mine sluicing was carried on from June to December on Carroll's Flat. Twenty-one thousand three hundred and fifty cubic yards of drift were treated, for a return of 4 tons 1 cwt. 2 qr. tin ore; the average yield being 0·43 lb. per cubic yard. Four men were employed.

On the new Aberfoyle Mine sluicing operations were carried on from April to December. For a little over three months the work was developmental, consisting of the cutting from the No. 3 to the No. 2 face. Twenty-four thousand cubic yards of tin-bearing material were treated, yielding 8 tons 16 cwt. tin oxide, an average of 0·8 lb. per cubic yard. Five men were employed.

Purdue Tin Mine.—This mine has been working steadily, and has produced 76 tons of tin ore, employing 22 men.

Moorina Tin Mine.—The Briseis Tin and General Mining Company has this mine under option of purchase, and has been prospecting by means of boring-rods.

The Weld Tin Mine.—The mine has been regularly worked by means of two hydraulic elevators, for a yield of 37 tons 9 cwt. tin ore. The number of men employed was 11.

The Wilberforce Prospecting Company.—Fourteen tons 18 cwt. of tin ore were obtained, six men being employed. This mine was closed down for three months.

Eastern Division.—Fancy Creek Tin Sluicing Syndicate.—Eighteen tons of tin ore were obtained by 10 men. Owing to the dry summer which prevailed on the North-East Coast sluicing operations were not commenced until the middle of April.

Anchor Tin Mine.—In spite of the rainfall of 66·38 inches, work during the year was much hampered by the drought, which started in 1908 and did not cease until the middle of April. The battery was completely closed down for 56 working days, and ran for 255 days, with an average of 70·89 stamps out of 100. Ninety-nine thousand seven hundred and sixty-eight tons of stone were crushed for 146 tons 7 cwt. 2 qr. 27 lb. of tin oxide, and 1 ton 11 cwt. 1 qr. 19 lb. of tin ore was saved from alluvial. Prospecting was carried on to some extent all the year on the various outlying properties. Work on the aerial tram to connect with the Australian Tin Mine was started during the year, but the bush fires destroyed all the timber prepared for trestles, &c This has now been replaced, and the erection of trestles, &c., is well in hand. During the year the crude ore obtained from the face has materially improved, and the average value is now higher than for several years. The result is mainly due to the new make of ore running under the heavy overburden on the east side of the mine.

Thureau's Deep Lead Mine.—Ten thousand five hundred cubic yards of earth have been removed by hydraulic sluicing. The quantity of tin ore obtained is about 5 tons 5 cwt.; average value about 1 lb. per cubic yard. Three men were employed.

South Esk Tin Mine.—Twenty thousand cubic yards of earth were treated by hydraulic sluicing, 12 tons of tin ore being obtained. During the dry weather the head-race was cut a further distance of 40 chains around the mine. A considerable amount of prospecting work was done. Shafts averaging from 6 feet to 20 feet in depth were sunk, and good results were obtained. The ground is now being opened up, and tail-races and pipe-columns are being constructed. On an average five men were employed.

Western Mining Division.—At the Federation Tin Mine work has been continuously carried on by two parties. Work at the Black Face, near Munro's shaft, has proved continuance in depth of payable deposit, from which satisfactory returns have resulted. A considerable distance south-eastward from the Black Face three men were engaged proving what appears to be a very well defined lode, carrying favourable tin, the width of which is said to be from 10 to 20 feet. Other work still further south is also most promising. Messrs. Tomkins, Lyall, and party, who hold a tribute on a portion of the Federation Consolidated lease, obtained very satisfactory returns for the year. A good deal of valuable dead work has been done, and ore has been broken out for treatment when water is available during the wet season.

Renison Bell Mine.—During the year this mine has been equipped with a dressing plant, comprising one 50-h.p. engine and boiler; one Gates' rock-breaker, No. 1; two 5-feet grinding pans; two Card concentrating tables; two double Luhrig vanners; two 5-feet Weir-Meredith vanners, with requisite hoppers, classifiers, elevators, and centrifugal pump (the latter being required for returning the middlings for regrinding). In addition to the above are two canvas strakes at the tail of the mill, over which the whole of the tailings are passed. A double-line self-connecting tram has been constructed 16 chains in length, together with the necessary brake-gear for conveying the ore to the mill; and branch trams, aggregating approximately 35 chains in length, have been constructed to connect the main tram with the various faces. The mill and tramway were completed, and mining and concentrating the ore was started, early in August. A main race, 4 feet wide by 2 feet deep, 54 chains in length, with a capacity of at least 33 sluice-heads, has been constructed, which makes the whole of the Argent River available at the mill for power and dressing purposes, the effective head available for power being 126 feet. The various faces of ore, which are worked by the open-cut system, are developing well. The No. 1 bench at the blow is upwards of 60 feet in height by 20 feet wide.

Up to the end of December 238 tons of crude ore were mined and concentrated, from which 46·98 tons of tin oxide were obtained, having an approximate value of £3977. Towards the end of the year preparations were made to duplicate the concentrating plant and to install a hydro electric power plant of 140 horsepower. These works are now in course of erection.

Boulder Tin Mine.—Five thousand seven hundred and forty-nine tons of stone were crushed, from which 66 tons of tin oxide were obtained, of an average assay value of

70 per cent., 17 men being employed. As a result of developmental work carried out on this mine a large amount of payable ore has been added to the reserves, and it has been deemed advisable to erect a 10-head battery.

Montana Tin Mine.—The work for the year has consisted principally of ground-sluicing the detrital matter on the southern portion of the lease, the water being brought on in two high-level races. As the tin-bearing stone occupies the upper reaches of the hillside, little or no difficulty is experienced in handling the detritus. The coarse stones are forked aside and stacked, while the smaller gravel is separated in passing over the grizzly plates, and the fine gravels go to the sluice-boxes, of which there are three. The tailings from these pass into sludge-dams for storage and subsequent treatment for the recovery of the slime tin.

During the latter part of the year a small dressing plant was installed to treat these accumulations, consisting of a Card table and four Luhrig vanners, with the necessary trommel and sizing apparatus, operated by a 6-horsepower "International" gasolene engine. A three-head prospecting battery has since been added to the equipment to deal with the over-size from the trommel. The tailings as they leave the mill pass on to two canvas strakes, each 40 feet by 12 feet. Excellent recoveries are said to have been made in the mill (the "Card" product is returned at 72 per cent. metallic tin, and that from the Luhrig vanners at 66 per cent.). During this run of three months this plant has recovered a little over 9 tons of tin oxide, valued at £762, and employing only one man per shift. The tin recovered at the sluice-boxes is hand-dressed to not less than 74 per cent., the best returns reaching 74·9 per cent. By direct sluicing 70 tons of oxide have been won, valued at £6054 14s. 5d., making a total recovery of 79·3 tons, valued at £6816 14s. 5d. The sluice forkings and hopperings are known to carry good tin values, and a site is being prepared for a battery and concentrating plant to operate on them, and subsequently on the lode-formations that are now being developed by adit level. The high-level race has been extended about 110 chains. Average number of men employed has been 33.

Stanley River Field.—A good deal of interest has been centred in this field during the year, but until there is proper communication with the field mining is not likely to progress. Mr. Henry New, an old miner, who returned from the field a short time ago, showed me some specimens of tin ore from the Stanley Reward Company's ground, which is said to assay up to 25 per cent. tin oxide. He informed me that the tributers were getting 500 lb. of tin ore per cubic yard, and about 1½ ton of ore was ready to pack out directly the pack-track is put in order.

Mt. Bischoff Tin Mine.—Productive work has been carried on vigorously and systematically in the different open-cuts and benches. Stoping has also been proceeding from the various levels of the Queen lode, and a considerable amount of surface prospecting and underground developmental work has been accomplished. A new hydro-turbo generator set has been installed at the power-station, and is working in a very satisfactory manner; and the mine is now fully equipped to meet any further demands for extra power. The original electrical scheme has to a large extent been remodelled, and the plant is now in first-class order. The electric locomotive on the main line between the mine and the mill, and those hauling underground, have been in constant use, and have coped with the increase of tonnage in a very satisfactory manner. The new 10-head mill, with the necessary concentrating appliances, was erected during the period under review, and is doing efficient work, a heavy stamp duty being maintained, and a decided reduction in the percentage of slimes. This plant is entirely separate from the main mill, and can be used for experimental purposes when required. The greatly improved recovery and efficiency of the main milling and concentrating plant made it impossible to work the ringtail sheds at anything but a decided loss, consequently they were shut down during the latter half of the year. Superior work in the Happy Valley, above the ringtail sheds, together with a careful examination of the alluvium of the creek, revealed the existence of a large quantity of tin wash of a highly payable nature. Sluicing operations were entered upon, with the result that several tons of tin oxide have been worked at a very small cost per ton. The crude ore delivered to the mills for crushing and concentration amounted to 198,771 tons, which constituted a record for a year's work. From the material treated, 1025 tons of concentrates were obtained, of an approximate value of £92,250. The average working costs are 4s. 1·447d. per ton of crude ore mined and treated. The company paid £36,000 in dividends. The total quantity of tin ore produced by this company is 68,518 tons, and the total amount paid in dividends is £2,196,000.

Coal-mining.

The total quantity of coal raised amounted to 66,161·75 tons, valued at £56,237; being an increase of 5094 tons on the previous year.

The raisings at the different collieries were:—

Colliery.	Tons Raised.	Men Employed.
Cornwall...	29,885	69
Mt. Nicholas	27,341	69
Tasmanian Wallsend... ...	5722·75	44
Spreyton...	1543	6
Mt. Cygnet...	970	4
York Plains...	560	2
Ida Bay	140	4
	66,161·75	198

Cornwall Colliery.—The workings have been carried on under the Longwall system in the old mine, and have been advanced a distance of about 400 feet from where the bulk of the supply has been obtained. The new tunnel which was commenced at the beginning of the year has been driven a distance of 1109 feet. This tunnel has been opened up on the same seam as that of the old mine tunnel, but in a position which should open up an area of coal not yet touched upon.

Mt. Nicholas Colliery.—In addition to the work done at the mine, the company has been prospecting behind the Killymoon Estate, and the manager reports the discovery of a 3-feet seam of bituminous coal assaying only 8½ per cent. ash.

Spreyton Colliery.—The company has been working seven bores on the north-east side of the hill, and is driving a tunnel on the south-west side of the hill, where it expects to strike the coal.

Ida Bay Colliery.—The company has driven about 500 feet, laid down a tramway from the mine to jetty, and erected a boiler and engine and the necessary sheds and screens.

Tasmanian Wallsend Colliery.—The work done has been of a developmental character, and the coal won has been chiefly got in furtherance of that object.

A steam-pump has been installed underground. A Longwall face has been opened up, and a number of accommodation huts for the men have been erected.

Iron Ore.

Since the closing down of the Tasmanian Iron Mine at Penguin last year no iron ore has been raised in the State for export.

Wolfram.

The output of wolfram ore was as follows:—

	Tons.	Value.
		£
Shepherd and Murphy Mine, at Middlesex	6·05	487
Ben Lomond Tungsten Mine	6·8	612
Other Ben Lomond Mines...	15·50	1395
	28·35	£2494

Bismuth.

The Shepherd and Murphy Mine, at Middlesex, obtained 2·9 tons of bismuth, valued at £980, from its tin ore.

Bucket-dredging.

The Dorset Bucket-dredge, working on the flats at South Mt. Cameron, obtained 26·05 tons of tin ore and 41·60 oz. of gold.

The Gladstone Tin Development Company's dredge at Gladstone has been dismantled, and the plant has been purchased by the Eskdale Bucket-dredging Company of Victoria, with the object of dredging for gold on the Mitta Mitta River.

Ringarooma Bucket-dredging Company.—This company obtained 31·90 tons of tin ore and 100 oz. of gold.

Oil Shales.

Oil shale deposits in Tasmania have been known to exist for many years, but up to the present very little practical work has been done to prove their value. Mr. W. H. Twelvetrees, Government Geologist, supplies the following information thereon:—

"1. An undefined area in the basin of the Mersey, near Railton and Latrobe, carries one or more seams or beds of oil-bearing shale (Tasmanite shale), which have been known to exist since 1852, but were not seriously tested experimentally until 1902, when analyses of the shale at various points were made on the spot at the instance of a

South Australian syndicate called the Tasmanian Shale and Oil Syndicate. The results showed an average content of 60 gallons of oil per ton of shale (benzine, lighthouse oil, and lubricating oil). Two new companies are now just about to start work in earnest, prospecting and preparing sites for extraction works, and other syndicates are in the field. Crown land has been applied for by investors and speculators up to about 14,000 acres on both sides of the Mersey, in the hope that payable shale may be found to extend beyond the limits of present exploration. How far this rush is justifiable cannot be stated until the area is geologically examined. The present applications for sections cover 3000 acres on the west side of the Mersey at Railton and Dulverton, and about 4000 acres further west at the Nook and on the Don River; and on the east side of the Mersey, about 7000 acres, as far east as the Rubicon. An official examination of the area has not been made since the date of Mr. Chas. Gould's report in 1861. I prepared a brief statement on it last year, published in the Report of the Secretary for Mines for 1908, pages 110-113.

"2. *Kerosene Shale or Cannel Coal.*—Sixteen miles south of Wynyard, on the North-West Coast, is an outcrop line of coal, which is too far from the sea to be worked profitably at present, but which will probably be exploitable when a tramway-line is constructed up the Flowerdale Valley. One of these seams, 20 inches thick, carries 6 inches of pitchy black conchoidal kerosene shale, or cannel coal, with from 67 to 75 per cent. volatile hydrocarbons. The exact nature of this substance has not been authoritatively determined. It is considered to occupy a position between the shale-cannel group and bituminous coal, and would perhaps yield benzines rather than oils. Probably its best use, from a commercial point of view, would be to enrich ordinary coal gas.

"Near Barn Bluff, 45 miles from the North-West Coast, coal closely resembling the preceding has been found in loose fragments, derived from some unknown disintegrated seam. Laboratory experiments show that on distillation it yields both oil and tar, but the latter is believed to be in excess. Its commercial value has not been investigated. Mr. Montgomery, a former Government Geologist, was of opinion that the fragments had resulted from destruction of the original seam by glacial action. It is possible that an intact portion of the seam may yet be discovered, but the country is high and remote, and can only be properly prospected during two or three months in the year.

"3 *Lignite and Brown Coal of the Tertiary System.*—Our brown coal has probably a tar content, but the coal generally is very impure and clayey.

"4. *Petroleum.*—I do not know of any surface indications *in sitû* of petroleum in this State, and the absence of these is a weighty argument against the occurrence of mineral oil in our strata. No oil or gas springs at surface indicate a deep-seated reservoir of rock oil. In our older schist and slate strata not a sign is present. Coal measures are nowhere characteristically the source of petroleum supplies. Triassic beds lie either horizontally or at low, regular angles, without the arching which favours the accumulation of gas or oil.

"On some of the islands in Bass Strait (Prime Seal Island, &c.) solid lumps of asphaltum are thrown up on the beach after storms, but their derivation is only a matter of conjecture. Their presence seems to point to some submarine oil reservoir.

"Some bituminous exudation has been reported from the banks of the Derwent, on the Kenmore Estate, Macquarie Plains (2 miles from the Glenora railway-station). It has not been examined, and possibly may be connected with the Tertiary brown coal series.

"5. *Salt Pans.*—Several of these exist in the Midlands, the individual lagoon beds varying from one to a hundred acres in extent. Some hundreds of tons of salt have in dry seasons been taken from them for domestic and farm purposes. These saliferous sandstones have not been made a subject of special study, but it is well known that oil springs are often accompanied by brine formation. In such occurrences the oil has ascended from the deep-seated shale or limestone in which it was generated into overlying porous strata, such as sandstone, in the arches or anticlinal folds of which it has collected in the order of specific gravities, viz.—gas under the crown of the dome; below the gas, oil; below the oil, brine. There has been very little folding of the strata in the Midlands, and this is unfavourable. Still, possibilities might be kept in view.

"6. From the above you will gather that the Mersey basin is the area which for the present offers most encouragement for early results. If the work now in progress is persevered with, we shall before long be in possession of some definite information on the subject."

Fuller's Earth.

Mr. W. Wise, of Glenmont, Kingston, while sinking a well on his property, came upon a deposit of Fuller's earth, about 18 inches thick, at a depth of about 25 feet from the surface. A sample was obtained and forwarded to the Government Analyst for analysis.

The following is the result:—

	Per Cent.
Silica	59·0
Alumina	28·0
Oxide of iron	2·9
Lime	0·4
Magnesia	0·6
Combined water	6·3
Moisture after air-drying	1·3
Not determined	1·5
	100·0

The following return shows the Quantity and Value of Mineral Products for the State of Tasmania during the Year ending 31st December, 1909:—

Mineral.		Quantity.	Value.
			£
Gold *	ozs.	44,777·366	190,201
Silver-lead Ore	tons	80,378·35	298,880
Blister Copper †	„	8638	586,419
Copper and Copper Ore	„	1587·8	21,619
Tin Ore	„	4511·2	418,165
Iron Ore	„	...	...
Coal	„	66,161·75	56,237
Wolfram	„	28·35	2494
Bismuth	„	2·9	980
Total		...	£1,574,995

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

† Value of gold deducted.

GEOLOGICAL SURVEY BRANCH.

This branch of the Department is increasing its usefulness to the State and community by the work it is accomplishing. During the year the geologists explored some of the unknown country drained by the northern and southern tributaries of the Gordon, and prepared reports and maps, which have been published in the last annual report of the Surveyor-General. In the southern area some exposures of serpentine were found to occur, suggesting the possible existence of ore-deposits in their vicinity. Beyond these, there was nothing on the routes which were followed to indicate that the area is at all valuable or encouraging, from a prospector's point of view. The Government Geologist, has, however, in his annual report, mentioned the likelihood of the country between Birch's Inlet and Rocky Point proving mineral-bearing, and any future western exploration programme ought to embrace this area, in which the Survey considers it probable that the southern extensions of the Lyell belt will be found to exist.

The Assistant Government Geologist's report of his examination of the North Dundas tinfield has been issued during the year. This bulletin, judging from the demand there has been for it, must have proved of great use to the mining public.

The Government Geologist's report on the Gunn's Plains and Alma districts was also published this year.

Both geologists spent three months on the Zeehan field investigating the nature of the lodes in that district, with a view of forming an opinion as to whether in general they may be expected to continue ore-bearing at greater depths than those at which they have been worked hitherto. A preliminary report has been issued stating the conclusions arrived at. These are briefly:—(1) That no evidence can be adduced in favour of the Zeehan lodes being merely superficial phenomena, and of their ore-shoots being only shallow secondary concentrations. (2) That the ore having originated from a deep-seated source, the lodes may be followed to still greater depths with some measure of confidence. (3) That the depressed state of the field is chiefly due to so few deep workings being in existence, and consequently when two or three companies worked out the best parts of their shoots simultaneously, and sufficient productive work was not going on on other leases, the effect was found to be felt acutely. (4) That much work remains to be done on parts of the field now idle, and that it is altogether inaccurate to describe the ore-deposits as being exhausted.

The Survey has devoted some time to collecting and preparing exhibits of ores, rocks, and minerals to be displayed permanently in the Victoria Museum, Launceston. The Launceston City Council, in whom the museum is vested, has kindly placed a large gallery at the disposal of the Department for this purpose. Donors of specimens may feel sure that all suitable samples of mineral which they may give will be exhibited and taken care of. The exhibits will be classified and arranged by the geologists.

Increased work in several directions has been planned by the geologists, but can only be undertaken gradually, and in proportion to the appropriation that may be made for this branch of the Department. The ordinary field work is so pressing that some of the publications which the Survey has in view have to be deferred. In the meantime the disposition of the staff has been carefully considered and settled. The Government Geologist carries out all examinations in the northern, eastern, and southern parts of the island, while to the Assistant Geologist is assigned the west and north-west. When the latter has finished each field he returns to Launceston and prepares his report at headquarters. This is the plan adopted by all geological surveys, as being the most effective and economical, and there is nothing in our circumstances which would make it wise to depart from it. By this means the officer is in touch with his draftsman; he has the departmental library, collections, and microscopical slides to refer to; and the necessary consultations with his chief are possible. Nothing is more fatal to continued efficiency or good work than isolation and severance from headquarters. Sending in reports from the mining field under examination is impracticable, and even if possible, would result in falling short of the standard aimed at in the bulletins. A desire has been expressed by one or two persons that the Assistant Geologist should be stationed at Zeehan. To establish a duplicate office there would mean additional expense without any particular advantage to the applicants, because, in the first place, the Geologist would be absent in the field just as much as at present; and, secondly, when he returned, he could not be interrupted during the preparation of his report. The disadvantages in point of efficiency and general convenience are obvious. The danger, too, would be present of his duties gradually degenerating into those of travelling mine inspection and reporting. The final decision which has been made is in harmony with universal practice, and will, it is believed, conduce to the greatest efficiency of the service at the least expense, and will prove the most useful plan that could be devised for the benefit of the community in general.

Inspectors of Mines.

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

Mining Managers' Examination.

No candidates presented themselves for examination during the year.

Diamond-drills.

The drills were not employed during the year.

Mt. Cameron Water-race Board.

The report of the Board is appended.

Departmental Staff.

There have been no changes in the staff of the Department during the year.

Revenue.

The revenue for the year amounted to £22,804 1s. 5d., being an increase of £2492 18s. 5d. on the previous year. This amount does not include a sum of £4886 14s. 1d. deposited as survey fees on applications for leases.

Conclusion.

In conclusion, I desire to thank the officers of the Department, and also the officers of the Mines Drafting Branch of the Surveyor-General's Department, 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. the Minister for Mines.

DIAMOND-DRILLS.

Statement of Work done to 31*st December*, 1909.

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 11¾
1888	Killymoon Estate—For Coal	Ditto	1	504	0 4 7¾
1888–9	Seymour—For Coal	Ditto	5	2266	0 7 8½
1889 1890	Beaconsfield (Phœnix 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 1½
1891–2	Back River, Prosser's Plains—For Coal	Ditto	2	854	0 6 1¾
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 1900	Blue Tier (Anchor Co.)—For Tin	Ditto	9	876½	0 9 1¾
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	

	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 1¾
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	

Aggregate number of bores 101

Total distance bored .... 32,901½ feet

W. H. WALLACE, Secretary for Mines.

No. 1.

***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, 1908, *and* 1909.

Year.	Quantity.	Value.
	ozs.	£
1880	52,595	201,297
1881	56,693	216,901
1882	49,122·3	187,337
1883	46,577·5	176,442
1884	42,339·95	160,404
1885	41,240·95	155,309
1886	31,014·5	117,250
1887	42,609·15	158,533
1888	39,610·95	147,154
1889	32,332·65	119,703
1890	20,510	75,888
1891	38,789	145,459
1892	42,378	158,917
1893	37,687	141,326
1894	57,873	217,024
1895	54,964	206,115
1896	62,591	237,574
1897	77,131	296,660
1898	74,233	291,496
1899	83,992	327,545
1900	81,175	316,220
1901	*69,491	295,176
1902	*70,996	301,573
1903	*59,891	254,403
1904	*65,921	280,015
1905	*73,540·5	312,380
1906	*60,023·4	254,963
1907	*65,354·25	277,607
1908	*57,085·1	242,482
1909	*44,777·366	190,201
	1,632,538·566	6,463,354

* Fine Gold.

Diagram showing Total Quantity & Value of Gold won in Tasmania during the years 1880-1909

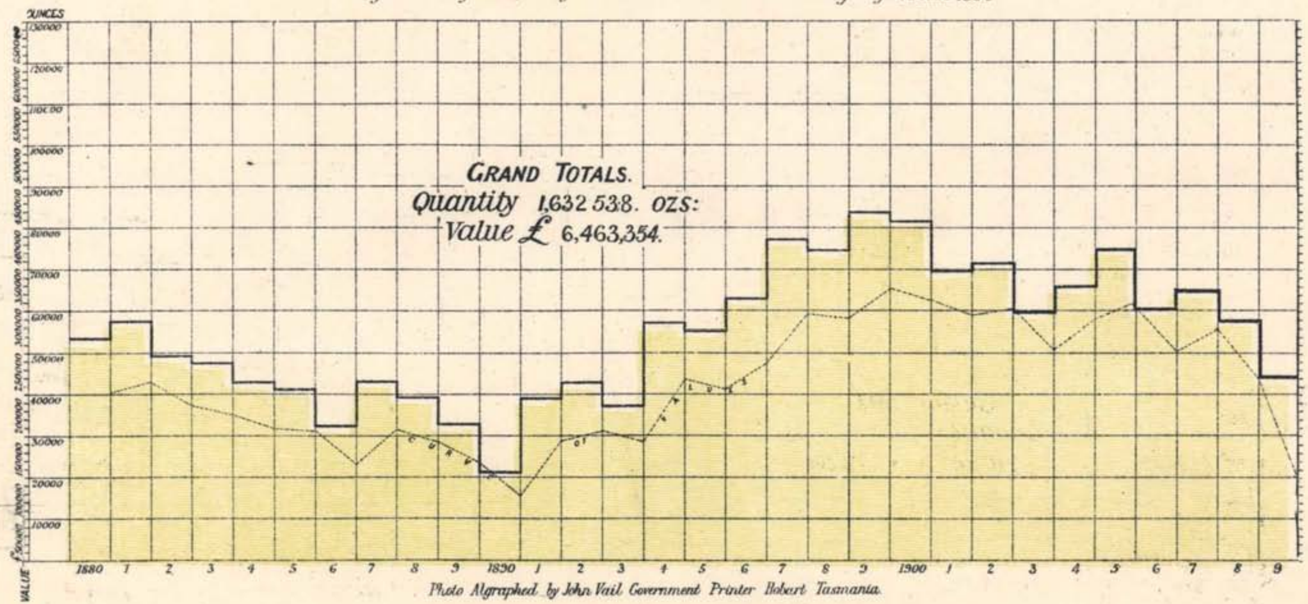

Photo Algraphed by John Vail Government Printer Hobart Tasmania.

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Diagram showing Total Quantity & Value of Coal raised in Tasmania during the years 1880-1909

Photo Algraphed by John Vail 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, 1908, *and* 1909.

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	48,863·5	41,533
1903	49,069	41,709
1904	61,109	51,942
1905	51,993	44,194
1906	52,895·75	44,962
1907	58,891	50,057
1908	61,067·75	51,907
1909	66,161·75	56,237
	1,119.387·75	958,309

No. 3.

***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, 1908, *and* 1909.

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	3607·5	409,853
1888	3775·25	426,321
1889	3764	344,941
1890	3209·25	296,368
1891	3235	291,715
1892	3174	290,083
1893	3128·5	260,219
1894	2934	198,298
1895	2726·75	167,461
1896	2700	159,036
1897	2423·5	149,994
1898	1972	142,046
1899	2239·25	278,323
1900	2029	269,833
1901	1789·5	212,542
1902	1958·25	237,828
1903	2376·15	300,098
1904	2171·5	255,228
1905*	3891·5	362,670
1906*	4472·75	557,266
1907*	4342·75	501,681
1908*	4520·8	421,580
1909*	4511·2	418,165
	98,547·4	9,428,926

* 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 1905-1909

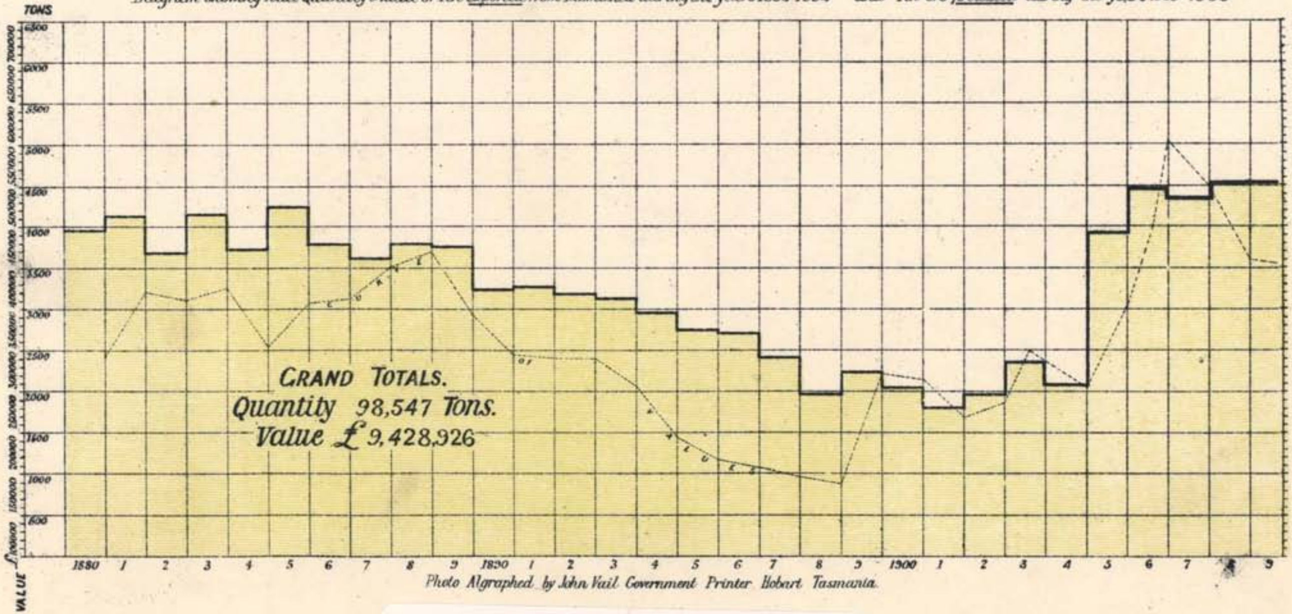


Photo Algraphed by John Vail Government Printer Hobart Tasmania.

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, 1908,** *and* **1909.**

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	31,519·5	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	75,270·5	246,888
1906	87,117·75	462,443
1907	89,762·5	572,560
1908	63,116·9	322,007
1909	80,378·35	298,880
	747,761·5	4,678,251

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, 1908, *and* 1909.

Year.	Quantity.	Value.
	Tons.	£
1896	41·5	1245
1897	4700	322,500
1898	4955·5	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
1909	8638	*586,419
	103,561	8,358,249

* 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, 1908, *and* 1909.

Year.	Quantity.	Value.
	Tons.	£
1902	2500	50,112
1903	3727	83,624
1904	—	—
1905	—	—
1906	—	—
1907	—	—
1908	—	—
1909	—	—
	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, 1908,** *and* **1909.**

Year.	Quantity.	Value.
	Tons.	£
1896	34	1020
1897	75	2250
1898	394	8128
1899	1695	26,833
1900	4221·5	63,589
1901	11,221	130,412
1902	5994	65,270
1903	102	790
1904	104	1640
1905	1150·75	52,939
1906	2234·5	72,480
1907	788·25	36,975
1908	1185	6588
1909	1587·8	21,619
	30,786·8	490,533

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, 1908,** *and* **1909.**

Year.	Quantity.	Value.
	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
1909	...	...
	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, 1908, *and* 1909.

Year.	Quantity.	Value.
	Tons.	£
1899	200	363
1900	128	113
1901	46·5	45
1902	—	—
1903	—	—
1904	—	—
1905	—	—
1906	—	—
1907	—	—
1908	—	—
1909	—	—
	374·5	521

No. 10.

RETURN showing the Quantity and Value of Wolfram produced during the Years 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, *and* 1909.

Year.	Quantity.	Value.
	Tons.	£
1899	3·5	99
1900	53·75	2058
1901	—	—
1902	—	—
1903	—	—
1904	15·5	1147
1905	32·25	2371
1906	19·75	1465
1907	40·75	4411
1908	4·5	338
1909	28·35	2494
	198·35	14,383

No. 11.

RETURN showing the Quantity and Value of Bismuth produced during the Years 1904, 1905, 1906, 1907, 1908, *and* 1909.

Year.	Quantity.	Value.
	Tons.	£
1904	·3	15
1905	3·5	800
1906	·3	24
1907	·175	27
1908	3·75	462
1909	2·9	980
	10·925	2308

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*, 1909.

Year.	Ore Smelted.	Products.			Yield.			
		Silver-Lead Bull'n.	Blister Copper.	Matte.	Copper.	Silver.	Gold	Lead.
	Tons.	Tons.	Tons.	Tons.	Tons.	Ozs.	Ozs.	Tons.
1896	26,028$\frac{13}{20}$	—	—	2417$\frac{6}{20}$	1235$\frac{1}{20}$	75,951	4707	—
1897	90,773$\frac{1}{2}$	—	3476$\frac{12}{20}$	257$\frac{16}{20}$	3583$\frac{14}{20}$	334,349	16,485	—
1898	170,933	—	4992	—	4783	606,123	24,418	—
1899	275,239	2295	8463	89$\frac{8}{20}$	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	6654
1903	399,032	7560	6683	3413	8094	1,855,158	25,238	7529
1904	433,366	—	8371	—	8265	1,896,134	26,809	7754
1905	466,578	9422	8611	—	8596	2,075,431	26,469	9086
1906	479,775	9380	8708	—	8613	2,150,405	24,986	9300
1907	472,658	10,590	8248	—	8145	2,147,120	24,531	10,060
1908	440,145	7181	8834	—	8723	1,654,350	22,008	6850
1909	429,549	6960	8640	—	8534	1,534,780	18,812	6696

No. 13.

***RETURN** showing the Average Number of Persons engaged in Mining during the Years* 1880 *to* 1909 *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	905	6581
1891	3219	1906	7005
1892	3295	1907	7516
1893	3403	1908	6466
1894	3433	1909	6054

No. 14.

***RETURN** showing the total Area of Land and Number of Sluice-heads of Water applied for during the Year ending* 31*st December*, 1909.

Mineral.	No. of Applications.	No. of Sluiceheads.	Area.
			Acres.
Asbestos	1	...	20
Barite	9	...	355
Coal	4	...	860
Copper	222	...	11,503
Galena	5	...	315
Gold	69	...	813
Guano (Phosphate rock)	1	...	60
Iron	3	...	50
Limestone	2	...	20
Machinery Sites	3	...	10
Minerals	181	...	9830
Shale	6	...	1427
Silver	46	...	2957
Slate	5	...	1093
Tin	189	...	7927
Wolfram	2	...	118
Dredging Claims	32	...	264
Water-rights	95	383	216
TOTAL	875	383	37,838

No. 15.

RETURN showing the total Number and Area of Leases issued during the Year ending 31*st December*, 1909.

Mineral.	Number.	Sluiceheads.	Area.
			Acres.
Barium Sulphate	1	...	80
Coal	10	...	2280
Copper	90	...	4417
Gold	57	...	998
Iron	1	...	19
Limestone	1	...	20
Minerals	74	...	5211
Nickel	1	...	80
Phosphate Rock	6	...	78
Silver-Lead	24	...	1346
Scheelite	1	...	80
Slate	5	...	2017
Tin	135	...	3339
Machinery Sites	2	...	5
Mining Easements	17	...	126
Dredging Claims	7	...	147
Water-rights	84	406	171
	516	406	20,414

No. 16.

RETURN showing the Total Number of Leases in force on **31*st December*, 1909.**

Mineral.	Number.	Sluiceheads.	Area.
			Acres.
Antimony	3	...	240
Asbestos	1	...	10
Bismuth	1	...	40
Barium Sulphate	1	...	80
Coal	29	...	7094
Copper	108	...	5500
Gold	87	...	1265
Iron	11	...	527
Limestone	5	...	403
Lithographic Stone	1	...	97
Minerals	168	...	12,625
Manganese	1	...	63
Nickel	2	...	100
Phosphate Rock	6	...	78
Precious Stones	1	...	80
Silver	93	...	5527
Slate	6	...	1297
Shale	10	...	1699
Scheelite	1	...	80
Tin	743	...	16,549
Wolfram	2	...	98
Zinc-Lead	1	...	40
Machinery Sites	32	...	129
Mining Easements	92	...	464
Dredging Claims	47	...	712
Water Rights	550	2210	1022
	2002	2210	55,819

No. 17.

RETURN showing the Average Number of Miners employed during the Year ending 31*st December*, 1909.

	Europeans.	Chinese.
Northern and Southern Division	731	—
North-Eastern Division	630	75
Eastern Division	463	30
North-Western Division	577	...
Western Division	3548	...
	5949	105

No. 18.

***RETURN** showing the Number and Area of Leases held under "The Mining Act," in force on 30th June in Years* 1902 *and* 1903, *and on* 31*st December*, 1903, 1904, 1905, 1906, 1907, 1908, *and* 1909.

Nature of Lease.	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.		In force on 31st June, 1909	
	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.	No.	Area.
		Acres.		Acres.		Acres.		Acres.		Acres.		Acres.		Acres.		Acres.		Acres.
For Minerals, Silver, Tin, &c.	1063	45,399	950	40,068	826	33,325	868	33,824	944	34,325	1307	43,036	1844	65,047	1269	44,099	1143	41,637
For Coal, Slate, Shale, &c.	52	7819	66	10,767	54	9119	47	7546	45	7185	35	6025	45	7962	45	8745	51	10,590
For Gold	425	4166	310	3117	243	2505	222	2268	195	2087	167	1836	222	2671	111	1344	87	1265
Dredging Claims	—	—	—	—	15	124	29	469	51	1196	91	2027	79	1494	64	916	47	712
Mining Easements	—	—	—	—	34	225	39	234	45	282	47	298	75	436	88	453	92	464
Machinery Sites	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33	133	32	129
Water-rights Mineral and Gold	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	550	1022 & 2210 sluice-heads

No. 19.

***RETURN** showing the Amounts paid in Dividends by Mining Companies during the Year ending* 31*st December*, 1909.

Mines.	Dividends. £	s.	d.
Copper	315,000	0	0
Gold	...		
Tin	68,587	0	0
Silver	5634	0	0
Coal	1812	0	0
TOTAL	£391,033	0	0

No. 20.

***RETURN** showing the total Amount of Rents, Fees, &c., received by the Mines Department during the Year ending* 31*st December*, 1909.

Head of Revenue.	Amount. £	s.	d.
Rent of Auriferous and Mineral Land	21,128	5	7
Fees, ditto ditto	1675	15	10
Survey Fees	4886	14	1
TOTAL	£27,690	15	6

No. 21.

***RETURN** showing the Mining Companies registered during the Year ending* 31*st December*, 1909.

Number of Companies.	Capital.
9	£25,700

In addition to the above, 15 Agents for Foreign Companies and 7 Syndicates, under 60 Vict. No. 51, were registered.

Diagram showing the Annual Value of Minerals & Metals raised in Tasmania from 1880–1909

Photo Algraphed by John Vail Government Printer Hobart Tasmania

No. 22.

***RETURN** showing Quantity and Value of Minerals and Metals raised in Tasmania from 1880 to 1909 inclusive.*

Mineral or Metal.	Quantity.	Value.
		£
Gold	1,632,538·566 ozs.	6,463,354
Silver-lead ore	747,761·5 tons.	4,678,251
Blister Copper	103,561 „	8,358.249
Copper Matte	6227 „	133,736
Copper and Copper Ore	30,786·8 „	490,533
Tin	98,547·4 „	9,428,926
Iron Ore	42,762 „	25,701
Coal	1,119,387·75 „	958,309
Wolfram	198·35 „	14,383
Bismuth	10·925 „	2.308
Asbestos	374·5 „	521
Unenumerated prior to 1894	...	31,988
Total	...	£30,586,259

No. 23.

COMPARATIVE Statement of Revenue from Mines, being Rents, Fees, &c. (exclusive of Survey Fees), paid to the Treasury for the Years ending 30*th June, from* 1881 *to* 1903, *and for Six months ending* 31*st December*, 1903, *and for the Years ending* 31*st December*, 1904, 1905, 1906, 1907, 1908, *and* 1909.

Year.	Amount. £	s.	d.	Year.	Amount. £	s.	d.
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	24,136	12	5
1893	16,971	9	2	1907	24,794	7	7
1894	16,732	7	7	1908	20,311	3	0
1895	15,323	1	9	1909	22,804	1	5

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, 1909.

9th May, 1910.

SIR,

WE have the honour to submit the report of the Board for the year ending 31st December, 1909.

Repairs.—The only repairs done have been those made by the Manager and Channel-keepers, and paid for out of the revenue received from the sale of water.

The laying of No. 5 syphon was completed in April, and is working very satisfactorily. No further construction work was done during the year.

Flumings.—There still remain 11 flumings to be replaced by earth and rock cuttings and embankments, and as the money for this work was provided during the last session of Parliament, the Board hopes to be able to put the work in hand very shortly.

Syphons.—The new syphons, Nos. 4 and 5, are giving satisfaction, and it is anticipated that the four syphons still remaining to be done will be put in hand and completed before the end of the current year. When the syphons and flumings are renewed the race will be in thorough repair, and the upkeep will be very considerably reduced, and the revenue to be paid to the Sinking Fund annually will be correspondingly increased.

The revenue amounted to £409 16s. 8d., being a decrease of £239 9s. 11d. as compared with the previous year.

Statistics for the year are as follows:—

Average per week of claims supplied, 11.

Greatest number supplied in any one week, 16.

Total number of heads supplied—

Under fixed or cash scale	$185\frac{2}{3}$
Under royalty or credit scale... ...	$2112\frac{1}{2}$
Total	$2298\frac{1}{6}$

Tin ore raised for the year:—Royalty scale, 16 tons 15 cwt. 1 qr. 7 lb.; fixed scale, 3 tons 4 cwt. 2 lb.; total, 19 tons 19 cwt. 3 qr. 7 lb.

Average number of men employed per week, 19.

Total receipts for the year:—Water sold, fixed scale, £60 14s. 9d.; water sold, royalty scale, £349 1s. 11d.; other receipts, nil; total, £409 16s. 8d.

Expenditure.—Cost of maintenance and management:—

	£ s. d.	£ s. d.
Salary and wages	489 4 0	
Repairs to race	24 16 0	
Repairs to syphon-pipes ...	12 0 0	
Repairs to flumings	21 19 2	
Travelling expenses	36 1 0	
Stores and tools	1 13 2	
Stationery and printing ...	4 7 8	
Insurance	3 6 0	
		593 7 0
No. 5 syphon (7 Edw. VII. No. 31) ...		3372 8 11
		£3965 15 11

Moiety of rents of mineral land served by the race paid to Public Debts Sinking Fund for the year ending 30th June, 1909, £22.

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

MINE MANAGERS' EXAMINATION.

MARCH, 1909.

SUBJECT—MINING.

1. Give various dimensions of a shaft to contain 14-inch single Cornish pump, two cage compartments, and ladderway with sketch of timbering you would recommend.
2. Give a description of the pit-work of a Cornish pump for sinking to a depth of 700 feet, the maximum flow of water being estimated at 17,000 gals. per hour. Give sketches of details and your reasons for adopting any particular design.
3. A quartz lode dip about 80° varies from 6 inches to 3 feet wide in easy working but fair standing ground. At what distances would you place levels apart, and what system of stoping would you adopt?
4. Describe and give sketch of what you consider the best cage-bearers for use underground at the plats and at ore-landing at surface.
5. A large lenticular ore body has to be stoped; timber is required. Describe what system or systems you would use.
6. Give a sketch of self-dumping skip, and of all safety appliances you would attach to it if used for raising men from a mine.
7. What are the requirements of a suitable machine drill for stoping? Describe the latest forms.
8. A large rectangular shaft has to be sunk through drift containing much water. How would you proceed?
9. In question 8, what description of pumps would you employ, and how would you arrange them?
10. In working an open cut, under what conditions would you use machine drills? What alternative methods for boring holes might you adopt? Describe the tools in each case.
11. Make a detailed sketch of hydraulic nozzle for working with a pressure of 400 or 500 feet, and discharging from 10 to 30 sluice-heads.
12. Make a sketch of a steel poppet-heads for a shaft through which 500 to 600 tons have to be wound in eight hours, giving approximate dimensions where you can.

SUBJECT—ORE-DRESSING AND SAMPLING.

1. Give a full description of a small cyanide plant for the treatment of 40 tons per day of sand from a battery—time of treatment, 60 hours.
2. What samples would you take in a gold mill to determine your extraction results, with a view to bettering the same?
3. Describe in detail a silver-lead concentrating plant you have seen, and point out how you consider same could be improved and the financial result of such alterations.

4. Describe the different kinds of jigs, and explain the theory of concentration by them.
5. Give a history of the evolution of the table of the Wilfley type, illustrated by sketches.
6. A tin lode, varying in width from a few inches to 3 feet, has been developed by about 3000 feet of adits connected by rises. The bulk of the lode appears to be nearly barren, but it contains occasional rich bunches of ore. How would you arrive at its average value?

Subject—Surface Work.

1. Work out the brake horse-power you would expect to obtain from a two-crank double-acting compound surface-condensing steam engine, having cylinders $13\frac{1}{2}$ and 27 inches in diameter, by 15 inches stroke, making 250 revolutions per minute, supplied with steam at a pressure of 100 lbs. by the gauge, and cutting off at $\frac{3}{4}$-stroke.
2. What weight of steam should the abovementioned engine consume per hour under the conditions stated?
3. What size Lancashire boiler would be necessary to supply the abovementioned engine?
4. How much cooling surface would be necessary in the condenser if the water-supply is at 60 degrees Fah.?
5. Calculate the amount of circulating water that would be required per hour, supposing the steam to enter condenser at 3 lbs. absolute, and be condensed to water at 120 degrees Fah.; circulating water to enter at 60 and discharge at 100 degrees Fah.
6. Give sketch designs of a self-acting tram to take 2 tons per trip on a grade of 1 in 10, length 500 yards. Assuming your own coefficients of friction, shew that the tram will act.
7. Give sketches of the various kinds of points and crossings used for mining tram-lines; also a crossing for a three-rail self-acting tram.
8. How would you arrange to stack tailings from a mill on a flat site?
9. What do you understand by the terms velocity head, entry head, and friction head, and shew how to calculate each in a water-main?
10. How would you calculate the loss of head in a compressed air-main of considerable length?

Subjects—Arithmetic, Mensuration, and Mining Accounts.

1. Simplify—

$$\frac{\frac{1}{23} \text{ of } 6\frac{13}{17} \text{ of } 24\frac{11}{13} - 4\frac{13}{18} \times 3\frac{33}{34} \div 3\frac{37}{96}}{8\frac{17}{19} \times 5\frac{14}{39} \div 4\frac{15}{32} - 7\frac{19}{20} \times 5\frac{11}{65} \div 14\frac{21}{25}} \times 4\frac{8}{23}$$

2. Find the circumference of a wheel whose diameter is 4 feet 8 inches. How many times will it turn round in $10\frac{1}{2}$ miles?
3. A dividend of 1s. 3d. per share in a company of 37,750 shares is declared. What is the amount to be divided?
4. Find the cost of painting a surface (1) 19 feet 6 inches by 83 feet 4 inches, at 1s. 6d. a square foot; (2) 25 feet 8 inches long and 16 feet 9 inches wide, at 2s. $10\frac{1}{2}$d. a square yard.

5. Find the cost of making a road 110 yards in length and 18 feet wide, the soil being first excavated to the depth of 1 foot at a cost of 1s. per cubic yard, rubble being then laid 8 inches deep at 1s. per cubic yard, and gravel placed on the top 9 inches thick at 2s. 6d. per cubic yard.
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 the terms sill, dyke, fault, unconformity, cementation, metamorphism, metasomatism.
2. Describe the saddle-reef formations of Bendigo.
3. Describe the faulting of some vein with which you are familiar, and all the observations and calculations you would make in such a case to pick up the continuation of the vein.
4. What do you consider the most probable theory of the origin of metallic veins? Apply it to explain the deposition of quartz and metallic sulphides.
5. Account for the occurrence of gossan, and generally describe the changes an auriferous copper ore has undergone in its formation, shewing the redistribution of values.
6. A wide lode of copper pyrites with considerable underlie has been much broken by faulting. The undisturbed portions of the lode have been proved unpayable. Would you still continue the search; if so, where and why?
7. Describe the chief ores of lead, and give some of its modes of occurrence.

Subject—Mining Surveying.

1. How would you proceed to chain a line on a steep hillside, only moderate accuracy being required?
2. Describe the operation of carrying levels down a shaft to a distant face, and give field notes.
3. Give a vertical section shewing the construction of the theodolite below the horizontal bubbles.
4. Explain the construction of the Vernier Construct one to read to the $\frac{1}{100}$th part of an inch
5. Is there any reason (1) for choosing good sites for doing the adjustments of collination and horizontality of axis; (2) for the order in which the adjustments are done? Describe both adjustments carefully
6. Give field notes of survey of an irregular dam-site of six sides, shewing all important features.
7. Find the area of an assumed seven-sided irregular figure.
8. Describe carefully how you would proceed to compute the volume of ore extracted from a large quarry.

SUBJECT—MINING LAW.

1. What quantity of gunpowder and what quantity of high explosive may be taken into a mine in each case or canister?
2. What places of refuge are required to be provided when sinking a shaft or putting up a rise in rock formation where blasting operations are necessary?
3. How are cages used for raising or lowering men required to be equipped?
4. How are cages required to be tested?
5. How often are steam boilers required to be (1) cleaned, and (2) examined and tested?
6. How often is a mine manager required to examine the state of all ropes, safety appliances, or gear connected with the cages or shafts of a mine?

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	Buffon, 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	Birrell, Samuel	23 Apr. 1906
36. 1906	Barker, George	24 July, 1906
37. 1907	Wisch, John G. A.	6 Nov. 1907

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 Pherson	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
29. 1902	Bird, Robert Chisholm	22 Apr. 1902	Second class
30. 1902	Briggs, William Albert John	2. Apr. 1902	Second class
31. 1902	Bartlett, William Henry	22 Apr. 1902	Second class
32. 1902	Phœnix, 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 Fitzarthur	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

CERTIFICATES of Competency—continued.

No. of Certificate.	Name.	Date of Certificate.	Class of Certificate.
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 Abraham	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
62. 1909	Watt, William Shand	20 Apr. 1909	First class
63. 1909	M'Intyre, William Keverall	20 Apr. 1909	First class,
64. 1909	Bruschle, Conrad C.	8 May,1909	Second class
65. 1909	Reid, William Daniel	30 June,1909	First class
66. 1909	Brook, Reginald H. T.	5 Aug.,1909	First class

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

GEOLOGICAL SURVEY OF TASMANIA.

REPORT OF THE GOVERNMENT GEOLOGIST.

Geological Survey Office,
Launceston, 23rd March, 1910.

SIR,

I HAVE the honour to submit my report for the year ending 31st December, 1909.

During the year I have made the following examinations:—

1. The country between Tyenna and the Gordon River.
2. The coalfield at Bona Vista, near Avoca.
3. Some gold quartz reefs near Gladstone.
4. The Zeehan mineral field (in conjunction with the Assistant Government Geologist).

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

1. Completion of Bulletin No. 6 on the Tinfield of North Dundas.
2. Exploration of the Loddon River Valley, Calder's Pass, and the Jane River Basin.
3. Examination of the Zeehan Field (in conjunction with myself).

Mr. Ward's annual report is attached hereto.

The following bulletins have been published during the year:—

No. 5. Gunn's Plains, Alma, and other Mining Fields, North-West Coast, by W. H. Twelvetrees.
No. 6. The Tinfield of North Dundas, by L. Keith Ward.
No. 7. Geological Examination of the Zeehan Field, by W. H. Twelvetrees and L. Keith Ward.

Western Exploration.

The geological exploration of the western country began in 1908 under the parliamentary vote was continued last year through the months of February and March. I proceeded from Tyenna round the south of Mt. Mueller, across the head of the Florentine River, north of Mt. Wedge, through McPartland's Pass and the Hermit Valley, finishing at a point on the Gordon River a little above the mouth of the Serpentine River, and 52 miles from the Tyenna post-office. I left Glenora with my exploring party on the 30th January, and returned there on the 2nd April.

Mr. L. K. Ward took a party from Gormanston across the Franklin River to the northern extremity of the Prince of Wales Range, and down the Jane River as far as the mouth of the Acheron. He left Gormanston on the 18th February, and returned to Launceston on the 17th April.

Our full reports on the country examined, together with topographical and geological maps, were published in the report of the Department of Lands and Surveys for 1908-9.

Without recapitulating the details furnished in these, I may be permitted to invite your attention to such matters as more particularly concern the Department of Mines. Mr. Ward deals with the particulars relating to his journey down the Jane; my remarks cover my own journey to the Gordon.

Speaking in a general sense, the results obtained on the traverse of the previous year repeated themselves. After travelling a certain distance west—to be precise, at 28¼ miles from the end of the Tyenna-road—the Palæozoic strata are left behind, and the Pre-Cambrian schists on which the former were laid down begin to appear. The button-grass country begins here and the wild and desolate quartzitic schist ranges which intersect the country continued to the end of my traverse, and from there could be seen further west as far as the eye could reach. The Archaean fundamental complex is absent; all these schists are Algonkian, and are dominantly altered sandstones. The more argillaceous varieties seem to have been converted to sericite schists of a greenish tint. Their material must have been derived from still older rock-masses, of which no exposures have been recognised in Tasmania, though from indications there is reason to believe that they exist. At any rate, it is probable that the greater part of the continent, the wearing down of which furnished the material, now lies buried beneath the floor of the Southern Ocean.

The schist-ranges have a dominant north and south trend, and the planes of foliation dip generally to the west. In places, however, connecting east and west ridges exist, which cause irregularity of outline and produce a confused network of mountain ranges.

The line of the old Gordon track, now restaked, enters McPartland's Pass at 31 miles from the end of the Tyenna-road, at a height of about 1250 feet above sea-level. This pass is about a mile long, and is a narrow gap between bold mountains of sericitic and quartzitic schist. It is slightly sinuous, but its mean direction is westerly, and at its west end it opens into the Hermit Valley. This is a long swampy plain intersected by creeks and covered with button-grass. On all sides are craggy schist mountains. McPartland's Pass is a divide separating the tributaries of the Wedge River from those of the Serpentine. From the Hermit Valley one descends westward into the broad marshy plain through which the River Serpentine meanders in its course from Lake Pedder. On its western side is the majestic schist wall of the Frankland Range. From here I struck north to the Gordon, through button-grass valleys flanked by schist hills, and reached the river at about 900 feet above sea-level. A narrow fringe of gum and manuka forms the river bank. The stream is about 170 feet wide. There is a ford 3 chains below where the track joins the river, but I found the river swollen after rains and not fordable.

From the prospector's point of view, this monotonous schist country is very unpromising. The only spot where I saw any mineral in it was about a mile east of McPartland's Pass. Some soft greenish sericitic schist is exposed along the track near the 30-mile. It contains a few veinlets of quartz carrying scattered crystals of pyrite. No formation is present, and the occurrence does not seem to be connected with anything which suggests an ore deposit. South of this, in McPartland's Plain, is some slate or argillaceous schist, which has been examined fruitlessly.

Between the 40- and the 41-mile peg on the track north to the Gordon, after leaving a belt of timber, the open country is entered by a sideling above a low flood-plain on the east. The sideling cuts through a soft formation of brownish oxidised schist, which possibly might be worth trenching upon, but I could see no mineral in it.

A piece of actinolitic schist was collected by Mr. R. Marriott, Jun., on his track south of the Gordon, west of the Wedge River.

Unless some exposure of igneous rock or mineralised formation or mineral veins can be found in this schist area, I must regard the outlook as not at all encouraging. Along the line of route certainly there is not much chance of anything being found. It is possible, however, that search in the unexplored localities may result in the discovery of granitoid exposures or veins which might put a better complexion on affairs.

Very little is known of the country west of the Wilmot and Frankland Ranges. Granite, however, has been reported from the Wanderer River, quartz tourmaline from near Moore's Look-out, and copper ore from the coast-line. There would seem, therefore, to be indications of mineral in that part of the country needing to be followed up. The best way of approaching the district would be from the Gordon or from Birch's Inlet at the south end of Macquarie Harbour. T. B. Moore's old track goes through the country, but no exploration has been carried out, and that part of the island may be said to remain as hitherto, *terra incognita*. This area includes the southern prolongation of the Lyell metalliferous zone, and its exploration may be considered as urgent.

So far, my remarks have had reference to the Pre-Cambrian schist area. East, however, of the 28¼-mile my expedition passed through country composed of Palæozoic strata. Between Tyenna and the south end of Mt. Mueller the lower Permo-Carboniferous grits and conglomerates prevail. The mudstone or argillaceous conglomerate contains pebbles of quartzite, sandstone, schist, and hornblendic quartz porphyry. This porphyry belongs to the porphyroid and porphyrite series of Dundas and the north-west, and stones of it are very common in the Permo-Carboniferous conglomerate of the south and centre of the island. They are released from this conglomerate by denudation, and are met with in the river shingle of the Gordon and the tributaries of the Derwent. Their presence has given rise to abortive gold-mining under a misconception of their origin and significance.

We found that Mt Mueller, Mt. Anne, and Mt. Wedge are capped with crowns of columnar diabase. On Mt. Mueller this rock is flanked by Permo-Carboniferous strata; at Mt. Anne it apparently rests on Cambrian quartzite; and at Mt. Wedge probably the same, but the sides of the latter mountain are so thickly clothed with timber that the formations are difficult to delimit. The general level at which the diabase appears suggests its former existence as a continuous sill.

West of the west fork of the Upper Styx the track passes through a plain of sandy soil carrying numerous large boulders (rounded and angular) of sandstone, diabase, and silicified conglomerate. They are scattered irregularly over the surface, and their distribution has no apparent connection with any existing drainage channels. They are probably moraine material of a Pleistocene glacier which descended from the western or south-western face of Mt. Mueller.

In the same plane boulders of limonite are abundant. About 150 feet north of the track is a trench which was opened by the Great Western Railway Company for a length of 40 feet and to a depth of 6 feet, showing concretionary limonite in yellow sand. The iron ore exposed is not very pure. South-west of the track at this point a knoll of limonite boulders is seen, and this has rather the appearance of a lode outcrop, but when carefully examined it is observed to contain patches of sand and soft sandstone. Near the knoll are water-worn boulders of similar sandstone. The ore is doubtless bog-iron ore deposited in this old lake basin, the waters of which drained into the valley of the Upper Weld. Further west in the myrtle forest the Great Western Railway Company's prospecting party also drove an adit south-east from the pack-track for about a chain across ferruginous chocolate-coloured slate with a view of coming underneath gossanous boulders strewn over the surface. I think that most of the iron blows in this part of the country are not indications of lodes, but are merely deposits of lake iron ore.

At the creek beyond this adit the track enters upon limestone country, and the latter continues for a couple of miles until button-grass land is reached, when a white crystalline sandstone is met with, again changing to limestone as the junction with the Port Davey track is approached. Beyond this Cambrian conglomerate and quartzite continue across the Upper Florentine and along the northern base of Mt. Wedge, till the Pre-Cambrian schist area is reached.

Along the whole of this traverse there were only two points where I saw igneous rocks at all capable of being related to possible ore deposits.

At the Fourteen-mile Creek, by proceeding across country to the south of the track for about 4 miles, an exposure of serpentine may be seen in the Styx River. The ranges between the track and the river are composed of conglomerate, which seems to be of Permo-Carboniferous age. The Styx flows east over the serpentine rock, which rises into low cliffs on the river bank. This rock was discovered here by the Clark Bros. nearly three years ago. On the south side of the river the serpentine extends to the Jubilee Range, which forms the divide between the Styx and Weld Rivers.

The rock is dense, light-green in colour, and contains disseminated grains of chromite. It is entirely serpentinised.

We know that serpentine is very generally associated with granite in Tasmania, and hence its occurrence in the Styx explains the reports of granite having been found in the same river. Loose boulders of the latter rock have been recognised in the stream, but there was always the possibility that these had been derived from the disintegration of the Permo-Carboniferous conglomerate, which certainly contains stones of granite.

It follows that some granite was exposed already during the Permo-Carboniferous period, and we may expect to see this rock in many places where the sediments of that period have been removed by denudation.

The gabbro-granite rocks in Tasmania are genetically associated with ore deposits, and we may legitimately search for metalliferous veins in strata that may have been intruded by these eruptives. The older strata (Cambrian ?) in this part of the island will doubtless be found to enclose such veins. This assumption is supported by the known existence of lead and copper ore lodes at the base of the Needles (Humboldt Mine) and the prospects of gold which are yielded by creeks in this district. Supposing that we could remove the Permo-Carboniferous conglomerate covering, the underlying strata would come to view, and we should probably see them traversed here and there by gold-quartz reefs.

Another occurrence of serpentine was met with on the track a mile beyond the Florentine River, at the edge of the great myrtle forest of the Sawback Range. On the south side of the path boulders are seen partly buried in the surface soil. The rock is dark-green in colour, and has an imperfect schistosity due to the gliding planes common in serpentine. Grains of chromite are disseminated through its mass. It forms a belt of unknown size, bearing apparently in the direction of Clear Hill. Here again it is probable that mineral lodes exist somewhere in the neighbourhood. At this point there is no Permo-Carboniferous conglomerate to obstruct the prospector, but the timber is heavy, and until it is cleared off prospecting is almost impossible. A galena lode somewhere under Mt. Wedge is said to have been discovered by the track-cutters when the track was first made to the Gordon, and this is just what might be expected.

The Messrs. Clark informed me that they know of serpentine north of the Gordon on the east bank of the Boyes River, north of Clear Hill. That, too, is a place which requires prospecting.

Apart from these possibilities, I am afraid that there is not much likelihood of any other than sporadic occurrences of ore being found in the country traversed by the Gordon track. At the same time, the country still farther west, viz., beyond the Wilmot and Franklin Ranges, as well as that along the track to Port Davey, remains unexamined, and cannot be condemned beforehand.

Bona Vista Coal Seams.

The extension of coal seams nearer to Conara than those now being worked along the Fingal railway-line has long been anticipated. Discoveries in the St. Paul's Valley and at Rex Hill have shown that the Upper Coal Measures continue to flank the diabase-crowned ranges in the neighbourhood of Avoca. The most recent discovery is that on the Bona Vista estate, of the late Mr. J. F. Rigney, at Avoca; and I paid a visit to it in June last.

The plain of the South Esk rises north of the river gently towards the hill range, which runs parallel with the Fingal railway-line. From below the alluvial drift and Tertiary basalt which border the river, the sandstones and shales of the Upper Coal Measures emerge and clothe the base slopes of the hill, until they junction with the Mesozoic diabase. These strata flank the hill ridge all round, and it is in these beds on the north side of the range that a strong seam of good coal has been located, about 4½ miles from Avoca railway-station. An adit has been driven on the seam in a south-easterly direction for a length of 40 feet. The seam is 10 feet

6 inches in thickness, and dips towards the south-east at an angle of 5 degrees. It contains one main band of about 6 inches. It is about 450 feet above the railway-line.

Although the seam belongs to the Jurassic system, its quality by analysis is excellent. The assay* shows—

Fixed carbon	62·00 per cent.
Volatile matter	24·00 per cent.
Ash	12·00 per cent.
Moisture	2·00 per cent.
	100·00

Sulphur, ·00127 per cent.

* By Mr. T. Boyd, Beaconsfield

The ash is a light white one, and the coal is said not to fly or clinker. In calorific power it shows 12,062 B.T.U. Mr. Hyman Herman, of Melbourne, who is the consulting engineer to the syndicate, estimates that there is coal for 30 years' work on an output of 50,000 tons of coal per annum.

The Goldfields Diamond-drilling Company put down three exploratory bores on the southern side of the range, with the view of ascertaining whether any seams came through to the south, and could be worked much nearer to the Hanleth or Eastbourne railway-station than the outcrop on the other side of the hill. A point on which information is desirable is whether the eruptive rock of the hill is a laccolitic mass forming the core of the mountain, or only a sill below which the coal measures pass without any interruption of continuity. The first bore was tentative in this direction, being put down in diabase to a depth of 100 feet, but was still in the same rock when it was stopped. The second bore was put down in coal measure sandstone for 300 feet, and passed through several small seams of coal of varying thickness, and finished in sandstone. The third bore, still nearer to the railway, was put down in sandstone for 500 feet, and at that depth passed through 4 feet of coal of good quality. These bores are about 1½ mile from the main adit.

Instead of beginning operations on this plain, the owners have traced the seam round the flank of the hill, and started another adit (No. 2) about a quarter of a mile to the north. This has been driven for 40 feet, and shows 10 feet of coal. It is the intention of the owners to connect the mine by putting in a rail on the Government gauge from Hanleth, so that trucks may be loaded direct from the screens without a second handling. The owners report that the coal has been tested on the turbine steamer "Loongana," on the steamship "Togo," on numerous stationary engines in Launceston, and on the Government railways, all with satisfactory results.

Gold-mining at Gladstone.

During the year I paid a visit to two points near the Gladstone township, where operations were proceeding. These were, (1) a reef explored by the Dreadnought Gold Mining Syndicate; (2) some reefs being prospected by the Gladstone Gold Prospecting Association. The Dreadnought reef runs east and west, and appears to be a parallel one with the Royal Tasman reef. The Gladstone P.A. reefs run north-west, east, and north-east, and have been sunk upon by two shafts.

Free gold occurs in these reefs, and they seem worth proving in depth. They are not far from the granite-slate contact, and may possibly prove to be slightly stanniferous.

The Zeehan Field.

I spent three months in the spring with the Assistant Geologist on the Zeehan field, in pursuance of your instructions requesting us to enquire into the occurrences of ore there and all facts bearing on the permanence of the mineral field. The summarised results of our investigations have been published as a preliminary statement in Bulletin No. 7. They are, in a measure, reassuring, and do not lend support to the pessimistic views entertained by the directors of some English companies operating in Zeehan.

Geological Survey Collections.

I have the pleasure of acknowledging the service which you have been able to render to the survey by making an arrangement with the trustees of the Victoria Museum for using one of the galleries of the enlarged building for the display of our collections of minerals and rocks. Collections of economic ores and their associated vein types and country rocks will now be displayed in a manner which will adequately represent our resources. Systematic collections of Tasmanian rocks will also be exhibited, and likewise a systematic collection of minerals, home and foreign. Structural geology will be illustrated, and the museum exhibits made as educational as possible. Type fossils referred to in the survey publications will be lodged here, where they will be cared for and be permanently safe. The managers of Tasmanian mining companies are invited to aid in the formation of permanent exhibits by sending in representative block samples of their ores and lode stuff, which, if addressed to the Victoria Museum, Launceston, will travel free on the Government railways. The management of the Oonah Company is specially thanked for the fine samples of stannite ore kindly presented. The existing collections have been transported to the museum, and we have already made a start with their arrangement. I beg to acknowledge, with thanks, the facilities offered by the City Council and the enthusiastic and valuable assistance given by Mr. H. H. Scott, the Curator of the museum.

By direction of the Hon. the Premier, a collection of minerals and rocks was prepared for a visiting scientist from Italy, the Rev. Dr. Capra. In addition, some requests for specimens were received during the year from officers of other State surveys and private individuals. In some cases the distance from sources of supply makes it difficult always to respond to the demands as fully as could be wished; but recognising the supply of educational material as a proper function of the survey, we are now taking every opportunity on our journeys of collecting and bringing home for future use. State schools here have not, as in England, began to ask for collections of Tasmanian ores and rocks, but the time will soon arrive, and it will be as well to be ready for the demand.

Office.

The correspondence during the year comprised 2937 letters, reports, &c., in and out. The office library has been added to by publications received from the Surveys and Mines Departments of other States and countries, and our bulletins have been forwarded in return.

At the beginning of April Mr. F. S. Grove, having completed the construction work on the Mt. Cameron Water-race, returned to the office, relieving Mr. W. D. Reid, who retired from the service.

The necessity of further office room has been still further accentuated, and I am looking forward to the autumn, when the two additional rooms promised by the Hon. the Minister last year may become available through the removal of the Technical School to its new building near the museum. The office at present is too crowded with material to be kept in proper order.

After the three field journeys standing next on the programme, an effort will be made to make a start with the new geological map of the island. The drafting work necessary for this, in addition to current drafting, will, however, probably overtax our office resources unless some of the improved methods of reducing hand-drafting to a minimum be adopted.

Field Work.

The order of the field work of the survey, though laid down in a definitely fixed programme, has been somewhat interrupted this year by the special investigations of the Zeehan field. The results of the examination will nevertheless, it is believed, be found to justify the departure from the programme.

From the date of his appointment the Assistant Government Geologist has been continually at work carrying out a considered scheme of field work, by means of which all the mineral districts of the western part of the island will be successively surveyed, their geologic structure elucidated, and their economic resources ascertained and described. His informative bulletins on the Mt. Farrell and North Dundas fields are illustrations of the type of publication by which it is intended to make known to the public the results of the work.

I have reserved for myself areas in the other parts of the island, in which examinations may be necessary. These are not so continuous as the mineral-bearing parts of the West Coast, and form on the whole distinctly separate fields. Consequently, a continuous survey is not at present practicable, and examinations have to be taken as the occasion for each arises.

The next piece of work on which the Assistant Geologist will be engaged will be a survey of the Mt. Balfour field, which is one of urgency, but which can be made to fit very well into the West Coast programme already long settled. On its completion he will examine the country between Zeehan and the Pieman, through which the inhabitants of Zeehan have applied for the construction of a line of railway to connect with Balfour.

My next journey was to have been to the Mt. Claude, Middlesex, and Dove River districts, where there has been a renewal of prospecting recently, and which are admittedly imperfectly developed mineral fields; but since the close of the year it has become apparent that the season will have advanced too far before I shall be ready to leave office. The Scamander journey standing next on the list, will probably be taken first.

Publications.

That the new series of bulletins meets a public want is evidenced by the numerous applications for them, both at home and abroad. It is desired to still further improve their style, principally in the direction of maps and illustrations, but the extent to which we shall be able to accomplish our wishes must necessarily depend upon the funds available. Our small working staff, too, limits very seriously the amount of work which we can turn out.

In preparing the bulletins the idea of making them of permanent value is adhered to. To carry out this purpose it is essential to deal with economic work and facts from the scientific side. Those who are imperfectly acquainted with the modern advances made in the study of ore deposits may labour under the mistaken idea that the scientific treatment of the subject must necessarily be solely academic. The ultimate economic value of such treatment is, however, now thoroughly established. In the early days of mining in this island, prospectors and company promoters were content with cursory geological visits, and the geologist was more or less a peripatetic mining reporter, whose duty it was to respond to the needs of the moment. But a great improvement in general knowledge has since taken place; mine managers and engineers ask for a close study of the geologic problems of both the districts and the mines, and are ready to apply the information when they receive it. They are entitled to require that their demand be satisfied, and to hear the last word which geological science has to say concerning the particular problems in which they are interested Much that is contained in such bulletins may not interest all alike; some of it may even be unintelligible to a few; nevertheless, the ever-growing demand justifies it, and it will doubtless be of permanent economic value. In the future, regardless of whatever mining sections may be under development at the time, new explorers will find the careful study of our bulletins an indispensable preliminary to their operations.

Notwithstanding what has been said above, the publications are prepared so that they also contain in plain language statements of directly economic facts, and descriptions of mining properties are furnished for the information of the general public. This distribution of useful knowledge is regarded as an important function of the survey.

Conclusion.

That this branch of your Department is becoming more firmly rooted, and is pursuing a career of usefulness to State and public alike, is convincingly proved by the growing demand for our publications and by the increasing applications to the geologists for advice and information. All such applications are readily attended to, and applicants are made to feel that they are entitled to the information which is at our disposal. The past year has been a busy one in this respect.

I have, &c.,

W. H. TWELVETREES, Government Geologist.

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

REPORT OF THE ASSISTANT GOVERNMENT GEOLOGIST.

Launceston, 23rd March, 1910.

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, 1909:—

At the beginning of the year I was engaged upon the preparation of the report on the tinfield of North Dundas, and the several plans and sections connected with that report, which has been published as Bulletin No. 6 of the Geological Survey of Tasmania. This work was completed on 12th February.

Thereupon I proceeded to the West Coast to continue the geological exploration of the country in the neighbourhood of the proposed Great Western Railway. The area which was examined lies between the Linda track and the junction of the Jane and Franklin Rivers.

From the date of my return to Launceston, 17th April, until 19th June, I was engaged upon the report and plans dealing with the observations made during this expedition. The report and maps have been published in the report of the Department of Lands and Surveys for 1908-9.

Thereafter, until 5th August, I was occupied with various duties in the office of the geological survey, connected principally with the cataloguing and arrangement of accumulated collections.

On 5th August I left Launceston for Zeehan with the Government Geologist, in order to undertake with him a joint examination of that mining field, with special reference to the possibilities of the continuation in depth of the argentiferous galena lodes. This examination, which included a brief investigation of the ore bodies in the neighbouring districts of Comstock and Heemskirk, occupied a period of three months. A preliminary report on the results of our observations was prepared on the field, and forwarded to you before our departure.

Leaving Zeehan on 8th November I proceeded to Mt. Farrell, in order to make a geological examination of the southern part of that field, where an important discovery of silver-lead ore had been made since my survey in 1907. A report on my observations has been forwarded to you.

After leaving Mt. Farrell I returned to Launceston on 16th November, and have been since then engaged upon the preparation of the report on the Zeehan field. In addition to this work, the task of assisting in setting out the State collections of minerals and rocks in the Victoria Museum has occupied part of my time.

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

Geological Exploration of the Country in the Neighbourhood of the Great Western Railway Route.

The continuation of the work of geological exploration in the western portion of Tasmania has resulted in the collection of a fund of information concerning a hitherto quite unknown part of the island.

The work carried out by me during 1909 was a continuous extension of that upon which I was engaged during the previous summer, and thus some geological knowledge has been gained of a strip of country extending from Gormanston to the foot of the Prince of Wales Range. From there, the information gathered by Mr. W. H. Twelvetrees in 1908 with regard to the country lying to the eastward carries the strip of country which has been geologically examined as far as Tyenna.

The expedition entrusted to my charge moved southwards from a point near the confluence of the Surprise and Franklin Rivers, at the foot of Mt. Arrowsmith, towards the Gordon River. A geological examination of the country traversed was made as we moved southwards, and at the same time the systematic prospecting of the area was carried out in such detail as was possible.

After many delays, which were caused by the dense character of the vegetation and the flooding of the rivers, we penetrated as far to the southward as the junction of the Jane and Acheron Rivers. The region examined proved to be almost wholly free from any intrusions of igneous rocks, and as a logical consequence there was a marked poverty in metallic minerals. Although our prospecting operations were unsuccessful, the geological observations which were made are of material value, and the expedition cannot be said to have been unfruitful of results.

The greater part of the area traversed was found to be occupied by the Pre-Cambrian schistose sediments. The high ridge between the Loddon and Franklin Rivers is for the most part composed of these quartzitic, micaceous, and argillaceous schists. At one point the schist carries pyrite and graphite, but no mineral of value was detected.

The Loddon River drains an area covered by sandstone, which lies unconformably upon the schistose series. The lower beds of sandstone carry in abundance the tubular casts which are commonly known as pipestems. These markings occur on several horizons, and conformably above them lie beds containing peculiar discoidal impressions.

The sandstone continues to the southward as far as Calder's Pass, and to the eastward as far as our observations extended. On the eastern wall of the entrance to Calder's Pass, which divides the Frenchman's Cap from the high ground to the eastward, a remarkably fine development of the pipestems and discordal impressions was observed. The tubes may there be seen as much as 2 feet in length, traversing the bedding-planes of the sandstone. They give place in the upper beds to the discoidal moulds, which usually conform to the bedding-planes. Unfortunately no trace of organic structure remains in these tubes and discs, and it is impossible to obtain any idea of the nature of the organisms which gave rise to them. We may surmise that the tubular casts represent the dwelling-tubes of some tubicolar annelid, but with regard to the discs no satisfactory explanation can yet be given.

From the fact that discoidal impressions, entirely similar in form but of very much smaller size, are found with the fossiliferous Upper Cambrian beds at Caroline Creek, and since the pipestems occur also in the West Coast Range conglomerate series, which is thought to be of Cambrian age, the sandstone of the Loddon River Valley may provisionally be classed as Cambrian.

The mountain mass known as the Frenchman's Cap and its foothills are all composed of the Pre-Cambrian schists. All varieties of crushed sediments are comprised within the group, from conglomerates of coarse texture to fine-grained shales. These have been rendered schistose by intense crushing, and are affected to different extents in different places.

At one point in Calder's Pass some detached fragments of pegmatitic vein matter were found. These were the only traces of igneous rocks which were encountered, and in consequence it is not a matter for surprise that traces of the valuable metals were not found, for it is found that in Tasmania, as elsewhere, mineralised regions are those in which igneous rocks are represented. During the examination of the Algonkian schists in the basin of the Jane River, observations were made which point to the possibility of a future subdivision of these Pre-Cambrian rocks into two main series, separated by an unconformity. The upper portions of the Surveyors' Range, Algonkian Mountain (at the northern termination of the Prince of Wales Range), the Raglan Range, and the Frenchman's Cap appear to belong to the upper series which is less markedly schistose than the lower, and quartzitic rather than argillaceous or micaceous in composition.

The only other rock which was observed was a limestone, which was never seen out of the actual bed of the Jane River. If this is the Gordon River limestone (of Ordovician age), its distribution can apparently only be accounted for by postulating a re-establishment of the Pre-Ordovician topography at the present day; that is to say, the hills and valleys of Pre-Ordovician time were preserved by the later sedimentation, and have now once more emerged at the end of a long cycle of erosion, during which the less resistant cover has been almost totally removed.

The Zeehan Field.

The examination of the Zeehan field and its immediate surroundings with a view to the report upon the probability or otherwise of the permanence of the silver-lead lodes in depth, has resulted in the accumulation of much valuable information, which possesses both directly and indirectly an economic application.

With regard to the immediate objects of the examination, it was found that:—

(1) The view that the known lodes of argentiferous galena had been worked to points beyond which they could not be expected to be payable, is, on any grounds, untenable.

The forthcoming report will contain a statement of our belief, based on geological evidence, that the lodes are of deep-seated origin, and certainly not surface reconcentrations of the contents of poor primary ore. The payable portions of these lodes are restricted to definite shoots, but the lower limit of the probable occurrence of other galena-bearing shoots has not been approached by the few deep workings on the Zeehan field.

(2) The shoots of ore are, at more than one point, developed at the intersections of fractures with other fractures, or with fault zones of earlier date. The country-rock has no genetic significance whatever, for lodes of the same composition are found in entirely different country rocks, and differences between lodes in the same country-rocks are also often observed.

(3) There is a zonal arrangement of ore bodies of different types about the granite of Mt. Heemskirk. Within the granite boundary the ores are characterised especially by cassiterite, in the contact metamorphic zone by magnetite. Beyond this zone the ore bodies are at first typically pyritic, and carry both lead and zinc, or even in one area tin; and still farther from the granite are the lead lodes marked by a gangue of iron carbonate.

In addition to these conclusions, which are concerned principally with strictly economic problems, the forthcoming report will include a somewhat detailed discussion of—

(1) The physiographical evolution of the field and the relation of the physical features of the Zeehan area to those of neighbouring districts. The crustal movements which have effected the West Coast region have hitherto been recognised, but no quantitative estimate of their magnitude over an extended area has been possible. Now, however, the observations made in and around Zeehan may be considered together with those made in the North Dundas tinfield, and the displacement of the strand line is seen to be such as would result from a simple elevation of like amount over the whole of the two districts. These observations will be of value as the survey of the island proceeds.

(2) The necessity for a subdivision into different groups and even systems of the rocks hitherto known as Silurian. The reclassification of the sedimentary rocks in the light of recently-acquired geological knowledge is inevitable. The Cambro-Ordovician strata, with their associated igneous rocks, and probably also both Cambrian and Ordovician sediments are present in Zeehan.

(3) The spilite, or so-called "melaphyre," of Zeehan, and its probable relationship to the great series of porphyroids and porphyrites of the West Coast region. The petrographic character of the spilite shows unmistakable signs of affinity with the keratophyres in Zeehan, as spilites do elsewhere in different parts of the world.

The South End of the Mt. Farrell Mining Field.

The geological examination of the recent workings at the south end of the Mt. Farrell field revealed a few points of interest, which were not visible when I made a geological survey of the district.

No undoubted signs of the presence of any igneous rocks of Devonian age have yet been seen in the whole of the Mt. Farrell field. But at the northern end of the drive on the lode in the Thomas' Blocks Mine I saw a vein of kaolinised material, which may possibly be an altered pegmatitic vein. The presence of such veins is especially probable at this mine, since there is a notable amount of fluorite in the veinstone.

The recently-discovered lode about 2 miles further south in the Stirling River Valley gives great promise. It is of the pyritic type, and contains galena of good grade, both in the form of clean bands and lenses of first-class ore and also disseminated in coarse grains through a broad lode formation. In structure the lode resembles the ore bodies of the North Mt. Farrell Mine.

The presence of this shoot of ore serves to prove that there is certainly a connection between the mineral-bearing areas of Mt. Farrell and Rosebery. The part of the district in which the new discovery has been made should certainly receive more attention at the hands of prospectors.

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, 10th March, 1910.

SIR,

I HAVE the honour to submit my report on the inspection of mines for the year ending 31st December, 1909. I beg to attach statistical tables and diagram concerning the number and nature of accidents which have occurred in Tasmania in and about the mines and works in connection with mines during the year under review.

I also append 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 employed this year at the different mines and smelting works was 6054. The number of fatal accidents was 6, the same as the previous year; and of non-fatal serious injuries, 49. The death rate from accident was 0·991 per thousand, compared with 0·928 in 1908. For the last three years the number of deaths has remained the same, but owing to the decreasing number of men engaged in mining, the ratio has slightly risen, being for these years 0·798, 0·928, 0·991.

Breakage of Haulage-rope.—I have to report a serious occurrence, which fortunately was not attended with loss of life or injury to any one. At the North Lyell main shaft, in December, one of the haulage-ropes broke off at the shoe while hauling a double-decked cage loaded with two full trucks, which were within 15 feet of the landing-brace when the accident happened.

The rope, 3 inches in circumference, had been in commission for 14 months, and was about to be changed. It had the manufacturer's certificate of not less than 31 tons breaking-strain. The weight of the cage, trucks, load, and wire rope was 3 tons 10 cwt. 3 qr., and this multiplied by 8, the official factor of safety, equals 28 tons 6 cwt. The fractured portions, on being examined by the inspector, showed no sign of previous wear or corrosion. The safety appliances, Miller's side-spring grippers, acted instantaneously, and held the cage until it was released.

Although the winding speed so near the landing place could not have been great, it is gratifying to be able to place on record another instance of the value of safety appliances, which in some quarters are looked upon as unreliable and useless devices.

Visit to the West Coast.—In the spring I had an opportunity of visiting many of the mines in the Western Division, and of conferring with the inspectors on many departmental matters. I returned from my visit impressed with their zeal and carefulness, and with the general efficiency which characterised every department of their work.

Health of Miners.—This is being carefully watched. On the whole the inspectors' reports respecting ventilation and sanitary conditions are satisfactory, and in many particulars a great improvement is noticeable compared with a few years ago.

The Miners' Association at Zeehan has requested the Government to subsidise its sustentation fund for the relief of miners who are incapacitated by lung trouble acquired in pursuing their calling in the mine. I have therefore considered it necessary to pay renewed attention to the question of miners' phthisis, and to the extent to which it exists in Tasmania.

First of all it may be mentioned that in other countries and in neighbouring States the prevalence of this complaint in recent years has aroused attention, and led to the initiation of most elaborate enquiries.

It is an established fact that the mortality rate from lung diseases among quartz miners at Bendigo has been seriously increasing during many years. The death rate from tuberculosis among miners' wives has also increased. In Western Australia unfavourable reports are bringing the subject to the front there also.

A high mortality due to similar causes prevails among miners in the Transvaal, and led to the appointment in 1902 of a Government Commission to enquire into the occurrence and cause of miners' phthisis, and to make recommendations for its prevention.

A report on the health of the miners in Cornwall by Dr. Haldane and Messrs. Martin and Thomas was presented to the Home Secretary, giving mortality statistics up to 1902, which showed an excessive increase in recent years in the death rate from lung diseases.

Although it is difficult to obtain full information respecting occurrences in Tasmania, there can be no reasonable doubt that miners' phthisis has existed here for some years; nevertheless, not to the extent experienced in some of the sister States.

Pulmonary tuberculosis with cavity formation has now been made a notifiable disease, but miners' phthisis is not so, and consequently the Health Department is not in a position to furnish the necessary statistics; but the present Chief Health Officer (Dr. Purdy), who is an authority on the latter disease, and has written on the subject, has promised to do what is possible in the way of collecting information. He has recently investigated the statistics of the disease at Zeehan, and has furnished me with the results, which I reproduce further on in this report. Dr. Ramsay, Surgeon-Superintendent of the Launceston Hospital, has kindly undertaken to assist in further inquiries.

I have endeavoured to ascertain what medical authorities have to say concerning the nature, symptoms, and exciting cause of the disease. Briefly, it appears that during continued daily work in an atmosphere which is heavily charged with stone dust, the minute particles of dust infallibly work their way into the ramifications of the bronchial tubes which traverse the tissue of the lung. The sharp-edged particles injure and penetrate the tube walls; the lung-tissue is eventually replaced by new fibrous tissue; the air-spaces of the lungs diminish in area, and the organs ultimately become useless to the individual, and readily receptive of true tuberculosis disease (pulmonary consumption). The type of disease which results from the inhalation of stone dust is known by the name of silicosis, to distinguish it from allied diseases caused by wool, cotton, metal dust, and the dust of coal mines. The coalminers' lung disease is called anthracosis; that of ironstone miners has received the name of siderosis; and of cotton factory workers, byssinosis. The group name for dust lung disease is pneumokoniosis.

The following quotations will serve to show clearly the nature of the disease:—

(*a*) Dr. Thomas Oliver (in "Dangerous Trades," Chapter XVII., on Dust as a Cause of Occupation Diseases), speaking of inhaled dust, says: "The particles set up irritation in the lung, followed by a very marked increase of its fibro-connective tissue, which encroaches upon the spongy structure of the lung and destroys its aerating function. . . . Hence are explained the difficulty and shortness of breath in people thus affected with what is called fibrosis of the lung. Such, in a few words, is the effect upon the lung caused by inhalation of the dust generated in a dusty occupation. The newly-formed fibro-connective tissue is of low vitality, and is badly supplied with blood-vessels, and yet it goes on increasing and encroaching more and more upon the lung tissue, which it replaces. Although it seldom tends to break down, the consolidated tissue notwithstanding shrinks, the chest becomes smaller, cough more harassing, and emaciation progressive. The affected workman is regarded as the victim of consumption, but the disease is not necessarily tuberculous. Under these circumstances, when a lung has become altered in structure, and its vital resistance diminished, it becomes an easy matter for true tuberculosis, as the result of its specific bacillus, to be grafted on to a pneumokoniosis or dust lung disease."

(*b*) Dr. Haldane, in his report to the Home Secretary on the health of Cornish miners, says: "Cases of lung disease among machine-drill men are usually far more rapid and acute than among ordinary miners. Shortness of breath and wasting seem to be usually the first symptoms. Definite signs of consolidation in the lungs are often absent until the disease is well advanced, and a doctor unfamiliar with miners' phthisis would probably fail to recognise the gravity of such cases. . . . . Up to the end the most marked and distressing symptom is the shortness of breath; and cases of phthisis in rock-drill men can often be at once distinguished by the prominence of this symptom. . . . So far as the Cornish miners are concerned, it seems evident enough that the stone dust which they inhale produces permanent injury of the lungs—gradually in the case of ordinary miners, and rapidly in the case of machine-drill men—and that this injury, while it is apparently capable of producing by itself great impairment of the respiratory functions and indirectly of the general health, also predisposes enormously to tuberculosis of the lungs, so that a large proportion of miners die from tubercular phthisis. That the primary injury to the lungs is due solely to inhalation of stone dust would seem to be practically certain."

(*c*) Dr. Walter Summons, in his report of an investigation at Bendigo into miners' phthisis (Melbourne, 1906), states

(p. 60):—"Silica dust is therefore to be considered the cause of non-tuberculous miners' phthisis. It is constantly found in their lung tissue enveloped by fresh fibrous tissue formed in consequence of its presence; and even after many years presents the same appearance as when it was inhaled. On incineration it was regained from the lungs, and by chemical analysis shown to be of the same nature as the country-rock of the Bendigo mines. Without the dust no lung disease is prevalent, hence it, and it alone, is the sole cause of miners' phthisis (non-tuberculous), and it can safely be asserted that with the absolute prevention of dust the lung disease would almost cease to exist. . . . It is a disease of purely local origin, and continues as such till tuberculosis, with its specific bacillus, is superadded."

(*d*) The report of the special committee of the Transvaal Medical Society on miners' phthisis is to the effect that the disease is primarily due to the inhalation of silicious dust. Its usual symptoms are stated to be, first recurrent bronchial colds, and subsequently shortness of breath, cough, and spit. Gradually this stage is followed by one of more urgent breathlessness, and towards the end the patient loses strength rapidly. This committee stated that the typical signs of tubercular phthisis are commonly absent.

The following information relating to lung trouble among miners in Tasmania has been collected from reports furnished to me. It must be borne in mind that any irritating gas, if inhaled for a sufficient length of time, tends to produce bronchial catarrh and broncho-pneumonia, and so far the statistician in Tasmania cannot separate cases of disease caused by irritant gas and those due to the inhalation of dust, as particulars are not procurable:—

Zeehan District.

1. Ill for two years before succumbing to miners' phthisis. Worked with rock-drills.
2. Died from pneumonia after a short illness.
3. Died from pneumonia after a short illness.
4. Died from pneumonia after a short illness.
5. After many years' mining, incapacitated, and receiving relief.
6. After 20 years' work incapacitated by miners' phthisis. Has been assisted from miners' sustentation fund.
7. Incapacitated by pulmonary trouble after mining over 30 years. Has been assisted from sustentation fund.
8. Incapacitated by lung trouble after mining and smelting work. Will come on fund if he does not recover.
9. Suffers from lung-irritation and cough, after mining discontinuously for 23 years.

Dr. J. S. Purdy, Chief Health Officer, has kindly supplied me with the following information bearing upon the Zeehan statistics:—

"Pneumokoniosis.

"During my recent visit to Zeehan I investigated the records of the registrar as to the incidence of pulmonary diseases among miners, as indicated by the death returns.

"For the period of 10 years—1st January, 1899, to 1st January, 1910, eleven miners died of phthisis in the Zeehan district. Eight of these were over 40 years of age, and six came from outside Tasmania, of whom four were from Cornwall, England, one from America, and one from Moonta, South Australia. The other two came from Kingborough and Bothwell.

"The other three, aged respectively 19, 20, and 25, came from Beaconsfield, Bothwell, and the Forth.

"During the same period thirty-nine miners died of pneumonia, five died from emphysema, two of whom came from Cornwall, England, aged 24 and 52; two from Isle of Man, aged 41 and 45; and one from Hobart, aged 73.

"There were 16 deaths from accidents in mines (eleven of these were in the first five years—five in 1899); only one in last two years, that from carbon monoxide gas; only five in last five years.

"The number of miners in the district was given as 1489.

"The explanation of the comparative freedom from diseases associated with the inhalation of dust is that in the main the mines are wet, and also that there are practically no quartz mines. I intend following up this enquiry as occasion occurs to visit the different mining fields."

Lyell District.

10. Incapacitated by lung trouble, and is drawing relief from sustentation fund.

11. Said to have contracted the disease locally, but information is insufficient.

12. Information insufficient.

Beaconsfield District.

During the past year no definite case of silicosis has been reported.

Mathinna District.

13. Suffering from miners' phthisis some time ago; has since died.

14. Sufferer from miners' phthisis for a long time.

15. Sufferer from miners' phthisis; had to visit a warmer climate.

In several of the above cases particulars are defective, and it is impossible to say how many of them are cases of silicosis and how many come under the head of some other lung disease; but such as it is, it is all the information which I have been able to obtain.

In the Lyell district the disease has made its appearance, but particulars are not forthcoming. The annual report of the Gormanston branch of the Amalgamated Mining Employees' Association for 1909 states that one member is at present on the funds suffering from this complaint. The North Lyell Mine is on the whole moist, and on a recent visit I did not see that dust from the rock-drills was being produced in dangerous quantity. In the dry pyrite body of the Lyell Mine, however, the dust created by the machines is considerable, but is greatly allayed by the spraying apparatus provided by the company. I saw this in operation, and noticed its efficacy and the increased coolness of the air after its application. But the men have some objection to it, based on the idea that the finely-divided and dust-laden water is carried into the lungs.

In the Beaconsfield district the mines cannot be said to be dry, except where they are drained by the Tasmania Mine, and the health of miners generally is better than it used to be some years ago.

Not much mining is going on at Mathinna now, but during the time that work was in full swing the place had a reputation for diseases of the respiratory organs. Pulmonary phthisis and silicosis probably co-existed. The reef-channels in the principal mines were moist, but the country-rock is rather dry, and on the whole mining may be said to have been carried on under conditions favourable to the disease in question.

We may accept it as a fact that the disease attaches itself most readily to miners working rock-drills, though, of course other miners are also exposed to it, but in less degree, and in their case the development of the complaint may, and often does, spread itself over the entire working life of the patient.

The special factors which govern the disease in rock-drill miners are:—

1. The dryness of the mine.
2. The speed of the drill, and consequently, the quantity of dust produced.
3. The drilling of dry holes (usually uppers).
4. The dust created in blasting.

Given a dry mine and confined working places, and faces at great distances from the natural ventilation current and with insufficient ventilating appliances, and the conditions exist which highly favour the creation of silicosis.

All sorts of experiments have been recommended to allay the evil. They have practically resolved themselves into—

(*a*) Destroying the dust by water jet or spray.
(*b*) Aiding in the removal of dust by attention to ventilation.
(*c*) Preventing contamination of air by attention to ventilation.
(*d*) Preventing the introduction of tubercular phthisis by exclusion of such sufferers from the mine.

Notwithstanding some illogical correspondence in the press, directed apparently against the continuance of the industry itself, it is certain that these remedies, if enforced, would be found practical and effective.

Unfortunately many miners themselves prefer dangerous working conditions to personal discomfort, and are dominated by opinions antagonistic to the proposed remedies. Inspector Curtain mentions that the spray used in the Mt. Lyell Mine is condemned generally by the miners, who allege that it does not allay the dust, but makes it slimy, and that they prefer the latter in a dry form. The answer to this objection is that the slime, if any exists, enters only the alimentary canal, but is not carried into the lungs.

It may be admitted, however, that atomisers produce a steamy humidity of the air, which is distinctly uncomfortable, and in a tropical temperature affects a man's working power. Where a high temperature prevails in the workings, the best authorities are in favour of adopting a limit of atmospheric saturation, beyond which spraying should not be permitted. The low temperature of Tasmanian mines compared with many mines on the mainland make it all the easier to cope with the difficulty.

Of course the saturated air impedes perspiration, and requires to be continually removed by a ventilating current. The effect, however, on the system, though temporarily unpleasant, cannot be compared for a moment with that of the dry dust.

A necessary condition is that the atomised water be free from contamination. Miners generally have a strong opinion that the compressed air escaping from rock-drills usually carries particles of oil and other impurities, which are entangled by the spray and carried into the system. A good deal has been said on this subject, and much difference of opinion exists. If the drills are kept clean, much of the objection falls to the ground. This point should be attended to scrupulously.

In stopes the dust evil can be combated by good ventilation, damping the stone, and arranging the return to the working faces at the proper interval after blasting.

The fact that the suffering miner sooner or later is apt to contract the deadly disease of tubercular phthisis, and likewise become a source of infection and injury to his mates and his family, imposes on the State the duty of surrounding his work with safeguards, as well as of attending to the afflicted and preventing the free spread of the complaint through the community at large.

Improved health, or perhaps more strictly speaking, arrest of the disease, in many cases may be obtained by change of occupation or removing to open air conditions, but when the disease has made too great an inroad on the lung, it unhappily produces permanent disablement, and the patient acquires a claim to the attention and care which it is incumbent on civilised nations to provide in such cases.

The provisions of "The Mining Act" aim at preventing the undue production of dust, and where sprays are deemed necessary by the inspectors of mines or mine owners their use should be welcomed by the miner. If their introduction is resisted by the men, it becomes difficult to insist on it.

From the above remarks you will gather that while pulmonary disease has not made the inroads among miners in Tasmania that it has made on the mainland, it is undoubtedly present to some extent. Its prevention and relief are matters which must receive conscientious attention and consideration by all who are charged in any way with the preservation of the public health.

Mt. Lyell Benches.—Owing to representations made as to the great need of care in the inspection of what were looked upon as dangerous working conditions at the open-cut at the Lyell Mine, I have examined this place from top to bottom. I found eight benches at work, and the excavation at the extreme bottom, called the dug-out. The latter has an area of about a chain by a chain and a half. The view of the whole of the bench workings from top to bottom, and *vice versa*, is a striking one, and to persons not accustomed to large engineering operations the conditions might appear fraught with excessive peril. Thanks to constant supervision, accidents on the bottom floor are extremely rare. The vertical distance between the benches averages 30 to 33 feet. The bench floors are kept clean, and the walls periodically examined and brushed. A certain amount of personal risk is always attached to quarry work, but I do not think there is anything unusual here beyond the magnitude of the scale on which it is carried on, and, of course, the peculiar position of the dug-out, which imposes alertness on the men and watchfulness on the part of the supervisors. Inspector Curtain is paying special attention to the state of the benches, and watches the conditions with conscientious thoroughness, in order that any special danger arising may be immediately removed. At the same time, I must say that the company's supervision appears to me to be excellent.

Weighing at Coal Mines.—I beg to call your attention to Inspector Griffin's remarks concerning the coal-weighing at the Mt. Nicholas and Cornwall Collieries. The owners received notice to provide for weighing the large coal, marketable nuts, and unmarketable slack according to "The Mining Act," which requires the total output to pass over the weighbridges. Instead of complying, the companies have come to an arrangement with their workmen, and pay them an extra price for the large coal, dispensing with a second weighbridge. This arrangement may possibly be mutually satisfactory, but that the owners have power to contract themselves out of the Act, appears inadmissible. Either the Act must be enforced, or such mutual arrangements must be made legal by amending it. The inspector points out that, as regards slack coal, it is of commercial value in the other States, but hitherto it was not a marketable product in ours, and that to require it to be weighed entails trouble and expense which could be avoided. In my opinion the Act might very well be amended by prefixing to the word "mineral" the qualification "marketable" or "saleable," or words to that effect.

"*The Gold Act*, 1909."—This has been substituted for "The Gold Act, 1908," which was repealed last session, owing to hardships having arisen in connection with the disposal of gold by prospectors and co-operative parties. The present Act will come into operation on the 1st April.—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*, 1909.

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 ,, 1905	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
,, 1909 ,, 1909	6054	54	6	49	55	9·085	0·991	8·093

Diagram showing the ratio of fatal accidents
in mines in Tasmania.
Rate per 1000 men employed.

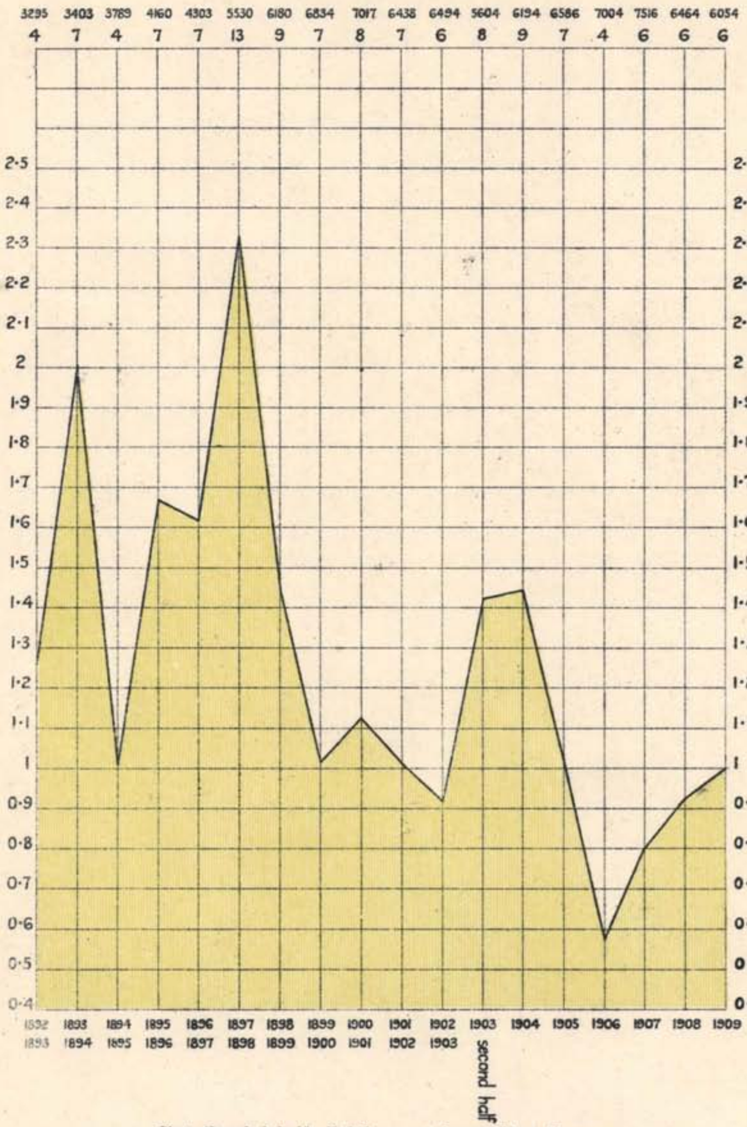


Photo Algraphed by John Vail Government Printer Hobart Tasmania.

TABLE showing Rate per Thousand Killed and Injured in the different Divisions for the Year 1909.

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	731	19	Nil	19	19	25·991	Nil	25·991
North-Eastern	705	4	Nil	4	4	5·673	Nil	5·673
Eastern	492	1	Nil	1	1	2·032	Nil	2·032
North-Western	578	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Western	3548	30	6	25	31	8·737	1·691	7·046
	6054	54	6	49	55	9·085	0·991	8·093

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	1991	14	4	10	14	7·031	2·009	5·022
Zeehan, &c.	1557	16	2	15	17	10·918	1·284	9·633
	3548	30	6	25	31	8·737	1·691	7·046

TABLE showing the Number of Persons Killed and Injured in and about the Mines of Tasmania during the Year 1909.

Place or Cause of Accident.	Inspection Districts.													
	Northern and Southern Division.		North-Eastern Division.		Eastern Division.		North-Western Division.		Western Division.				Total.	
									Zeehan and other Districts.		Lyell District.			
	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.	Killed.	Injured.
UNDERGROUND—														
Falls of Ground	...	5	...	...	...	...	...	...	...	3	...	2	...	10
Shaft Accidents—														
Things falling down shafts	..	2	...	...	...		...	...	...	...	....	...	...	2
Haulage	...	...	...	...	...		...	...	...	...	...	...	...	...
Falling down passes and shafts....................	...	1	...	...	...	...	...	...	...	...	2	...	2	1
Total	...	3	...	...	...	...	...	...	...	...	2	...	2	3

Miscellaneous (underground).														
Haulage—														
Trams, &c.	...	2	...	...	...	...	...	...	...	...	...	1	...	3
Sundry accidents	...	3	...	...	...	...	...	...	1	2	1	...	2	5
Explosives	...	...	...	...	...	...	...	...	1	...	1	...	2	...
Total	...	5	...	...	...	...	...	...	2	2	2	1	4	8
Total Underground	...	13	...	...	...	...	...	...	2	5	4	3	6	21
On Surface—														
Smelting-works	...	...	...	...	...	...	...	...	...	5	..	...	...	5
Machinery	...	1	...	...	...	...	...	...	...	2	...	1	...	4
Falls of stone	...	...	...	2	...	...	...	...	...	...	...	...	...	2
Tramways	...	2	...	...	...	...	...	...	...	3	...	2	...	7
Falls of persons	...	1	...	...	...	...	...	...	...	...	...	1	...	2
Falls of timber	...	...	...	1	...	...	...	...	...	...	...	...	...	1
Miscellaneous—	...	2	...	1	...	1	...	...	...	...	...	3	...	7
Total Surface	...	6	...	4	...	1	...	...	...	10	...	7	...	28
Gross Total, 1909	...	19	...	4	...	1	...	..	2	15	4	10	6	49
Total during 1908	...	16	...	5	...	4	...	2	1	15	5	16	6	58

REPORTS OF INSPECTORS OF MINES.

Mr. Inspector Griffin (Launceston) reports :—

I have the honour to present my report as Inspector of Mines in the Northern and Southern, North-Eastern, and Eastern Divisions of the State for the year ending 31st December, 1909.

Accidents.—I am pleased to be again able to state that no fatal accidents have occurred at the mines within the above divisions during the year.

Twenty-four accidents of a nature serious enough to be recorded as coming within the meaning of Section 20 of the amending Act of 1908 was reported. Most of these were of a nature only to be considered serious by reason of the sufferer being absent from his usual employment for a period of 14 working days. Some four or five were of a rather more serious nature than the rest. Of these latter, Charles Grant fell from a ladder in the Burnie Copper Mine, in which he was a working member of the syndicate that took the mine over from the original company. A knocker-line parted. Grant went up the ladder from the bottom level to splice the line. The place was very wet and slippery. He must have missed his footing when getting through on to the first platform, 25 feet from the bottom. His candle was afterwards found on the platform. His mate heard a thud, and on going to the ladder compartment found Grant lying insensible on the well-boards at the foot of the ladder. He was conveyed with as little delay as possible to the Devon Hospital at Latrobe, where an examination showed his injuries to be of a most serious nature, he having sustained a comminuted fracture of the right leg, cuts on his head, and fracture of the base of the skull. He was in a most precarious condition for several days, and it was some three months before he was finally discharged from the hospital. No one is to blame for this accident. The ladders were in good order, and the man-hole in platform large enough for a man to get through easily.

James McLoughlin, employed stacking wood at the Pioneer Tin Mine, incautiously went from under cover when a load of wood was being tipped into the chute at the foot of which he was working. He was struck by a piece of wood, and sustained a fracture, and also dislocation of an ankle. McLoughlin says he called to the woodcarter not to tip the load until he fixed something. The carter says he did not see or hear him.

Joseph Herbert had a narrow escape of being killed in a very narrow stope in the Tasmania Gold Mine. He neglected to timber for a couple of sets. A slab of rock fell out of the hanging-wall and jammed him against the opposite side. He got a very severe bruising about the hips and back; no bones broken. He was in the hospital for some considerable time as a result of this accident.

Harold Clyde had the wrist of his right arm broken when trucking from the mullock quarry at Tasmania Mine. He ran his truck out over the points on to the main line; was overtaken by another truck, which could not be stopped in time to avoid an accident.

Joseph Tresize, a lad, was running to uncouple trucks at Tasmania battery. He slipped and fell on the tram-rail, breaking his right forearm.

These were the more serious accidents. Of the remaining 19, nearly all were of a nature that scarcely would have been recorded as serious had it not been for the fact that the sufferer lost 14 days from his usual employment. The nature of injuries was in the majority of cases cuts and bruises about the hands and feet, some very painful accidents of this kind occurring to men handling stones and boulders in the open-cut faces of the big sluicing mines, as also to truckers employed both below and above ground. One man received an accidental blow of a drill-hammer on the head whilst turning a drill. He was off work for 10 weeks as a result of this. Another, while preparing for a set of timber in a stope face, was caught by a fall of 6 or 7 cwt. of stone from the hanging-wall side; fortunately he escaped very serious injury—only muscular bruising. There were no accidents from the use of explosives, nor from noxious gases. Only one machinery accident occurred—a man got his thumb jammed in cog-wheels. Hauling-ropes, chains, shackles, and detaching-hooks have been frequently inspected. Only in three cases was it found necessary to condemn ropes, and these were windlass ropes. It is but rarely that accidents now occur from the breaking of a hauling-rope or chain. This must be attributed to the care taken, in all the big mines, at all events, where the shaft equipment is frequently overhauled, ropes cut and recapped, and chains and shackles annealed, at regular intervals, whether there are signs of weakness or not.

Safety-cages are tested regularly every two months by the managers, and are changed if found defective. Altogether, the equipment of mines in this direction is satisfactory.

Ventilation.—The ventilation of the metalliferous mines is fairly good, in most cases very good; and, with one or two exceptions, is obtained by natural means. At Beaconsfield fans are in use at two mines. It is only at times, when atmospheric conditions are unfavourable, that these are required. Even then it is not always that good ventilation can be maintained, as the great quantity of gas in the rock stratas, when once liberated, requires more powerful machinery than that in use to expel it.

The big mine (Tasmania), being well provided with shafts, manages for the most part to obtain adequate ventilation by natural means. At times men have to be taken out of places when weather conditions are unfavourable, or when a greater amount of gas than usual is liberated with an inrush of water.

Sanitation.—The sanitary condition of the mines is fairly good. It is not always easy to get as good latrine accommodation as could be desired. Good ventilation is generally followed by satisfactory sanitation underground. Pans and disinfectants are used where necessary. The health of the miners employed in these mines is apparently much better than was the case a few years ago.

Complaints.—Only one complaint of unsafe conditions prevailing in a mine was received. Investigation showed there was some ground for this. It was not, however, a serious matter.

Magazines and Explosives.—The magazines in the mines generally are kept in good order, and the explosives are in a safe condition for handling and use. In one case it was found necessary to revoke the licence for a magazine owned by a mining company, and situated in a township, owing to the negligence of the owners in not seeing that proper care was taken. Doors were not properly fastened, and the building frequently contained a greater quantity of explosives than the licence allowed.

Coal Mines.—The working of these mines has been satisfactory, so far as safe working and ventilation is concerned. In one case only was an order given by the inspector disregarded. It was at one of the small mines in the south. Certain timbering at a tunnel entrance was defective and dangerous. It was ordered to be remedied, but the order was not obeyed. The lessee of the mine, who was also the manager, worked for a couple of months after my visit, and then gave it up altogether. It was only when the mine was reopened after being idle a couple of months that I discovered that the order given was not obeyed.

The two principal collieries, Mt. Nicholas and Cornwall, maintained a fairly good output, which was much increased, and nearly doubled, when the Newcastle strike was on in November and December.

The Mt. Nicholas Colliery had a good length of long-wall face open, a portion only of which was being worked, owing to slack trade, until the strike commenced. It was therefore in a position to increase its output straight away. The seam being worked is what is known as the "6-feet"; 4 feet 6 inches is, however, all that is taken in the present working, a foot of coal and 6 inches of clod being left at the top. The coal in this seam requires a good deal of clearing to make it a good marketable fuel. Assuming that its area and extent are equal to the old 4-feet worked out below it, then the mine should have a good many years to live. The mine was never in better working order than at the close of the past year.

The Cornwall Colliery workings are confined to the southern portion of its 4-feet seam left when the more northern portion was worked during the years prior to 1909. There is still a fair extent of seam to work. A 5-feet seam at lower level was opened in November, 1908, but was abandoned two months later, when a collapse of the roof had taken place, the mine having been idle for a fortnight at Christmas time. The coal in this seam is not of very good quality. It is rather soft and dirty near the outcrop, but may improve if followed well beneath the hill.

The working of the colliery during the year has been satisfactory, and the ventilation adequate. With regard to the weighing of coal contracted to be gotten by miners on the tonnage system, it was discovered in the early part of the year that the provisions of Section 189 of the Mining Act of 1905 were not being complied with by both the Mt. Nicholas and Cornwall Collieries, and that "the amount of mineral contracted to be gotten" by the miners employed was not paid for according to actual weight. The men received 3s. per ton for the large coal, passing over screens with 1-inch openings, no allowance being made for small coal, or nuts. These latter represent one-twelfth of the whole of the coal gotten, and were selling in the market at about seven-tenths of the price of the large coal. The owners were notified to make provision for complying with Section 189, which, if observed according to the strict wording of the section, would entail considerable expense to them, as machinery would have to be provided for weighing "the whole of the mineral contracted to be gotten," including slack, which in our Tasmanian coal mines is an unsaleable product. The conditions imposed by Section 189 of the Act are similar in every respect to the law prevailing in New South Wales, with regard to coal-weighing. In that State, however, the coal slack from most of the mines has a commercial value, being used for coking, kiln-furnaces, brickmaking, &c. The whole of the coal is weighed at the pit mouth, or as near thereto as practicable. It is then passed over screens, making three sizes—large coal, nuts, and slack—and is again weighed to ascertain the rate to be paid on each class or size. All this entails much trouble and expense, mainly to the owners, of course, but in part also to the men, who have to appoint and pay a check-weigher. The New South Wales miners—at some of the mines, at least—have tired of this cumbrous system, where three weighing-machines, and perhaps as many check-weighers, have to be employed. They now agree to accept payment, at a rate agreed upon, for large coal for nuts respectively, and let the slack go. By this arrangement the first weighing of the whole coal is dispensed with. The owners of the two collieries—Mt. Nicholas and Cornwall—when given notice that they would be required to comply with the provisions of Section 189, objected strongly, mainly on the grounds—(1) That they paid, and were still paying, a higher price for the large coal gotten than could be reasonably claimed if nuts had also to be paid for. (2) That portion of the work of cleaning the coal (separating it from stone or other substances) has to be done as it is passing over the first screen; and that weighing before screening is therefore impracticable, as there would be no means of ascertaining the weight of the substances to be rejected, unless an extra weighing-machine were provided. Other objections were also made, but the fact still remained that the law with regard to weighing was not fully complied with. Large coal was weighed and paid for. Nuts were not weighed, nor was there any allowance in the way of payment made for them. The miners employed were most reasonable in their demands. They did not insist on a first weighing, nor did they ask for any payment for slack, which they know is dumped to waste, being of no value to anyone. What they did ask was that they be paid a proportionate rate for nuts, which the owners were selling at a fairly good price. There was some little delay and unpleasantness before an agreement was come to between owners and men. Eventually it was decided that the price for the large coal—then 3s. per ton—be increased by one penny, and that a second weighing-machine be dispensed with. The hewing price is now 3s. 1d. The men are thus receiving 1s. per ton for the nuts; that is, assuming that the proportion of 1 ton of nuts to every 12 tons of coal is correct. All parties concerned appear to be satisfied with this arrangement; yet I am not sure that it is either valid or desirable, from an inspector's point of view. The Wallsend Colliery Company, Sandfly, is now paying on the tonnage system on large coal and on nuts, no payment being made for slack, which is worthless. Weighing-machines are provided: No. 1 weighs the large coal as it leaves the first screen; No. 2 the nuts as they pass off the bottom screen; the slack falling through to the floor is not weighed. This is much the same as the methods adopted in some of the New South Wales collieries already referred to. It would be well, I think, if the Mt. Nicholas Colliery owners were required to make similar arrangements to the above, and provide a means of weighing the small coal called nuts, as well as the large. I have no desire to interfere with, or in any way disturb existing arrangements with regard to coal-weighing at these collieries, could I be sure that trouble will not ensue at a later period. Section 189 (2) of the Act is emphatic enough, and shows the necessity for observance of the principal section.

Subsection (4) provides for the "average weight" being accepted by both owners and men until such time, not exceeding a period of one year, as weighing machinery can be procured.

A year has now passed since notice was given to these coal mine owners, but nothing has been done to provide a second weighing-machine at either colliery.

I respectfully submit that enforcement of the law, so far as is reasonably practicable, should be made; or, failing this, that the section of the Act be altered or amended in such a way as would admit of such arrangements being lawfully made between owners and men with regard to weighing, or averaging, as is now the practice.

Wallsend Colliery.—Development work has been going on during the year, and the mine is now assuming more shipshape order. Long-wall working is a good deal interfered with by the occurrence of minor faulting of the seam. The direction of roads has to be altered to meet these jumps or down-throws, and ventilation is made more difficult as a result of this.

The working of this colliery with regard to safety is generally satisfactory. The roof, which is of hard clay, is generally unsound and being divided by the cleavages of faulting, it must be carefully watched and well supported with props and timber-packs in face and roads, so as to avoid accidents. Some 20 places were working at the close of the year, the output of coal being 250 tons per week. The seam, which is only 3 feet, now that the bottom canch of 12 inches of inferior coal is not included, is turning out some good quality coal. Some 60 miners and wheelers are employed underground. In addition to these, there are 20 hands employed on the surface at screens, railway, timber-getting, &c.

Of the smaller coal mines, the Mt. Cygnet has been doing a little, but not much. A change of ownership took place about August, when Mr. Wm. Berry made a not very successful attempt at coal-getting, and now another party has taken over the mine.

At Ida Bay the Dawson Brothers made a good attempt to open up at 4-feet seam. The coal is dull of lustre and rather soft. It will probably improve when worked further beneath the hill. Work has been suspended of late, pending the raising of more capital. The mine is 1 mile from the old jetty at Ida Bay (Southport).

Coal at Port Esperance.—Strathblane Mine.—This is situate to the south-east of Adams Peak, about 8 miles by road from the town of Dover. There are two seams, with from 8 to 10 feet of clay and shale between. The thickness of seam is, in each, 3 feet; no bands or partings of any consequence. Short adits were driven and a quantity of coal taken out for a test. Some of this, used on one of the channel boats, is said to have given a satisfactory result. A short line, 9 chains, has been constructed from the coal to connect with the tramway of a timber company running down to the port, a distance of 4 miles. I understood from Mr. Wm. Anderson, who was in charge as manager at time of my visit in August, that active operations to open up the seam would be at once commenced, but no work of any consequence has been done since that time.

York Plains.—Mr. Gregg still continues to get a small output from this mine. The coal, which is a kind of anthracite, is only used by brewers and maltsters, it being a smokeless kind. The trade is therefore limited.

Spreyton Colliery.—Mr. Allison still manages to get a fair output from this 20-inch seam. Work is at the new pit, opened a year ago, not far from the Tarleton railway-station. This is the only mine of the Mersey coal group now working. Nothing has been done in the way of coal-getting at Dulverton for some years past.

Coal at Avoca.—Early in the year a discovery of coal was made on Mr. James Rigney's Bona Vista Estate, near Avoca. A short tunnel, 70 feet, was driven to the dip, from which some fairly good steaming coal was obtained. Subsequently, boring was done by a syndicate that has secured the right to mine for coal on the estate, with the result that the seam is now being opened up for working. The outlet for this coal will probably be to the Hanleth station on the Fingal Line, which is 11 miles from Conara Junction, and 46 miles from Launceston. The construction of about 4 miles of tram will be required to connect with the railway. Other coal discoveries have been made in the Avoca district, on the St. Paul's River to the south, and at Mt. Rex, a foothill of Ben Lomond, to the north. The Cornwall Coal Company has had a lot of prospecting done at the latter place, and coming south-west towards the Bona Vista seam. It is not unlikely that a second colliery will be opened here. The distance from the Hanleth railway-station is, however, much further than that of the Bona Vista coal, and the line would have to pass through private property.

A good deal of attention is being given to coal of late, especially in localities such as the Bona Vista, where the cost of carriage will be lessened by nearly one-half, as compared with that for coal from Mt. Nicholas mines, which are 33 miles further from Launceston.

Dalmayne Coal.—Mr. Wm. Gibson, of Scone, Perth, has had a good deal of prospecting on what are known as the Dalmayne seams, which are situated about 8 miles south of St. Marys, on the slope of the range 4 miles west of the coast. The seams at this place have been tested at different times during many years past. Some fairly good coal is to be seen in one or two places. The best seam is about 2 feet 6 inches in thickness. Two 5-feet seams with a parting of 3 feet of clay between, look promising. A test further in from the outcrop is needed before arriving at any definite conclusions as to the value of the coal in these seams. The only outlet for coal from this locality would be Seymour, where a large outlay would be required in the construction of a jetty and harbour works before vessels of any considerable tonnage could berth there.

Gold-mining.

The Tasmania Gold Mine had a burst of water on June 3, and the mine was flooded for eight weeks, until July 28, during which time all underground work, excepting that in connection with pumps and repairs, had to be suspended. Grubb's shaft has been sunk to 1370 feet, from which level a crosscut is being driven. This does not go directly to the lode, only sufficiently far to get the floodgate in. A connecting drive will be run out west to Hart's shaft. The object of this is twofold. In the first place it will enable the work of rising to connect to be commenced and carried on at the same time as the crosscut is being extended to cut the lode directly from Hart's shaft. This shaft was sunk below the 1250-feet level early in the year, but the water was so heavy that it was deemed advisable to suspend until Grubb's shaft, which was drier, could be got down to the 1370-feet level. This has been done, and now rising to connect, instead of sinking, will go on at Hart's. In driving this crosscut a rather heavy inflow of water coming from the country-rock is encountered. This is unusual, but is not looked upon as a drawback, as there will not be so much danger of an overwhelming burst when the lode is cut.

Bonanza.—Prospecting drives south and west at the 1000-feet level, also driving on a lode at 300-feet level, occupied a good deal of the time; but unfortunately no good results have been obtained. The mine was shut down for a time, but is now working again.

Mathinna.—The New Golden Gate Company continued its prospecting on the East Gate section, at the 200-feet level. A good deal of work was done crosscutting and driving, but no payable results were obtained. Operations have now ceased altogether. At the old mine one tribute party found employment for the year at the 800-feet. The company's wages men took out a large block of stone, about 2000 tons, at the 300-feet level. Other places were tried, but the life of the old mine appears to be drawing to a close.

Searl's Section, near Old City of Hobart.—The Golden Horseshoe Company purchased this property from Mr. Searl in the early part of the year. A new shaft was sunk 60 feet and a steam winding plant installed. This was obtained from the Tower Reefs Gold Company, which ceased operations a little while before. A good deal of driving and crosscutting has been done, but no payable results have been reached so far.

Lefroy.—The Gift Mine has done a good deal of development work during the year, but is not yet on payable stone. The principal lode is small, but carries good gold in places. The North Volunteer (South Murchison Syndicate) sunk, or rather cut down, an old shaft, and did some driving on a large lode-channel, but so far the thing is not much spoken of. The New Pinafore Company is not doing anything at present The only work on this field is south of the town, in the vicinity of the old Volunteer group.

At Golconda the New Wyengatta Company worked on and off in a sort of way, for part of the year, but has now ceased altogether.

The New Panama resumed work in July, after a long spell of idleness. A new bottom-level tunnel is being driven to cut the lodes already prospected by the upper adits. The stone or ore is complex stuff, too low-grade to admit of it being sent long distances to smelters.

Golden Pyramid.--Mr. Parsons is still persevering in a desperate attempt to reach a lode supposed to exist about the contact of the granite and sandstone rocks. When the face of the adit wall gets too soft and wet in the decomposed granite, a shaft is sunk immediately over it, and driving is resemed, but at a higher level. Twice has this process been repeated, but the contact is not yet reached, and another shaft is to be put down. So much perseverance deserves success.

Alberton.—Mt. Victoria Field.—Not much doing; in fact, so far as could be learned, operations at the two or three small shows there had ceased by the end of the year.

Tin Mines.—The Briseis Tin Mines, Limited, or as it is called, the Briseis Tin and General Mining Company (the name has been altered since the company acquired gold-dredging properties in Victoria), is working persistently and with good effect in removing the very heavy overburden from the tin-drift on the northern section, called the "Ringarooma face." The huge drift deposit of the old mine, or Briseis proper, from which thousands of tons of tin oxide have been won, is now getting very small, and cannot last much longer. There is still that portion of Krushka's old mine covering the deep lead as it dips beneath the river, to be worked. In the early days, when Krushka Brothers' Home Mine was opened, work was commenced at a bar crossing the creek at a point about 10 or 12 chains up from the river. No attempt was made to work below this bar, as the ground was too deep to be attempted with the appliances then in use; this was before the advent of gravel-pumps and hydraulic elevators. Since the Briseis Company acquired the Brothers' Home claim, which was added to its mine some years ago, prospecting by boring has proved the existence of good payable tin in the older drift deposit covering the gutter below the bar referred to, and dipping deep, nearly 80 feet, beneath the Ringarooma River. This portion of the old mine can now be worked to better advantage, since the company has secured the "Clarke" dredging claims on the river bed, and there is no longer a break in the continuity of its property.

Pioneer Tin Mining Company.—The construction of the Frome dam and of the new hydro-electric plant was completed in April last. Two barges, each of which has a 400 B.H.P. motor, were running and doing good work until the water-supply gave out at the close of the year. The two steam plants had also to be stopped, as there was not sufficient water for sluicing purposes. The dry weather set in early this season, and is affecting all the tin-sluicing mines on the coast, the Briseis being the only one that has managed to keep going, and even its supply has been considerably reduced.

The Arba Tin Mine.—Fairly good progress is being made, and more satisfactory results have been obtained than for the past few years. This mine, too, is affected by the early drought.

Briseis Extended Tin Mine.—This mine has ceased operations altogether. In the early part of the year a "Henic" elevator was installed to lift the gutter drift, a depth of 20 feet, left as below the reach of the steam gravel-pump. This latter was lifting to a height of 112 feet, fully 25 feet higher than it should lift if fair efficiency could be expected. The taking up of the gutter wash was a mistake, as it was known to be poor stuff, not by any means rich enough to elevate to a height of 132 feet with the appliances and power in use. After this failure, sluicing was again resumed at the upper level, but matters went from bad to worse, and work ceased for good in November.

Mutual Hill Tin Mine.—Fair progress was made in removing overburden during the winter months, when water was plentiful. The tin drift was not attacked until late, and the dry weather put a stop to work.

Derby Hills Tin Mine.—If reliance be placed on reports appearing in the newspapers, one might expect to find a promising show being well opened up at Derby Hills. What the ground really contains in the way of tin is not yet known, and will not be, until some better attempt at opening up and working is made than exists at present. A change of management took place at the end of the year, which may improve matters.

The Great Pyramid Mine.—When the prospector, Mr. Charles Cheshire, announced his discovery of lode tin in the sandstone country on the north side of the Scamander River, only some 4 miles inland from the coast, a year ago, many mining people visited the locality, and after inspection came away satisfied that a good thing in the shape of a tin lode had been struck. The prospecting done comprised a series of trenches in a belt of quartzite traversing the sandstone on the northern side, and near the top of a ridge, about 500 to 600 feet above the river level. Every trench showed bands and seams of tin in the stone, in places very rich.

Mr. Purdue made an inspection, and arranged for an option with the prospector. Eventually the concern was floated into a large company—120,000 shares at £1 each—the head office being in Adelaide. A mine manager (Mr. Gullock) was appointed, and the work of thoroughly testing by means of adits driven into the ridge from both sides was commenced.

Mr. E. W. Bonwick, an expert appointed by the company as its consulting engineer, furnished a report, which, if it did not please some people, who appeared to think the whole hill was payable, at least gave a fair, and not by any means discouraging, estimate of values, as ascertained from careful sampling. The belt of quartzite tested by trenching was 900 feet in length by 30 feet in width. An average of tin veins in these trenches gave 1·72 per cent. The first adit driven into the ore-body about 70 feet below the surface, and 140 feet in length, gave averages of from ·16 to ·83 per cent. for the sections taken over—about 100 feet. Portion of the remaining 40 feet gave as high as 2·95 per cent.

Seven adits were driven, some on the north-east and some from the south-west side of the hill. Shafts were also sunk, and everything done to thoroughly test the ore-body by a systematic process of sampling before the erection of a large plant could be decided upon; and now Mr. Bonwick's last report pronounces it a low-grade proposition, not good enough to go on with.

Dredging.—Of the three dredges constructed and started on the Ringarooma River, at Gladstone and South Mt. Cameron, only one is now in use. The Gladstone was laid by more than a year ago. The two at South Mt. Cameron—Dorset and Ringarooma—worked with varying success in the early part of the year; now the Dorset alone is working. It would seem from this that dredging for tin is not a profitable business in Tasmania. It is not surprising that the Gladstone dredge failed. It was faulty, both in design and construction, and the locality was not the best to commence in. The Ringarooma dredge should have done better, but it would seem that tin is not too plentiful at the particular place where it has been working.

The Purdue Extended has nearly completed its plant—pontoon, gravel-pump, &c.—to work ground on the river flat known as "Jewel's," near Gladstone.

Daw and O'Neill are preparing to work river-flat ground 5 miles below Gladstone. A gravel-pump operated by a Pelton wheel on a pontoon will be used for elevating the wash. The water for the Pelton will be obtained from the Mt. Cameron water-race. Other plants of a similar nature are likely to follow in the same locality.

LIST of Accidents in Inspector Griffin's District for Year 1909.

Fatal, 0 ; non-fatal, 24 ; total, 24.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1909. 15 Jan.	Burnie Copper Syndicate	Blythe River	Fall from ladder in shaft	Grant, Charles	Married	Comminuted fracture of right leg near ankle; fracture of base of skull	Was climbing ladder from bottom of shaft to adjust a knocker line ; slipped at first platform, and fell 25 feet on to wellboards at bottom.
15 Jan.	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Truck leaving rails	Burke, Alex	Ditto	First finger of left hand cut off, second finger badly bruised	Was cleaning a fluming underground ; moved a truck out of his way ; in doing so the truck left the rails, and jammed his hand against the drive timbers.
22 Jan.	Ditto	Ditto	Jammed by passing truck in cramped space	Quinn, Charles	Ditto	Bruised stomach	Was trucking underground ; stopped his truck and stood on side where there was not sufficient room ; passing truck jammed him against wall.
25 Jan.	Pioneer Tin Mining Co.	Bradshaw's Creek	Screwjack slipping	Dennis, Fredk.	Ditto	Top joint of forefinger of right hand jammed off	Was handling rock at Frome Dam construction works ; screwjack slipped, causing rock to jam his finger.
26 Jan.	S. & M. Tin & Bismuth Syndicate	Middlesex	Carelessly turning cog-wheels by hand	Aidinson, Cecil	Single	Top joint of thumb jammed off	Engaged as mill hand ; machinery stopped for repairs ; was turning trommel round by hand, got his thumb jammed in cog-wheels.
10 Feb.	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Lamp falling	Caldwell, George	Ditto	Cut on left hand	A lad, age 15 ; was lifting a pipe out of a shaft ; it came in contact with brace lamp, which fell, striking him on back of left hand.

19 Mar.	Ditto	Ditto	Slipped and fell in pass	Snoxall, John	Married	Cut on right fore-arm	Slipped getting down pass at No. 105, cutting his right forearm; doctor put stitches in, and Snoxall returned to work, but got wound poisoned, and was off work 3½ weeks.
14 April	Ditto	Ditto	Stone rolling back on truck	Hawkey, Harr.	Ditto	Stab in middle finger of left hand	Was filling a truck at 1250 feet crosscut; a piece of stone rolled back, catching his hand against shovel handle; was off work 3¾ weeks as a result of accident.
16 April	Ditto	Ditto	Hammer slipping	Crawford, Peter	Ditto	Nasty cut on right side of forehead	Was turning a drill in 251 Block, when he received an accidental blow from the hammer wielded by his mate; was in hospital 10 weeks.
21 May	Pioneer Tin Mining Co.	Bradshaw's Creek	Firewood descending shoot without warning	McLaughlin, James	Ditto	Broken and dislocated ankle	Was stacking firewood at boiler near foot of wood-shoot; carter mistook signal and tipped wood into shoot, a piece struck McLaughlin on ankle, causing injury named.
22 May	Tasmania Gold Mining Co.	Beaconsfield	Slipped and fell in front of truck in motion	Williams, John	Single	Bad cut on leg and bruises	Was employed on slime dam at battery, horse-driving; attempted to fly-shunt, contrary to instructions, slipped on rails, was pushed along by truck-wheel, but not run over; off 30 working days.
28 May	Ditto	Ditto	Slab falling in shaft	Dally, Alfred	Married	Cut on left cheek and nose	Dally, head contractor at Grubb's Shaft, was assisting to get large timber into position, it swung against side, displacing a slab which, when falling struck him on the face.

LIST of Accidents in Inspector Griffin's District for Year 1909—continued.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1909. 7 June	Anchor Tin Mine Co.	Lottah	Stone bursting suddenly	Hodge, Walter	Single	Sprained foot at ankle-joint	Was bursting a boulder, in open cut face, with hammer and gad, stone suddenly split, one half rolling against his leg; he was treated at Launceston Hospital.
28 June	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Handling a heavy iron plate, which slipped	Davidson, Arthur	Married	End of forefinger on left hand badly crushed	Davidson, while shifting a heavy iron plate on the surface, got his finger jammed; he lost 17 working days.
27 July	Ditto	Ditto	Fall of ground in stope	Herbert, Joseph	Ditto	Lower part of back on left side badly bruised	Was working in a narrow stope in 106 Block, portion of the hanging wall fell, jamming him against the other side; he was badly bruised; at expiration of 40 days had not returned to work.
20 Aug.	Briseis Tin and General Mining Co., Ltd.	Derby	A stone rolling	Kean, Victor	Single	Flesh of right hand torn from palm and between fingers	Was putting stones into race at North Ringarooma face; one fell and jammed his hand badly; doctor says no permanent injury will result, but the accident was most painful.
15 Sept.	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Piece of skid falling in shaft	Smith, John	Married	Flesh torn for about 3 inches on right forearm	While working in Grubb's Shaft a piece of skid, with nail projecting, fell, striking him en right forearm; was off 15 days.

22 Oct.	Wallsend Colliery Co.	Sandfly	Struck on ankle by piece of stone, underground	Pearce, Henry	Ditto	Bruised ankle	Was struck on the ankle of left foot by a piece of stone while working in coal face; treated the matter lightly at first, but after a few days had to go to the Hobart General Hospital.
1 Nov.	Tasmania Gold Mining Co., Ltd.	Beaconsfield	Collision of hand-trucks being run on surface tramway	Clyde, Harold	Single	Wrist of right arm broken	Ran an empty truck from main shaft out over points on to mullock quarry line, without looking for clearance; was overtaken by truck run by J. Waugh (who could not pull up), and got jammed.
2 Nov.	Ditto	Ditto	Running on tramline, slipped and fell	Tresize, Joseph	Ditto	Right forearm broken	Tresize, a lad of 15 years, was running on tramline at battery to couple up trucks; he slipped and fell on rail, breaking his arm.
5 Nov.	Ditto	Ditto	Fall of hanging wall stone	Hayes, Patrick	Married	Muscular bruising	Was working in No. 106 stope, preparing to open up a set of timber, about 6 or 7 cwt. of stone fell from the hanging wall and struck him; no bones broken; off work 26 days.
16 Nov.	Ditto	Ditto	Stone falling in ladderway	Smith, John	Ditto	Struck on shinbone of left leg	Whilst ascending ladderway in Block No. 202 a small piece of stone came away, striking him on shinbone of left leg; was off work 16 days.
3 Dec.	Ditto	Ditto	Pulled a lump of quartz on to his foot	Cowie, Thomas	Ditto	Bruised toe	Whilst working in Block 203 he pulled a piece of quartz over on to his right foot, bursting the big toe; was off work 20 days.
18 Dec.	The Briseis Tin and General Mining Co., Ltd.	Derby	Bar slipping when removing stone	Allen, James	Single	Broken finger of right hand	Was assisting to bar large boulder into race, bar slipped and jammed his hand, breaking bone of small finger; was off work over 14 days as a result of accident.

Mr. Inspector Harrison (Zeehan) reports:--

Accidents.—In submitting my annual report for 1909, I beg to state that the accident list is as follows:--Two fatal and 15 non-fatal; most of the latter were not of a very serious character. Five of them were in connection with our local smelters

Safety Appliances.—The various mines are well supplied with the necessary appliances, which are kept in good order.

Ventilation.—The ventilation of the mines in this district is, on the whole, very good.

Magazines.--Magazines, 40 in number, are kept clean and in good order. I am having others erected at Whale's Head and on the Balfour field.

Prospects of the Field.--I regret to say there has been a considerable falling off in the returns from the field, caused partially by the closing-down of some of the mines through the low price of metals, and the local smelters closing down.

Silver-lead.—Towards the end of the year a most promising find was made at the 5-mile by the Wallace Bros. Mr. T. Vincent, manager of the Mt. Zeehan (Tas.) Company, purchased the property, and is now getting ready to open it up. Several other parties are prospecting in the same locality.

At North-East Dundas tin-mining is going ahead, and the output steadily increasing.

Mt. Farrell.—At Mt. Farrell the North Farrell Mine has opened up a deeper level, which shows that the large lodes worked from the adit levels still live down. Other mines on the field are still turning out ore.

Stannite.—The Oonah Mine has been worked by the present company, and large bodies of stannite ore exposed. Smelters have been erected to treat same, and the general manager, Mr. Alabaster, informs me that the results obtained from treatment are most satisfactory.

Zinc Blende.—The zinc blende deposits at Comstock are about to be opened up and treated on a large scale by a powerful company, the sampling of the ore-bodies having proved satisfactory.

Tin Fields.—The Renison Bell tinfield is looking very well, and the returns from same are increasing every quarter. The same remarks apply to the Heemskirk field. The reward sections on the Stanley River have been floated into a large company, and active work is to be at once undertaken.

Superphosphate.—We have two mines—the Chester, at North Pieman, and a tribute on the Oonah—breaking large quantities of pyritic ore for the superphosphate works in the neighbouring States.

Mt. Balfour Field.—Numerous good lodes have been exposed on this extensive field. Up to the end of November last the Murray Bros. had sent away 1172 tons of copper ore, of a gross value of £15,000. Water is the difficulty on this field, until means of getting machinery on to it is provided. About 30 feet is the limit for windlass work.

LIST of Accidents in Inspector Harrison's District for Year 1909.

Fatal, 2 ; non-fatal, 15 ; total, 17.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1909. 3 Feb.	Magnet	Magnet	Fall of stone	Bricknell, W. J.	Married	Small bone of right leg broken	Caught by large stone while spalling in slope
16 Mar.	Anderson P.A.	Dundas	Fire in bottom of shaft	Birkett, A. S.	Single	Smothered	Smothered by smoke from fire in shaft
16 Mar.	Ditto	Ditto	Ditto	Berresford, C.	Ditto	Laid up for 8 days	Partly overcome by smoke but able to return to surface
24 Mar.	Mt. Bischoff	Mt. Bischoff	Shunting trucks.	Colgan, T.	Married	Elbow, brachial artery crushed	Caught by buffers while shunting on surface
30 Mar.	Adelaide	Dundas	Oiling	Johnson, F.	Ditto	Not serious	Hand caught by pump-crank while oiling
3 Apr.	Tasmanian Smelters	Zeehan	Cleaning conveyer	Lyons, H.	Ditto	Tops of two fingers taken off	—
27 Apr.	Ditto	Ditto	Hot slag	Haywood, A.	Single	Injury to eye	While putting stopper in tap-hole of furnace was struck by hot spark of slag
22 June	Ditto	Ditto	Fall into ash pit	Winslade, D.	Married	Two ribs broken	Fell into ash-pit of boiler
13 July	Mt. Bischoff	Mt. Bischoff	Missfire	Grills, F.	Ditto	Scalp wound	Returned to what he thought was a missfire
21 July	Hercules	Mt. Read	Crabwinch	Airey, J.	Married	Crushed hand	While working crabwinch his foot slipped and hand was caught

LIST of Accidents in Inspector Harrison's District for Year 1909—continued.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1909. 19 Aug.	Chester	N. Pieman	Runaway truck	Kinghorn, M.	Married	Sprained ankle	Was riding on empty truck, which got away with him ; in jumping off sprained his ankle
13 Sep.	Montana	Zeehan	Fall of rock	Sawley, S.	Ditto	Broken leg	Fall of rock from back of drive for want of few laths, which he thought were not required
13 Sep.	North Mt. Farrell	Mt. Farrell	Fall of lode matter	Wilkinson, H.	Ditto	Back hurt	In working out the effects of a shot some lode matter fell on his back
24 Sep.	Tasmanian Smelters	Zeehan	Hot slag	Crane, E.	Single	Feet burned	Cleaning up overflow of hot slag put his feet on the crust
13 Sep.	Magnet	Magnet	Trucking	Blegg, C.	Ditto	...	While trucking, the trucker following ran into him
20 Oct.	Tasmanian Smelters	Zeehan	Fall	Barrow, F.	Ditto	Arms dislocated	Fell from one floor to another
18 Nov.	North Mt. Farrell	Mt. Farrell	Fall of stone	Jones, Robert	Ditto	...	Piece of stone fell out of slope and struck his leg

Mr. Inspector Curtain (Queenstown) reports:—

Dealing with the casualties that have happened in this portion of the district for the past year, I wish to make further reference to those which were attended with fatal results, as an analysis of the circumstances attendant thereon points to the fact that none of these lamentable occurrences should have really taken place.

(1) Referring particularly to George Lapham, whose death was the subject of a successful claim for damages by his widow and family against the Mt. Lyell Mining and Railway Company. In this instance, had the deceased made himself acquainted with the state of the means he had adopted for affording escape, there is not a shadow of doubt but there would have been no necessity for this painful investigation. He was practically the leader of the party of contractors who were engaged sinking an "incline shaft" from one level to another for general purposes, and to assist in entering and leaving the work, tied a rope around a projecting drill-shank, about midway (15 feet) down the "winze"; yet shortly after, and after having spit a round of heavily-charged blasts, it was found useless, having from some cause come off and fallen to the bottom. Lapham called for assistance to his mate, who, within a minute or two before had used the rope, and then informed him of its safety, but in the confusion that followed before help in any form could be obtained, the explosions took place and killed Lapham instantaneously.

In this case the letter of the regulations was not complied with, inasmuch as ladders were not mounted. But it is questionable whether these would have been used, as the shaft was a particularly flat one, out of which is was possible to walk or climb without any assistance, and this created a belief in its safety which I feel sure was entertained by Lapham, who, being a thoroughly practical man, would not have taken or permitted any unnecessary risks to attend his labours.

(2) Charles Richardson, a platman at the same mine, during a brief darkness caused by a temporary cessation of the electric current, walked into a compartment of the main shaft and fell some 400 feet. The shaft was mounted with safety gates, and it was part of the deceased's duty to see that they were securely shut, yet on investigation the one next to where he was last seen standing was found ajar, and through this he had fallen, death being instantaneous, so that beyond the unfortunate man's own actions, no one else could possibly be held responsible.

(3) James Brennan, working in the No. 7 level of the Mt. Lyell Company's Iron Blow Mine, was overcome with deleterious fumes, followed by acute pulmonary troubles, from which he never recovered, and died in the Queenstown Hospital some six weeks later. This is another case where warning was given that the men on the top level purposed "firing" a strong charge in order to bring out a "cut," but Brennan and his mate, believing they were all right, remained below, with the result that, owing to the ventilation of the mine, the fumes were drawn downwards, and penetrating the men's workings drove them out. They reached the plat, where it is needless to state the conditions were worse than the end they had left, and signalled for the cage, but owing to a skid

being displaced this could not be sent through for some time, and when accomplished both men were found suffering severely, Brennan continuing in this state until he succumbed, as already stated. Had he complied with the wish of his mates, who called from the top level to come up, this occurrence would also have been avoided.

(4) William Edward Thornbury, another leader in a contracting party of the North Lyell Mine, wanted logs for a staging in order to adjust a rock machine, and for this purpose removed from a pass its covering, and although it was stated that other timbers were substituted, it is questionable if the latter were properly arranged, with the result that, the guide studs of the machine subsequently breaking, permitted its body (cylinder and drill) to leave the "seat" or "saddle," and striking Thornbury with much force precipitated him, or caused him to roll, into the pass, down which he fell 33 feet, and sustained serious injuries, which terminated fatally some two or three hours later.

The balance of the accidents need no further comment, beyond that which accompanies each in the tabulated list furnished herewith, but on the lines of the jury's recommendation on the last case cited, it behoves our Department to visit with a heavy penalty those men who take up the dangerous calling of mining and yet wilfully neglect their own safety.

Health of the Miners.—As a whole I have still to report this as favourable. There are cases where men are reported to be suffering from lung trouble, brought on by the inhalation of dust from rock-drills, but enquiries from the medical officers and secretaries of the Miners' Association both here and at Gormanston have failed to elicit any definite information. That ill-effects are present I have little doubt, but they are not at all rampant. However, there is no gainsaying this fact: that all "uppers"—especially in rises and the back of close stopes—where rock-drills are used, produce dust, which must eventually affect the health of the men engaged in such operations. Consequently, it becomes necessary that some suitable provision be made to remove this menace to health. Hydro-pneumatic sprays have been mounted on the drills, but they produce an excess of vapour in the air, the humidity of which soon becomes uncomfortably apparent, and this device has met with general condemnation from the workmen, who invariably state that the dust is not allayed by this method, but made "slimy" (as their expectorations demonstrate), and hence they prefer it in a dry form, without an accompanying wet jacket.

Latrines Below Ground are in general use at the North Lyell Mine. The design of the model of a commode I obtained from the Chief Inspector of Mines while in Victoria has been tried, but the balance of the conveniences are open seats, and the effluvia in their near vicinity is offensive, and sometimes nauseating. A plentiful supply of deodorants is provided, but whether from laxity of use or other causes the presence of a nuisance is at times apparent. Receptacles for crib-wrappers and waste food find little approval from those whom it is intended to benefit, and only that the mine is well stocked with rats, which act as scavengers, another evil would arise.

The Temperature throughout these workings is remarkably cool. During the hot weather in the last month I took various readings, and the highest registered was that at the top of the "upcast," which was 15 degrees Centigrade, while at the plat of the 1100-feet level it only read 11 degrees. The "dead ends" to this last level, and to which no stope-connections have yet been made, being also cool and pleasant, while the quality of the air varied from 0·15 to 0·20 Co^2, which compares favourably with any other large mine in the Commonwealth.

Future Prospects.—Those of the Mt. Lyell group are exceptionally favourable, and the establishment of high-grade ore (bornite) at the 1100-feet level of the North Lyell Mine must tend to increase the general manager's estimate of this mine's reserves considerably.

At the Iron Blow underground mining is actively resumed at the Nos. 6, 7, and 8 levels, which, in addition to the extractions from the open-cut, will produce the necessary complement of basic ore required to successfully treat that from the North Mine for years to come. The old South Lyell deposit is also in readiness to draw upon from the deepest level of the parent mine if ever required for this purpose.

The other mines in the district which are doing serviceable work are the Lyell Consols, Blocks, Comstock, and Tasman Crown Extended, and Davie P.A. and Darwin Syndicates, upon which properties the respective managers are satisfied with their developments, and speak hopefully of their prospects for the incoming year.

Miners and Others working in the district, *i.e.*, directly attached to the mines mentioned, number 2150 men, which number it is believed will be maintained, and most probably increased, during the ensuing 12 months.

LIST of Accidents in Inspector Curtain's District for the Year **1909.**

Fatal, 4 ; non-fatal, 10 ; total, 14.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single	Nature of Injuries.	Particulars.
1909. 20 Feb.	Mt. Lyell Mg. & Ry. Coy., Iron Blow, Open Cuts	Gormanston	Premature explosion	Collins, William	Married	Lacerations of face, eyes, arms, and chest	This man was assisting to remove a rock-drill from off a shallow blast that had been loaded with cheddite and gelignite, when it unexpectedly exploded, and produced injuries to his arms and eyes, from which, though he pursues light work at the mine, he is still suffering.
23 Mar.	Mt. Lyell Mg. & Ry. Coy., Nth. Lyell Underground	Nth. Lyell	Explosion of prepared round of blasts	Lapham, George	Ditto	Severe contused wounds over head and body that caused death	The deceased, after "spitting" a round of heavily-charged holes, found the rope on which he relied to assist his escape had fallen down the shaft, and before another rope could be handed down the charges exploded.
15 May	Mt. Lyell Mg. & Ry. Coy., Reduction Works	Penghana	An aerial bucket at No. 2 plant left the travelling-way	Higgins, Leslie	Single	Hand severely bruised and two fingers broken	Higgins was a tipper at the terminal station where a bucket left the rail, and its "clip" or fastener catching his hand against the hanger, produced the injuries stated. He has resumed work at the smelters.

21 May	Mt. Lyell Mg. & Ry. Coy., Nth. Lyell Mine	Nth. Lyell	Fell down the main shaft 400 ft., from the 700 ft. to the 1100 ft. plat	Richardson, Charles Edward	Ditto	Decapitated. Body mangled and otherwise broken	The deceased was an assistant platman, and during a temporary darkness caused by the electric current cutting off, appeared to have passed through the protecting gate in some way, and fallen. A Coroner's jury recorded a verdict "that there was no blame attachable to anyone."
25 May	Mt. Lyell Mg. & Ry. Coy., Iron Blow	Gormanston	Deleterious fumes after blasting	Brennan, James	Married	General prostration followed by pneumonia	Brennan, an old and experienced miner, was notified that some heavy charges were about to be fired. Believing himself perfectly safe, he remained below, with the result that the subsequent fumes penetrated these workings and seriously affected him and his mate.
10 June	Ditto	Ditto	Fell from face while barring down	Sweeney, John	Single	Principally shock and bruises, attended by partial paralysis of the right side	Sweeney was suspended on a rope held by Bird, and by some means the latter lost his balance and control and fell over the face, it is believed on to Sweeney, thereby adding to his (Sweeney's) injuries. Both men were conveyed to the casualty ward, which Bird left and resumed working within 14 days, but Sweeney has ever since been affected, and is at the present in one of the neighbouring States seeking medical advice.

LIST of Accidents in Inspector Curtain's District for the Year 1909—continued.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1909. 3 July	Mt. Lyell Mg. & Ry. Co., Iron Blow	Gormanston	Struck and jammed by a travelling loaded truck against another	Francis, Henry	Single	Bruised severely about the hips and buttocks	Francis and others were engaged trucking at No. 5 level, when a somewhat uncontrolled loaded wagon from a side line ran into him, and produced the injuries as herein described. He has resumed work.
21 Aug.	Mt. Lyell Mg. & Ry. Coy., Main Haulage	Ditto	While coupling a rake of trucks got the top of his thumb jammed off between the buffers	Fisher, James	Ditto	Top joint of thumb crushed off	Fisher was coupling and making up a rake on the top haulage, when an incoming shunt approached with more than ordinary speed and caught him. He is again working at the same employment.
15 Sept.	Mt. Lyell Mg. & Ry. Co., Iron Blow	Ditto	Loaded wagon of pyritic ore overturned	Ward, Marcus	Ditto	Compound comminuted fracture of right leg below the knee that subsequently necessitated amputation	Ward and two others were filling a wagon at the end of a slightly elevated tramline, when it "came back," and the bow or frame plate catching his leg, pinned it with such force to the floor that the bones were shattered. He is about on crutches, an artificial limb having been ordered for him from America.

4 Nov.	Mt. Lyell Mg. & Ry. Co., Nth. Lyell Mine	Nth. Lyell	Struck by the rebound of an uncontrolled rock machine, and fall down an ore pass	Thornbury, William Edward	Married	Fractured base of skull and other bodily injuries that produced death	Thornbury, with a mate named Apps, were the leaders of a contract party in stope 18, over the 850 feet level. They were afternoon shift, and prior to their taking possession of the stope it was conclusively proved that the pass down which the deceased fell was securely covered when the day shift left it. A rock machine had been "rigged," but, giving some trouble, timber was taken off the pass in order to provide a staging whereby it might be more readily adjusted, and although it was stated that other timber was substituted. it was certainly the want of this necessity that permitted the man to go through.
13 Nov.	Lyell Blocks Copper Mine	Nth. Lyell (Linda)	Fall of ground from the face of the main or Consols adit	Hughes, William George	Ditto	Left thigh broken, with bruised shoulder, back, arms, and hands	Hughes and a mate named Stapleton were preparing for another set (timbers), but, owing to the safe appearance of the ground, without pitching "back laths" (slabs), chanced it, with the same old but disastrous result—it came away, and catching him, caused serious injuries that still detain him in the hospital.

LIST of Accidents in Inspector Curtain's District for Year 1909—continued.

Date of Accident.	Name of Mine.	Locality.	Cause of Accident.	Name of Sufferer.	Married or Single.	Nature of Injuries.	Particulars.
1909. 25 Nov.	Mt. Lyell Mg. & Ry. Co., Iron Blow	Gormanston	Jumped or fell off a ledge he was barring down from, in order to avoid a piece of falling schist	Bantick, Louis	Married	Several cuts and abrasions about head, and bruised or jarred knee-joint	Bantick was clearing down a ledge some 12 feet up the face, in order to "rig" a machine, when, noticing some of the side country coming away, in endeavouring to avoid it he sustained the injuries which still incapacitate him.
2 Dec.	Mt. Lyell Mg. & Ry. Co., Nth. Lyell Mine	Nth. Lyell	Fall of mullock that had been run from the surface for filling (stowing) purposes	Marshall, Clarence Wilmot	Ditto	Left hip dislocated	Marshall and his mate (contractors) were engaged in 18 stope, 850 feet level. Their work was in "made ground," through which they had cut a gullet some 8 or 10 feet deep, with the result that it caved in, and caught both of them. Marshall, though recovering, is still unable to work.

19 Dec.	Mt. Lyell Mg. & Ry. Co., Reduction Works	Penghana	Fall of furnace girder	Jones, Robert William	Ditto	Two middle fingers of left and crushed above first joint that necessitated their amputation	Jones was assisting to straighten a girder, and for that purpose had rigged it on edge between the base frames of Nos. 4 and 5 furnaces, so as to be able to force it with a "bottle jack." While under pressure both kicked or canted, and the weight falling on Jones' hand, severely crushed it; from which he is still suffering.

THE CAUSE, EFFECT, INCIDENCE, AND PREVENTION OF THE PNEUMOKONIOSIS OF QUARTZMINERS.

By J. S. PURDY, M.D. C.M. (Aberd.), D.P.H. (Camb.),

Chief Health Officer for Tasmania.

The term "Pneumonokoniosis," introduced by Zenker, embracing the various forms of fibrosis of the lung due to the inhalation of dusts in various occupations, includes anthracosis (coalminers' lung), due to the inhalation of the comparatively harmless and, as statistics show, possibly beneficial coal-dust; chalicosis, due to the inhalation of mineral dusts producing the so-called stonecutters' phthisis, or the grinders' "rot," of the Sheffield workers; and siderosis, or silicosis, due to the inhalation of mineral dusts.

The consideration of the cause, characteristics, and means of preventing the lastnamed condition, more especially in quartzminers, is a subject, not only of medical academic interest on account of the special features of the disease, more especially from a pathological point of view, but also of economic value as indicating the possibilities of reducing the incidence and mortality of a disease affecting a special class of workers at an age when in most employments the individual as a working unit is at his best.

Early association with miners, together with some time spent as surgeon to a coal company in the north of England, followed by service in the Health Departments of three countries more recently developed in which mining is an important industry, afforded opportunity of observing conditions affecting the health of the workers and collecting information with regard to diseases connected with the calling of mining. After the South African war, one of my duties, whilst in the employ of the Natal Government, was attendance on workmen (European and native) engaged in mining.

It was just at this time that attention was being directed to the high mortality from what was known in Johannesburg as miners' phthisis.

So prevalent was the disease on the Witwatersrand, the great quartz gold-mining area of the Transvaal, that it had been estimated that out of 1377 rock-drill miners employed prior to the Boer war, 225, or 16·34 per cent., had died during the two and a half years immediately preceding the outbreak of hostilities.

From time to time comments were made in the press of the number of Rand miners who had returned to England and died of miners' phthisis, said to have been contracted in the mines at Johannesburg.

In August, 1902, a committee of the Transvaal Medical Society made an investigation and furnished valuable evidence to a Royal Commission set up later by Viscount Milner to enquire into the extent to which miners' phthisis prevails; to ascertain the cause of the disease; and to make recommendations as to the prevention and curative measures which should be adopted, either by legislation or otherwise. The investigations showed that miners' phthisis (or more correctly, silicosis, a chronic fibrosis of the lung) was due to the inhalation of fine angular dust suspended in the mine atmosphere, causing irritation, and so producing an enormous development of the delicate fibrous tissue in the lung. Bands and patches of solid useless material gradually encroach on the normal apparatus and interfere seriously with the respiratory functions. The quantity of silica in some of the lungs examined amounted to 24·4 per cent.

The average age of the deceased miners was low, according to one series of statistics, the average being 35·5 years. When tuberculosis was found it was usually a secondary development. The condition is in no way peculiar to South Africa. Thus, Cornish tinminers have long been credited with the highest death-rate from diseases of the lungs of any occupied class in the United Kingdom.

The fine, angular, gritty particles causing the disease can be demonstrated under the microscope and recovered from the affected tissues.

Irritation from dynamite fumes and from oil vapour contained in the exhaust air from the rock-drills are subsidiary factors.

Clinical investigation and examination show that the disease is an extremely insidious one, of very gradual development, having in its earlier stage little or no obvious effect on the general health, so that by the time the working efficiency of the miner becomes seriously impaired the disease is, as a rule, already well advanced.

Pathologically, the disease is characterised by a chronic catarrh of the larger and smaller bronchi, and of the air-cells with a slow but progressive increase of the fibrous tissue around the bronchi and blood-vessels, and throughout the substance of the lung, as the irritant penetrates into it along the lymphatic channels. The pleuræ also are thickened, and in advanced cases almost invariably extensively adherent to the chest-wall. The true lung tissue in the affected areas ultimately becomes replaced by fibrous tissue, and in advanced cases the consolidated areas are very extensive. The affected portions may come to have the consistency of indiarubber; the whole organ feels firm, and is of a dark-grey colour. In one case examined the tissue which could be described as even comparatively normal did not amount to more than a quarter of each lung. The breathlessness which is so marked a feature of advanced cases of the disease finds here its obvious pathological explanation.

Cavities may be found in the consolidated tissue; they are usually necrotic in origin. The disease is bilateral, the changes being similar in each lung, but varying in extent and degree, and while the process is a diffuse one, it is usually found to be more advanced in the posterior and lower portions of the lung. None of the cases examined showed naked-eye signs of tuberculosis.

An analysis of the material in an affected lung showed that it was similar to that of a case of "ganister miner's lung." Ganister is a close-grained, hard, silicious stone, containing about 95 per cent. of silica, and used for lining the bottom of bessemer converters.

Causation.—The inhalation of silicious dust is the main cause of the disease, the fine, angular, gritty particles can be demonstrated under the microscope, and can be recovered in some quantity from the affected tissues.

This conclusion, which would be justified from clinical and pathological considerations alone, is fully and finally confirmed by the fact that the mining processes which are admittedly the most dangerous, viz., "raising" and "driving," are precisely those in which the presence of dust in the air is at a maximum

The reasons for this are :—

(1) That the "raise" and the "drive" are culs-de-sac in which adequate ventilation is a matter of great difficulty.

(2) That many of the holes bored are "dry," emitting a constant stream of fine dust, with which the atmosphere is impregnated; and

(3) That the practice is frequent of returning after blasting a certain number of holes to blast the remainder or to inspect the results, before sufficient time has been allowed for the fumes and dust to have cleared away.

Rock-drill work in the stopes is not exposed to such great disadvantages, and few dry holes are there necessary, unless "overhand" stoping is employed.

At the close of each shift the whole atmosphere of the mine after blasting becomes charged with the dust and fumes so caused, and although this vitiation is not (so far as dust is concerned) as great as obtains under working conditions in a raise or drive, it still is a factor to be considered.

Also, apart from that actually caused by drilling and blasting, the dust raised in the subsequent handling and removal of the broken rock still further exposes the miner to the inhalation of dust. The dust particles inhaled are caught in the mucus of the respiratory passages. Nature has made a wonderful provision for rejecting foreign particles in the air we breathe in the cilia of the epithelium, which mechanically prevent the lodgment of dust; the act of coughing, often induced by reflex action, causing its expulsion. But, as constant dripping wears away the hardest stone, so the constant inhalation of dust overcomes the cilia, the first line of defence. Although the cilia ultimately fail to repel the invader, a still further defence remains in the action of phagocytes. Osler has termed the mucous and the alveolar cells the normal "respiratory scavengers." It is owing to these agencies that the air-cells are protected from the dust, the particles being taken up by the alveolar cells. Even these fail to deal with all the particles of dust, which thus penetrate the mucosa, reaching the lymph spaces. Arnold has shown how, having gained the lymph stream, they become distributed in the nodules surrounding the bronchi and blood-vessels, the interlobular septa beneath the pleura and the substernal, tracheal, and bronchial glands. Ultimately a condition of interstitial sclerosis is brought about.

The main symptoms are those of repeated attacks of bronchitis, with a more or less chronic cough, the ciliated epithelium of the bronchial tubes being gradually destroyed. At first the general health remains good, but as the irritation continues and the damage to the lungs becomes more progressive, shortness of breath is a prominent symptom. As the condition becomes advanced, dyspnœa is more marked, with wheezing, prolonged expiration, hurried breathing, and stridor.

Dr. Summons, of Bendigo, Australia, who records an examination of 192 cases, found that, "associated with the frequent recurring bronchitic attacks, the men complain of flitting pleuritic pains—'stitches in the side,' as they term them. Rarely was a case moderately advanced examined without finding evidence of old or present pleurisy, as a rule of the dry, chronic type. Notably was this the case in the region of the fifth and sixth ribs in the axillary regions. Here, also, where the parietal pleura is nearest the root of the lung, and where the inter lobar septum comes to the surface, the early pleuritic rubs are heard."

Physical Examination.—Expiration prolonged. On exertion breathing hurried and distressed.

Inspection.—The chief feature is diminished chest expansion and rigidity. Seldom does the expansion exceed $1\frac{1}{2}$ inches. A drawing in of the lower intercostal spaces, usually bilateral, may be noted.

Palpation.—Tactile fremitus generally increased, with occasional diminution in places.

Percussion.—Dulness most marked in the axillary region and towards the base. Sometimes cardiac displacement, with enlarged area of superficial cardiac dulness, due to fibroid contractions.

Auscultation revealed alteration in the respiratory murmurs, in the shape of diminution, prolongation of expiration raised pitch and different grades of bronchial breathing. Creaking sounds, perceptible both on inspiration and expiration, with cardio-respiratory murmurs along the left cardiac border and in the region of the apex beat—notably a series of short puffs synchronous with the heart-beat, and equally well heard on expiration as on inspiration, with crackles and fine pleural friction, in this region are common.

Although the rigidity and lack of expansion of the chest in a miner might suggest a condition of miners' lung, an examination of the sputum leaves no doubt as to diagnosis. Although at first the expectoration may be scanty, when bronchitis is developed it becomes sometimes profuse and muco-purulent, with a bluish-black discolouration, more especially when there is a caseation and necrosis of the lung tissue. The particles of dust, which in a quartz mine consist of minute, sharp, angular mineral substances with a jagged edge, can be recognised in the sputum, as they are also found in sections of the lungs enclosed in fibrous tissue, of which their presence has caused the formation.

In most of the Australian cases examined it was found that a condition of tuberculosis was ultimately grafted on the fibrosis, with progressive loss of weight and weakness. With the signs of consolidated and breaking-down lung, were also pleuritic signs. Hæmoptysis was rare. Examination of the sputum in advanced cases, even in those which were believed to be simple fibrosis, showed bacilli abundant.

On the other hand, in the Transvaal it was concluded, as the result of extensive investigation, that only in a minority of cases was a true tubercular phthisis found to co-exist or to have been superadded to a condition of fibrosis.

Dr. Haldane, reporting an investigation among Cornish miners, recorded 17 as tubercular out of 23 examined. We thus find a pure fibrosis of the lungs, or true silicosis, may continue as such, or through secondary infection become a case of tubercular fibroid phthisis.

Microscopic examination on sections of the lung show particles identical with those found in the dust of mines. It is related of a professor of pathology at Edinburgh University that, by an examination of a section of a lung at an autopsy, he correctly located the previous residence of the miner to have been Dalkeith, from a peculiar stratification of the minute particles. An interesting fact, showing that once mineral matter is deposited in the lung it persists, was pointed out to me by Dr. Robertson, Waihi, New Zealand, whilst I was making enquiries there *re* lung affections among miners. In a recent *post-mortem* on a man who had not worked in a coal mine for 40 years, the lungs were found to be in a condition of typical anthracosis.

The dust particles lie generally in elongated, well-defined areas, corresponding to the lymph channels. In the alveoli the bronchioles and bronchi, a condition of catarrhal inflamation is seen, with proliferation and shedding of the epithelium, together with phagocytic cells lying free in the alveoli closely mixed with dust particles.

The jagged edges cause a chronic inflammation, producing fibrous tissue, which ultimately forms an envelope to the particles.

The section is gritty to cut, and the whole lung of an india-rubber-like consistence.

The impairment of chest-expansion and loss of elasticity, due to changes in the lung itself, are still further increased by pleural adhesions and the gradual development of a condition of emphysema.

Dr. Summons found at Bendigo that "any and all pathological lung changes may obtain in the miner's lung, but the common changes are dust, pigmentation, and fibrosis primary, with emphysematous changes, and at some time or other infection with the tubercle bacillus occurs, and the pathological changes peculiar to the inroads of that organism are altered somewhat as the tissue affected is not normal, but a fibroid lung."

Investigation in New Zealand and Tasmania recently, more especially into the statistics of pulmonary disease among miners, has convinced me that, in addition to the changes of temperature to which miners are exposed, the contrast being sometimes marked on coming above ground after sweating at the hard work in the mine, as the cause of the high incidence of pneumonia in the mortality returns of quartz-mining districts, the damage done to the lungs by the inhalation of irritating dust makes a suitable soil for the pneumococcus.

The fact that alcoholism is common, but less prevalent than formerly, among miners, although a contributing factor, does not sufficiently account for the high death-rate among miners who develope pneumonia.

As to statistics, information was collected of 174 rock-drill miners who had died of chest diseases in the Transvaal. On the Gelderhuis Deep, 21 men, having worked rock-drills for an average period of 5·5 years, died from chest disease at the average age of 35·5 years. On the Gelderhuis Estate 33 men who had worked 6·9 years at rock-drill died at the average age of 34·4. On the Jumper's Deep 39 men who had worked rock-drills for 6·8 years died at the average age of 37; on the Crown Reef 32 men who had worked rock-drills for 8·8 years died at the average age of 32 years. From the Crown Deep 49 men who had worked rock-drills on an average for six years died at the average age of 36·6.

In Johannesburg Hospital, out of 93 males who had died from diseases of the respiratory organs from June, 1901, to November, 1902, 47, or more than half, were miners; as against 46 of all other occupations, according to Dr. Irvine, who was examined by the Commission.

On behalf of the Commission, out of 4403 miners officially declared to be working underground in the gold mines of the Witwatersrand, 1210 were medically examined. Of this number, 187, or 15·4 per cent., were certified by the examining doctors to be affected by the disease, while a further 88 were suspected cases. Their average age was 35·5 years; and 91·98 per cent. of the affected cases were employed on rock-drills. Only 20 men gave any family history showing a tendency to pulmonary disease. The average time the men had been employed as rock-drillers was 6·49 years.

Out of the 187 men referred to, 169 had been employed in the Transvaal for an average of 4·89 years, whereas 64 men had worked for an average of 4·76 years on rock-drills in countries outside the Transvaal. Only 24 of the men affected had been employed over 10 years at rock-drilling.

Dr. Walter Summons, of Bendigo, Australia, made an investigation into miners' phthisis in the Bendigo mines, and issued an excellent report in 1906, which shows that tuberculosis is prevalent among the 3650 miners employed there. From 1875 to 1906 there were 891 deaths from tuberculosis of the lungs, and 280 from chronic bronchitis. The total deaths from lung diseases has risen from 77·0 to 191·6 per 10,000. The number of deaths among miners from tuberculosis was, in 1896, six times as great as amongst adult males in Victoria generally. The death-rate from tuberculosis among non-miners in Bendigo, which has a healthy climate, has also increased. Thus in Bendigo, the number of deaths among females, calculated per 10,000 living, is 12·03, as contrasted with 12·03 for the female death-rate throughout Victoria.

Bendigo had a total consumptive death-rate in 1902-5 of 22·24 per 10,000 of population, as compared to 10·78 for the whole of Victoria, whereas in 1870-72 the corresponding figures were 16·61 and 11·85 respectively.

Prior to 1880 the detrimental effects of the machine-drills had not become manifest. In Bendigo, unfortunately, the statistics show that tuberculosis is rife, and that the tubercle bacillus has added to the dangers incidental to the inhalation of dust.

With regard to New Zealand, speaking generally, the disease is not so prevalent among miners as in the Transvaal. In New Zealand provision is made by the mining regulations for the supply of water for jet purposes in developmental work. This is one of the recommendations, together with the heavily penalising of the miner who fails to use the water in drilling holes, on which stress was laid by Dr. Porter, Medical Officer of Health, Johannesburg.

At Waihi, the largest New Zealand gold mine, especially are the figures available reassuring. Thus, the registrar (Mr. Mann) tells me that during the past 10 years there have only been 30 deaths from respiratory diseases amongst the miners in the Waihi district. There are altogether 1600 men engaged there in mining, 700 of whom are underground workers. That makes a yearly average of 1·87 per 1000, contrasted with 1·6 per 1000 for the four centres, including deaths from all ages above five years, for respiratory diseases.

Thus, the Waihi figures confirm the general opinion prevailing there that miners' phthisis is not common in that town, as the conditions under which the men work are as near perfect as the industry will allow. However, respiratory diseases are still a noticeable factor in the sickness rate. Dr. Robertson, superintendent of the Waihi Hospital, has supplied me with the following from the hospital register :—

Respiratory Diseases in Waihi Hospital, from 1904-8.

Age.	Phthisis.	Pneumonia.	Bronchitis.	Pleurisy.	Asthma.
Males—					
1–10	...	10	1	...	...
11–20	1	4	...	1	...
21–30 ...	2	13	2	1	...
31–40	3	9	2	3	...
41–50	3	3	5	4	3
51–60	...	4	4	...	1
61–70	1	...	10	1	...
71–80	...	1	2	...	...
Total...	10	44	26	10	4
Miners in these totals	5	20	7	2	3
Females—					
1–10	3	6	2	...	...
11–20	2	2	1	...	...
21–30	3	3	1	3	...
31–40	2	3	...	...	...
41–50	...	1	...	...	...
51–60	...	...	...	...	...
61-70 ...	...	...	1	...	...
71–80	...	...	1	...	...
Total	10	15	6	3	...

At the ages from 21 to 60 it is noticeable that 60 men were affected with respiratory diseases, as contrasted with 16 women during the same age period.

Mr. Henry Smith, registrar for Reefton, New Zealand, informs me that the total deaths among miners from respiratory diseases for the last 10 years was 72.

Dr. Conlon, of Reefton, says he knows of no "old" working quartzminers in Reefton. With possibly 700 miners, I can point to only one working miner of the age of 55. The disease usually manifests itself at about 40 years of age, and death ensues after that from five to 10 years.

In Tasmania, Mr. Twelvetrees, Chief Inspector of Mines, writing to me on the subject of pneumokoniosis, states that there are four mining centres where lung trouble of one sort or another exists, viz.—(1) the gold-quartz mining field of Beaconsfield; (2) the gold-quartz mining field of Mathinna; (3) the galena mining field of Zeehan; (4) the cupriferous pyrite mining field of Lyell. During a recent visit to Zeehan I investigated the records of the registrar as to the incidence of pulmonary diseases among miners, as indicated by the death returns. For the period of 10 years, 1st January, 1889, to 1st January, 1910—the number of miners in the Zeehan district being given as 1489—11 miners died of phthisis. Eight of these were over 40 years of age, and six came from outside Tasmania, of whom four were from Cornwall (England), one from America, and one from Moonta (South Australia). The two Tasmanians came from Kingborough and Bothwell, agricultural districts. The other three, aged respectively 19, 20, and 25, came from Beaconsfield, Bothwell, and the Forth. During the same period, 39 miners died from pneumonia, five from emphysema; two of whom came from Cornwall (England), aged 24 and 64; two from Isle of Man, aged 41 and 54; and one from Hobart, aged 73. I went down two of the mines, the Oonah and the Tasmanian Copper Mines, and found that the rock-drill machine was not in common use; also, in the main, the mines are wet, and there is little quartz worked, which accounts for the comparative freedom of the Zeehan miners from diseases associated with the inhalation of dust.

With regard to coalminers, anthracosis is not only a harmless condition, but the statistics show that coalminers, as a class, suffer less from tubercular and respiratory diseases, especially, than other trades.

Dr. Ogle, who places coalminers at the head of the list as regards freedom from respiratory diseases in the supplement to the 45th Annual Report of the Registrar-General England, explains the comparative innocuity of coal-dust in causing lung disease by the microscopical character of its particles, which are comparatively free from sharp points and corners.

He is also inclined to contribute to coal-dust a special property of hindering the development and arresting the ingress of tuberculosis, a disease which one might expect to be very fatal to coalminers, from the fact of their working in a heated, vitiated atmosphere, and being liable to sudden alterations of temperature in going to and leaving off work. In 1904, in the "British Medical Journal," I was able to supplement and confirm from experiences in 1898 at Cambois and Ashington (one of the largest coal mines in Great Britain) the opinion of Dr. Trotter, of Bedlington, a neighbouring colliery in Northumberland, that the women, speaking generally, were affected more than the men in colliery towns. This is due to the bad housing and sanitary arrangements, a condition of affairs which, unfortunately, existed until recently at Huntly, the largest coal-mining centre in the North Island of New Zealand.

Prevention.—If cessation from work at the onset of early symptoms were the rule, fibrosis of the lung from the inhalation of silicious dust would probably not progress. The pathological character of the disease is in itself sufficient evidence that when well established it cannot be wholly cured, although removal from its existing conditions will unquestionably greatly ameliorate its symptoms and prolong life.

Since the generation and inhalation of rock-dust are the primary factors in its production, the problem of prevention becomes the purely mechanical one of controlling the generation of the dust and preventing its inhalation. Thus, dry mining should as far as possible become wet mining. The following suggestions seemed to the Transvaal Committee to be of value :—

1. That the general ventilation and sanitation of the mines be rendered as efficient as possible.
2. That "raising" as far as practicable be discontinued.
3. That some arrangement be provided which will under all circumstances ensure a jet of water being thrown into each hole as it is drilled.
4. That wherever possible, and especially in a "raise" or "drive," water should be provided, by spray or otherwise, to lay the dust after blasting and during handling.

In a despatch to the Secretary of State for the Colonies, dated April 18, 1904, Viscount Milner, Governor of the Transvaal, records the gazetting of the following as an outcome of the Miners' Phthisis Commission :—

Legislation—Regulations.—(*a*) Making managers responsible for the sanitary conditions of the mines and works of which they are in charge, and regulating the minimum number of sanitary conveniences for persons employed, both on the surface and underground. (*b*) Making it compulsory that a suitable change-house be provided (to be used by white miners) proportionate in size to the number of white men employed. (*c*) Making certificated miners responsible that no person enters their working-place until the fumes caused by the explosives shall have been sufficiently dissipated.

Dr. Porter, Medical Officer of Health, Johannesburg, a member of the subsequent Mining Regulations Committee, writing on 30th October, 1908, in reply to enquiries, states :—

"We have gone pretty thoroughly into the question of miners' phthisis, and we are convinced that, on the Rand, at any rate, the evil can be successfully combated by the conversion of 'dry' to 'wet' mining, by the use of jets in all developmental work and in drilling of what are called locally 'back-holes'; that is, holes which are being drilled upwards and will not therefore retain water.'

"I may say that the Western Australian Commission, in its report of 1905, were very favourably impressed by the possibilities of an apparatus devised by Mr. Armand Caudan, of Kalgoorlie, for use with rock-drills. It consists of an adjustable tubular arm with a trumpet-shaped mouth, which he proposed to fit pretty closely to the rock-face round the drill hole by means of a pneumatic cushion. I find also that the same idea has occurred, apparently quite independently, to Dr. J. S. Haldane, who, in his report on the health of Cornish miners, writes as follows :—

> 'We made a number of experiments as to the practicability of surrounding the mouth of the hole by a wetted canvas bag, through an opening in which the drill passes, the bag itself being fixed to a metal ring pressed by means of an adjustable rod against the rock round the hole, and luted round with clay. We found that this arrangement was very effective in stopping dust. It did not, however, appear to be practicable, as it was often impossible to fix the ring securely, particularly when the surface was very irregular and the rock crumbly.'

"Engineers on the Rand, however, consider this suggestion an impracticable one, as miners who will not take the trouble to use the ordinary jet will certainly not take the trouble to adjust a mechanism of this kind. I think that I am safe in saying that our Commission will at once recommend the compulsory provision of sufficiently clean water for jet purposes at each working face in developmental work, and the heavily penalising of the miner who fails to use the water in drilling holes."

"It appears to me that really the only place in which the exhaust apparatus would fill a useful purpose on these fields is in a very steep rise where the use of the water-jet will practically mean that the men are kept wet throughout the whole shift.

"Against the use of the water-jet is the objection that wetness favours ankylostomiasis, but this can be combated, as in the Belgian and Westphalian mines, by proper attention to excrement disposal."

One of the most useful contributions to the solution of the problem was the offer by the Transvaal Chamber of Mines of prizes of the aggregate value of £750 for practical suggestions and plans for laying the dust, with the object of drawing upon the experience of various countries where mining is carried on, and of eventually adopting the best means of removing or minimising the causes of the diseases. An advertisement inviting competitions was inserted in the local press, and in leading papers in various parts of England, Europe, the United States, and the Australian States. Whilst stating that it possessed no definite information as to the cause of the disease, the Chamber pointed out that the general assumption was that it was chiefly due to the inhalation of the fine dust given off during machine-drilling operations, and that it would be desirable in submitting devices to specially take into consideration :—

1. The applicability of the device or apparatus to the existing system of machine-drilling.
2. The practical demonstration of the device or apparatus.

Some 240 competitive proposals were sent in.

The following cutting from the "Transvaal Leader," of 6th May, 1904, describes the apparatus for which the prize was given :—

"It is particularly gratifying to note that the first prize has been taken by a Rand engineer in competition with engineers from all parts of the world.

"The excessive mortality among miners, caused through the inhaling of fine dust in the mine, whilst he was general manager of the Wolhuter Gold Mines, led Mr. Britten to study the question, more particularly as to some means or method by which the dust might be done away with or laid. It was almost immediately apparent that it was utterly impossible to do away with the dust, and therefore the only alternative was to devise some means of laying it, the simplest method of which appeared to be by the use of water."

Essential Points.—In designing any apparatus the following essential points have to be taken into consideration :—

1. Economy of water and air.
2. Simplicity of design, in order to render the apparatus easily workable.
3. Economy of space to be occupied, and a design that would not cause any great delay to the drill-men's work.

With these objects in view several apparatus were constructed, all of which, on trial, were found to fail in one or other of the respects above mentioned, and Mr. Britten attributes this to the fact that they were on the ejector principle.

The Principle of Atomising.—The design ultimately adopted embraces the atomising principle, which admits of the minimum amount of air and water being used, with the maximum benefit resulting from the use of a given quantity of water. The dust occasioned through drilling and blasting operations is of such an infinitely fine nature that Mr. Britten found the application of water by means of an ordinary spray or rose allowed a very considerable quantity of dust to escape through the water, but, by the use of the atomiser, where the water is atomised into infinitesimally small globules, it is impossible for any atom of dust, however small, to escape being thoroughly saturated, and when once this is accomplished it falls and never rises again. The small atomiser, for use when drilling, is attached to the throttle-valve of the machine-drill by means of a ⅝-inch rubber pipe, and is thus made part and parcel of it, so that the atomiser works when the drill works, and stops when the drill stops; thus the miner has no second valve to operate, and, unless he disconnects the pipe, must derive the benefit from the apparatus during the whole time he is at work. The bucket containing the water, and upon the handle of which the atomiser is clamped, can be hung upon an arm attached to the column of the drill or placed upon the ground. In all the inventor's experiments the quantity of water used has not been more than 10 gallons in a rise, and half that quantity for the dry holes in a drive during one shift.

Use in Drives and Stopes.—For the laying of dust after blasting in drives, rises, &c., a slightly larger apparatus is used, and connected direct to the air-main about 50 feet back from the face,, instead of to the throttle-valve of the drill, and so soon as the miner has lit his charges he starts the atomiser upon his exit from the face, which plays towards the face, and thus prevents any particle of dust passing it. As the face advances, the atomiser is carried further in for operation. The intervening space between the atomiser and the face, once damped by means of the spray carried in the hand, renders all the relief required.

For stopes, a bucket sprayed along the walls of any stope twice a week is all that is necessary, as the roof and footwall of the slope become so moistened that when once any particle of dust attaches to it, it never rises again. It is evident that the longer the apparatus is in use in any particular portion of the mine, the more efficient must be the result. For disinfecting and sanitary purposes its methods of disseminating disinfectants is far superior to any method now in vogue, inasmuch as the disinfectant is thoroughly distributed.

Ventilation.—"Wherever the atomiser has been at work at the top of a long rise or at the end of a long drive with a dead end, the atmosphere is kept cool and refreshing. The more important point of increasing the ventilation of an entire mine can also be accomplished by the use of two or three of the larger size fixed near the top of the main downcast shaft of the mine. Its action is to cool and saturate the air as it enters the shaft, which thus more rapidly descends, forcing the hot vitiated air of the mine to the surface.

"An interesting experiment has recently been made by Mr. Weldon, the Chief Government Engineer, now Acting Commissioner of Mines, at the Rietfontein Mine, where by means of two of the larger apparatus, he increased the ventilation of the mine 600 per cent., and he is further of the opinion that had two more of the atomisers been placed to work a considerable distance down the shaft an even better result would have been obtained."

A further extract, an interview with a rock-drill contractor, from the "Transvaal Weekly Illustrated," 6th September, 1909, gives an idea of the opinion on the Rand as to the new apparatus, which has been slightly modified since its introduction :—

"What do you think of the new jet that has been introduced? Had it been introduced years ago there would be more good miners alive to-day than there are.

"Where does the benefit of its introduction come in? First of all, in the collaring of a hole. Formerly, when the machine was collaring no water was applied to the pulverisation. The force used at this stage of drilling a hole is enormous, you must remember. Few people on the surface know that when collaring is going on sparks fly to an intensity which literally illuminates a drive. Just think of the contact of iron with a solid rock driven at a pressure of from 60 to 80 lb., and projected at such a rate that would make ordinary counting of the strokes impossible. The sparks emitted have been responsible for the loss of sight (partial and total) of scores of miners, and it is while the miner is engaged in collaring a hole that most of the damage is done to the lungs. This is where the new jet comes in; and no sparks fly when it is used. The jet has now relegated "dry" holes to oblivion. A few months ago, before a certain Government notice was issued by Mr. Warington Smyth (Secretary of the Mines Department), the spray was unable to allay the dust in dry holes, created a fog, and was more nuisance than enough to the operator. Now a boy may direct the jet at a hole and keep the atmosphere almost pure. Where the jet has been installed the thanks of the miners have followed. It has increased the degree of comfort experienced in working underground, and as a life preserver, perhaps, there is no scheme that could be introduced that could better stave off the approach of lung trouble."

With regard to the use of respirators, experience has shown that the greatest objection is made by many of the workers in dusty trades to their use.

Under actual working conditions they are found to be an annoyance even by those whose lungs are healthy, and where the breathing is already impaired their use is still less practicable.

Examination of Workers.—The New Zealand Government two years ago introduced legislation giving compensation to the dependent relatives of a worker who died from pneumokoniosis contracted in mines. A clause making medical examination of miners a necessary accompaniment of this clause was so bitterly opposed by the miners' unions as to cause practically a strike. No insurance company would undertake the unknown risk, which had ultimately to be taken over by the Government Insurance Department until Parliament assembled, when, although no actual case had been reported for compensation, the clause was struck out. It is advisable, however, that a regulation be made requiring a certificate as to health from all young persons before commencing underground work, on the lines generally required in the United States.

Education.—Lectures and instruction should be given in mining centres, and it is advisable to enlist the co-operation of the miners' societies in spreading information as to the cause and prevention of miners' phthisis. In all schools in mining areas opportunity should be taken to demonstrate to the children the dangers of dust-inhalation and the means of prevention.

More especially should stress be laid on early training in nasal breathing. The mere presence of an excess of carbonic acid in the atmosphere causes more frequent and hurried breathing, and also encourages breathing with the mouth open, thereby causing the inhalation of more dust. Consequently, apart from the better ventilation of mines, the early acquirement of the habit of nasal breathing is especially advisable in those who will in later life be exposed to conditions creating dust.

Provision for Those Affected by Miners' Phthisis.—Whilst from the nature of the disease it is impossible to hope that, when the pathological process is well developed, even removal from the conditions in which he works will leave the worker without some permanent damage to his lungs, yet there is no question that, in cases where the process has not gone too far, great amelioration may be looked for by that means. The fact that men suffering to some extent from chest symptoms before the South African war were able to serve throughout the campaign with good health, but on resumption of work underground rapidly relapsed, and in several cases succumbed, showed that lungs capable of maintaining health in the open air were unequal to the strain of a return to the conditions of mining work. Prospecting also often insures a miner having a respite from the conditions underground, and gives him practically a new lease of life.

In Victoria (Australia) provision is being made for miners who suffer from phthisis. In New Zealand the results of treating miners at the Government Sanatorium have not been satisfactory, so far as recording any recoveries.

The tree-planting camp at Kerere, now managed by the Forestry Department would offer really the best solution to the problem of providing work for men whom it is considered have become affected in the mines. It is almost impossible, however, to induce a man to leave lucrative work and take up other employment not so highly paid.

However, as the effects of dust-inhalation are better realised, and workers recognise that economically 10 years' work in the open is better than two underground after the lung is affected, it is probable that the large friendly societies and miners' unions will co-operate in assisting movements to secure treatment for those affected on the lines of an open-air working colony.

Tasmania.—At Queenstown, the registration centre for the Lyell field, embracing Queenstown, Gormanston, North Lyell, and Linda Valley, during the period 1899-1910, there were recorded three deaths from phthisis and three from pneumonia among miners, the number of whom employed for the year ending 1909 was 832. Of the miners who died from phthisis, two were aged respectively 38 and 44, the birth-places given being Glasgow and England. The other, aged 47, hailed from Hobart.

Of the three cases of pneumonia, aged 24, 25, and 49, one came from New South Wales and the others from Lefroy and Oatlands, Tasmania. Of three other cases of miners who worked on this field alleged to have died from miners' phthisis, I have heard from Dr. Wilson, Medical Registrar, Melbourne Hospital, that one, L———, died there on 17th May, 1910, of ulcerative endocarditis of the aortic valve. A *post-mortem* showed no evidence of tubercle in his lungs. Of the other two, one was ailing four years and off work nearly 12 months. His was considered, by Dr. Walpole, of Gormanston (to whom I am indebted for much valuable information), to be a pure case of fibrotic change, due to dust and fume inhalations, without any tubercle. The other, who died in Victoria, was tubercular, with a tubercular family history.

Records of cases which have worked on this field and died are—

W———, an old miner, who had worked on many mines and left Queenstown four years ago, dying a year or so later in Launceston Hospital.

D——— worked on the Lyell field for many years, until shortness of breath compelled him to follow other occupation. Died in Bendigo last November, 10 months after an attack of pneumonia, but some years after giving up mining.

C——— came to Lyell after working in Bendigo and Broken Hill. Had, on arrival, cavities, breathlessness, and was emaciated. After working only a few months at North Lyell Mine returned to Victoria, where he died.

H——— came under medical attention two years ago. Had worked underground at the North Lyell for many years; tubercular; no family history; died recently.

Other eleven cases known to be affected are still living, but of these five have left the district.

It may be mentioned that Queenstown enjoys some reputation among miners as a resort for cases of lung diseases, owing to an idea which arose that the fumes from the smelters were good for the treatment of consumption.

It is trusted that an arrangement will be made between the Queenstown and Strahan Hospital Boards for the treatment of any cases of phthisis at the hospital at Strahan.

At Waratah for the 10 years ending 1st January, 1910, no miners died from phthisis; whilst of five deaths from pneumonia, one had resided only one month in the district. At the mines here, the chief of which are the Mt. Bischoff Tin Mine, employing 419, and the Magnet Galena Mine, with 164, miners, rock-drill machines are seldom used.

A satisfactory arrangement for making provision for the care and treatment of miners who contract respiratory diseases would be the inauguration of a fund maintained by contributions from the mineowners and the men, by which monthly payments were made in the form of an insurance to provide the cost of maintenance of cases of lung disease, and to also provide for the families of those incapacitated—practically an extension of the present benefits secured by membership of some friendly societies.

In answer to enquiries, Mr. G. H. Knibbs, Commonwealth Statistician, has furnished the following particulars for the Commonwealth, which show the death returns among miners from lung diseases, as well as the death rates from these diseases among all male workers:—

	1907.	1908.	1909.
Deaths of males working in mines and quarries—			
Under 25	77	78	54
25 to 64	1001	950	930
65 and over	748	809	719
Not stated	4	8	3
Total	1830	1845	1706
Deaths of males from pulmonary and laryngeal phthisis—			
Under 25	261	290	261
25 to 64	1372	1417	1383
65 and over	167	157	129
Not stated	1	3	4
Total	1801	1867	1777

Deaths of males from diseases of the respiratory system—			
Under 25	955	851	892
25 to 64	916	937	884
65 and over	962	930	1044
Not stated	5	6	1
Total	2838	2724	2821
Deaths of males in mines and quarries (all ages)—			
From pulmonary and laryngeal phthisis	236	252	244
From diseases of the respiratory system	252	264	261
Death rates per 1000* of males, 25 to 64—			
From all causes	9·76	9·93	9·47
From pulmonary and laryngeal phthisis	1·44	1·46	1·40
From diseases of the respiratory system	0·96	0·97	0·89

* On the assumption that the age composition of the population in 1907, 1908, and 1909 was the same as at the census of 1901.

GUNN'S PLAINS, ALMA, AND OTHER MINING FIELDS, NORTH-WEST COAST.

I.—INTRODUCTION.

ATTENTION has been lately directed to some copper ore properties situate up the Leven and Forth Rivers, and these ore deposits having some bearing on the question of railway facilities now under discussion, it was deemed advisable to make a geological examination of the localities and ascertain the prospects of any mineral output which would contribute in any way to the traffic on the proposed line to Castra.

The examination was considered also as likely to be of use in elucidating further the geology of the North-West Coast, as up to the present not much has been definitely known with respect to the sequence of the strata, more especially as regards the position of the copper-bearing beds in the geological record.

Copper and silver-lead ore veins are being frequently discovered (in many instances rediscovered would be the more appropriate term) in the older rocks which have been cut down into the creeks and rivers, but none of these occurrences have so far been shown by actual work to be of any great importance. Some of them have been worked and abandoned as soon as the ore-shoot pinched, and as a result a feeling of uncertainty has developed as to the outlook and the possibilities of these fields. Some information seems to be necessary in regard to the correlation of the ore-deposits with those in other parts of the island, and their probable permanence. The geological age of the enclosing strata is a question which of necessity has hitherto remained unsettled, and it is quite time that some attention should be paid to it. Economic geology and general geology are indissolubly connected, and if one is pursued to the total exclusion of the other, results of work cannot be illuminating and informative, while the State eventually must inevitably suffer reproach.

For the last 18 months some work has been carried on at Gunn's Plains, 12 miles from Ulverstone, by the Copper

Creek Mining Company, and as the Public Works Commissioners have strongly recommended the construction of a line of railway from Ulverstone through the Plains, under the provisions of "The Local Government (Tramways) Act, 1907," mining enterprise in the district merits consideration. Some other ore outcrops occur along the Leven River, which may in time receive attention. Some of the known copper ore occurrences on the east flank of the Dial Range may also receive a stimulus when this tramway is built. A little silver-lead prospecting at South Preston likewise indicates the existence of mineral-bearing country within range of the proposed railway.

Mineral country also exists between the Wilmot and Forth Rivers, a short distance above their confluence. West of the Forth is the old Barrington Copper Mine, on which the Alma Prospecting Syndicate has recently resumed work. Deposits of barytes occur on this property.

Westwards, between the Blythe and Emu Rivers, is a line of copper and iron ore deposits, tried for copper ore by the Burnie Copper Company and the Rutherford Company somewhat inconclusively. The former company would doubtless have proved its lode to a greater depth but for losses in other parts of Tasmania. The Rutherford lode remains to be tested. The noted iron ore lode of the Blythe is in this belt.

This coastal country, largely covered with basaltic soil and occupied by agriculturists, unquestionably possesses mineral lodes which indicate possibilities and appeal legitimately to mining enterprise. The points at which mineral appears are, however, somewhat scattered, and this renders the work of fixing the relationships of the deposits and making comparisons a little difficult, for the area under review is wide and broken.

The limestone beds on the Coast, too, are of importance. Good limestone occurs at Railton, the Don, Gunn's Plains, and the same stone is known at the Blythe River. These beds are destined to be greatly exploited as population increases, both for building and agricultural purposes.

II.—PREVIOUS LITERATURE.

Official reports on various parts of the Coast have been issued from time to time by the Government of Tasmania.

In a report by Mr. G. Thureau, Government Geologist, on the North-Western mineral deposits, dated 30th December, 1881, reference is made to quartz reefs up the Castra-road, S.S.E. from Ulverstone, and to the Barrington Copper Mine, near Alma. Mr. Thureau describes Reid's reef as cropping out at the side of a gulley emptying into the Clayton Rivulet: "This reef observes a strike of W. 3° N., and the strata in which it is embedded of N. 38° W. It is a very massive one, being over 15 feet wide at the surface, with a northern underlay of 65°. The quartz is hard, coarsely laminated, and reddish in colour near the surface; where the stone has been followed beneath the surface it assumes a bluish hue, owing to the presence of crystalline iron pyrites . . . The tunnel intersected the reef at a distance of 60 feet from its mouth, and the quartz broken down exhibits a more favourable appearance."

At this time the Barrington tunnel was "driven in a north-westerly direction to a length of 281 feet. Two crosscuts extend from this tunnel to the west for a length of 33 feet and 32 feet respectively."

Mr. A. Montgomery, Government Geologist, in his report on the Gawler River, &c., of the 29th July, 1895, described a visit to a gold-bearing reef which had been discovered about 2 miles from Ulverstone: "The lode consists of from 8 to 12 inches thickness of quartz and some 6 inches of clay, the latter being on the walls. The quartz has a vitreous appearance, and contains a good deal of iron pyrites, with a little copper pyrites and blende. Strike about W.N.W. and E.S.E., dip 67° to the northward. . . . Several prospects washed from the quartz gave very poor results, though a little gold was seen, and it would appear that the reef is auriferous, but as yet nothing like payable. It might, however, be prospected with advantage, and should be traced both east and west along its strike, and tested at intervals to find if its gold contents increase. . . . From time to time it has been reported that a little gold occurs in the Gawler Range itself. . . . Though nothing of much consequence has yet been found, it seems probable that the locality is of a favourable nature for minerals, more especially gold, and is therefore worth some attention from prospectors."

The writer, in his report on the Dial Range, 19th December, 1903, described some of the copper ore formations on Walloa Creek, and his report on North-West Coast mineral deposits, 26th July, 1905, included an account of the Barrington Mine at Alma.

III.—PHYSIOGRAPHY.

This part of the North Coast is a raised peneplain dissected by river systems, the waters of which are discharged into Bass Straits. Two fine rivers—the Leven, at Ulverstone; and the Forth, at Leith—empty into the sea at those places, having their sources far away in the interior in the high land near Mt. Pelion, and west of the Middlesex Plains. These rivers, with their tributaries, have cut deep channels through the basaltic covering of the tableland, through the sub-basaltic gravels, and down into the underlying ancient rocks, with the result that sections of the latter are frequently well exposed in the banks of the valleys or walls of the river gorges. Each of the rivers named has an estuarine expansion at its mouth, and the adjoining flats occupying the township areas have only emerged from the sea within the Recent period. The Leven, at 10 miles south of Ulverstone, is not more than 150 feet above sea-level, while the surrounding plateau has risen to between 700 and 900 feet.

The town of Ulverstone is situated at the mouth of the River Leven, on both banks. This thriving town is in a picturesque position, commanding striking views of the Dial Range to the west, the gnomon of the dial being a prominent feature. The flat ground extends back from the sea for nearly a mile, and then the land rises to form the table-land, the soil of which nourishes the potatoes and other root crops for which this coast is famous. Various gorges and romantic river reaches occur at intervals along the course of the stream. At the south end of the reserved township of Leven the road passes alongside the river through a charming ravine for 2 miles, winding round the base of the Sugar Loaf before it emerges on Gunn's Plains—an open, hill-locked valley, 5 miles in length from north to south. The alluvial soil which forms the floor of this valley is highly suitable for agriculture, fruitgrowing, and dairying. The Public Works Commissioners, in reporting on railway facilities for the Castra District, and recommending the construction of the line through Gunn's Plains and Preston to Blackwood Park, say:—"Gunn's Plains have an area of 9040 acres, mostly rich agricultural soil, of which 697 acres have been under cultivation this year (1908); 1300 acres have been cultivated, and are now in grass; 5543 acres are in rough grass; and 1500 acres in scrub. The produce this year has totalled 2092 tons

The River Leven keeps to the west side of the Plains, having probably cut its channel from time to time further and further west. The bed-rock underlying the alluvial bottom is limestone, and the open valley which constitutes the plains probably owes its formation to this. After the river has traversed the limestone belt and enters the hard conglomerates and igneous rock area, the plain contracts to a narrow ravine, the only available outlet for the river. The massive rocks of the Dial Range system are responsible for many windings of the stream on its way to the sea.

A good carriage-road exists from Ulverstone to the Plains. After attaining an altitude of 700 feet above sea-level it descends through Leven for 500 feet in a couple of miles to the farms on the river.

IV.—GEOLOGY.

The rock-types developed on the North-West Coast are of somewhat numerous varieties. They have, so far, been imperfectly examined, and offer a fine and comparatively untouched field for geological study. Students may usefully devote time to the examination of the different rock-exposures on the sea-coast, and to following up the geology inland.

The geological sequence and the rocks observed near Ulverstone and the Forth will first be dealt with, and some outlying occurrences also referred to.

(1)—Pre-Cambrian Strata.

These are strongly developed at Ulverstone, and deserve attention, as being the floor on which the whole superstructure of our Cambrian and Post-Cambrian sediments rests. We have not yet succeeded in obtaining evidence of the existence at surface in Tasmania of rocks really belonging to the Archæan complex. The oldest rocks which have been found are those dominantly sedimentary foliated strata which belong to the Upper Pre-Cambrian. The United States Geological Survey has separated these sedimentaries from the igneous Archæan complex below, and termed them Algonkian. Chamberlin and Salisbury, the American geologists, have designated them Proterozoic, reserving the title Archæozoic for the great granitoid and schist series of the Archæan. It is these Algonkian schistose quartzites and micaceous schists which occupy so large an area in the western part of Tasmania. They constitute the headlands which project into the sea at Cox's Bight and Port Davey, and form the mountain ranges generally in the south-west of the island. They form a large block of country west of the Denison Range and the Thumbs, and comprise a good deal of the high land at the head of the Forth. The quartzite at Rocky Cape and Sisters belongs to this division, as also the micaceous schists of the lower Forth. Further east the group is represented by the schists of the Asbestos Range.

The bearing of these strata does not diverge much from north and south, and is mostly a few degrees east of north. At Ulverstone, on the East Beach, they are exposed in long lines at low tide, running out northerly into the sea, and dipping steeply to the west. At Picnic Point, on the West Beach, they strike N. 20° E., with a north-westerly dip. Going west they crop out occasionally in the sand, but are shown strongly at Goat Island. In the bay west of this island they are covered by Tertiary basalt, and on the beach opposite Barkworth's are succeeded by drab slates. The last strike of the schistose conglomerate west of Goat Island is N. 10° W., while the slates of the succeeding systems strike N. 20° W. The junction of the Cambrian and Pre-Cambrian strata is here unfortunately concealed by the basalt lava flow.

The rocks composing this system are schistose quartzites or quartzitic schists, sericite schists, and schistose conglomerate. All these represent rocks originally sandstone and conglomerate, with, perhaps, some shale or argillaceous beds. Sometimes the metamorphic process has not been intense enough to obliterate the original granular texture; at other times the deforming forces have produced a development of the silky, filmy mica known as sericite, which coats the folia of the schist and causes the rock to become a sericitic quartzite schist or a sericitic schist. Some of the schistose conglomerates show beautiful examples of stretched quartz pebbles. Thousands of these pebbles may be seen stretched by rock movements several inches in length without breaking, and bent in conformity with the curves in the schist. When crowded together they often present the appearance of drawn-out strings of quartz, forming a purely quartz schist.

The Algonkian sediments have resulted from the mature decomposition of still more ancient rocks, either Lower Algonkians or Archæan. The earlier systems have not been yet identified in the island. As matters stand at present, these schists are the oldest which are known to us, and spread, as they are, over so large an area of Tasmania, thicknesses are involved which denote an enormous period of time during which this sedimentation proceeded.

They are seen in a quarry three-quarters of a mile south of Ulverstone, up the North Motton-road, where the land rises to form the plateaux; but are concealed from view at Gunn's Plains, even though the height there above sea-level is inconsiderable. They are also prevalent in the Forth Valley, south of Hamilton. There was evidently a Pre-Cambrian schist-forming period in Tasmania, because the Cambrian sandstones and slates are not schistose.

The quartz, which is abundant in the schists, is not in the form of reefs, but seems to occur generally as segregation veins and irregular patches and strings, without any economic mineral. Considering, however, the proximity of the intrusive granite to the coast-line, there is no apparent reason why the schists should not prove to be the receptacles of ores, as they must have been invaded at various points by the granitic metal-bearing magmas.

(2)—CAMBRIAN.

The only certain exposures of rocks belonging to this period in Tasmania are between Railton and Latrobe in the north, and at the Humboldt Divide and in the Florentine Valley in the south.

The Caroline Creek beds near Railton have furnished fossils which have been identified by Mr. Robt. Etheridge as representing the genera Ptychoparia, Dikelocephalus, Asaphus, and Ophileta. Mr. Etheridge states that it is more than probable that the age is "that of the Lingula flags or Menevian beds of Great Britain, and the Potsdam sandstone of North America.*.

Sandstones on the north flank of Mt. Stephens, at the head of the Florentine Valley, have yielded imprints of Dikelocephalus which Mr. Etheridge has named D. florentinensis.

By general consent the upper limit of the Dikelocephalus fauna is considered as the upper limit of the Cambrian system; and at Railton a fortunate exposure at Mr. Blenkhorn's quarry shows the Dikelocephalus sandstone passing (apparently conformably) below the Lower Silurian limestone (Gordon River series).† The upper-

* Proc. Roy. Soc. Tas., 1882, p. 158.

† On this occasion I collected from the Dikelocephalus beds at the quarry a fragment of a trilobite, recognised by Mr. Etheridge as Ptychoparia stephensi (formerly known as Conocephalites stephensi).

most Cambrian beds consist of cavernous argillaceous strata, containing indistinct fossils. These are exposed at the abovementioned quarry for a width of about 6 feet, and are underlaid by the Dikelocephalus sandstone beds, which pass downwards into chocolate-coloured clay slates and thinly-bedded sandstones and pebbly grits. The whole series continues north-west from the quarry along the Latrobe-road, crossing the railway-line at the bridge over Caroline Creek, about 4 miles from Railton. The dip is uniformly south-westerly. At the bridge the strata appear in the railway-cutting as chocolate-coloured sandstones, dipping at an angle of about 30°. On the bank here fragmentary and ill-preserved remains of trilobites may be collected after a little search. Boulders of yellow friable sandstone seem to be the home of most of the fossils.

In the Railton township yellowish slates, sandstones, and coarse grits are exposed near the Wesleyan Church, the latter carrying impressions of univalves, considered by Mr. Etheridge as belonging to the genus Raphistoma. The strata are steeply inclined, sometimes vertical, but on the whole dipping to the N.E.

The Railton exposures of Cambrian strata correspond with similar exposures on the Humboldt Divide, where the trilobite sandstone underlies the Gordon River limestone and passes down into chocolate-coloured slates near the Humboldt Mine.

At Gunn's Plains the limestone rests upon a series of cherty conglomerates, breccias, tuffs, and chocolate-coloured slates, which are probably of Cambrian age. The yellow fossiliferous sandstones of Caroline Creek, however, appear to be absent there, and until further evidence is available, it is perhaps safer to use the indefinite term Cambro-Ordovician for this breccia-slate system.

(3)—Cambro-Ordovician.

At Gunn's Plains, the northern boundary of the Gordon River limestone (Ordovician) is seen on the west side of Walloa (Copper) Creek, in the block charted in the name of C. J. Kent. Its strike is N.W.-S.E., and dip S.W. The cherty conglomerates of the Sugar Loaf Gorge and the Copper Creek country pass below the limestone at a high angle.

The accompanying map shows the remarkable development of the conglomerate series as exposed along the Leven River for a couple of miles from the Plains. The whole series has a N.W.-S.E. strike, with a south-westerly dip.

The ravine of the river intersects numerous parallel belts of conglomerate, breccia, slate, and tuff, alternating in rapid succession and interrupted at intervals by dykes or other intrusions of igneous rock.

The conglomerate is characterised by three marked features. Its texture on the whole is fine or medium-grained. The pebbles have a tendency to become angular in form, the rock assuming the nature of a breccia; and the dominant components are not quartz pebbles, but stones or fragments of chocolate-coloured or greenish cherty slate. These characters produce a lithological *tout ensemble*, which invariably makes the recognition of this series easy, in whichever part of the island it may occur. It may be remarked *en passant* that they distinguish it from the variety of the West Coast conglomerate familiar on the mountain ranges north and south of Mt. Lyell. It is identical with the fine-grained breccias which are exposed on the coast-line east of Lodder's Point and at the Neptune Mine. The breccias tend to become gossanous and pyritiferous, and either to enclose patches of igneous rock or to be subject to intrusions of same. They are themselves largely tuffaceous. This association with tuffs and intrusive rocks will be referred to subsequently in this report.

The same series of purple, green, and black slates continue west to the mining sections on Copper Creek, alternating there also with conglomerate and breccia. Opposite Mr. E. Wing's house, at the north end of the gorge, black slate crosses the bed of the Leven, and probably exists below the flat land of the valley there. Where the road turns to ascend the Leven Hill it intersects a band of conglomerate, and thereafter is in igneous rock of the porphyroid group right up to the level of the plateau.

These Cambro-Ordovician strata extend east and west below the basaltic covering of the North-West Coast, interrupted at intervals by intrusions of porphyroid, serpentine, and granite. They are exposed at Stowport, between the Emu and Blythe Rivers, and at the Blythe Iron Mines. Here, however, they strike N.E.-S.W., and dip S.E. The same geological succession appears to prevail as at Gunn's Plains. The limestone rests upon the older series on E. Addison's 31 acres, No. 9336, west of the Blythe Bridge. Although the underlying rocks are greatly concealed by the overlying basalt, enough can be seen to establish the occurrence of conglomerate between the limestone and the slate strata. The conglomerate is visible on the main-road, east of the Blythe iron lode, on O. Allen's land, and descends south-westerly to the Blythe River, where it constitutes the hanging-wall country of the iron lode. Two miles further south it emerges on the 320 acres, (T. S. Rutherford), east of the iron lode on that property. The copper-bearing strata west of this line are those in which the Burnie and Rutherford Mines have been worked. The ascending sequence is accordingly—(1) Copper-bearing slates. (2) Conglomerate. (3) Limestone.

At Alma a succession of copper-bearing slates, conglomerates, and breccia also occurs, but no definite datum-line for deducing their geological horizon-line has been found. The limestone is absent, but schists occur on the Forth River further north, and these are assumed to be Pre-Cambrian. The Alma strata are, therefore, probably Cambrian or Cambro-Ordovician. They are associated with porphyroids, and may be taken as members of the same system as the copper-bearing series at Gunn's Plains. It must be borne in mind that the term Cambro-Ordovician is only provisional. It is extremely probable that later research will make it necessary to transfer many of these strata to the Cambrian.

Mr. L. K. Ward, after examining the slate series of the Dundas field and the brecciated conglomerates there, and comparing same with the above observations, and my specimens from the North-West Coast, correlates these strata in both districts as belonging to one system.

The task remaining for the survey is to establish the exact geological position of the breccia slate series, *i.e.*, to determine whether it is higher in the record than the Dikelocephalus sandstone or whether it occupies a lower horizon in the Cambrian. At Gunn's Plains it is immeddiately below the limestone; at Lodder's Point it succeeds the Pre-Cambrian schists.

(4)—Ordovician.

The limestone occupies the floor of the Gunn's Plains Valley from north to south, bearing in a N.W.-S.E. direction, and dipping S.W. It would thus have an observed width of about 5 miles, and its strike, if prolonged S.E., would take it into the Mole Creek district. Its first appearance on the Plains is on the west bank of Copper Creek, at Mr. Wells' farm, where it comes down from Kent's land on the hill. It occupies the slope of the hills on the west side of the Leven River, and has a similar position on the east side of the Plains. It is sparsely fossiliferous, and the fossils are generally replaced by calcite. However, a few imprints of a small Orthis are occasionally obtainable. It undeniably belongs to the Mole Creek and Gordon River series.

A small lime-burning industry exists at the Plains, and the lime, which is of excellent quality, finds a ready sale at Ulverstone at 2s. per bushel bag. The stone is also used for metalling roads at the Plains.

Caves have been known and visited for some time at the Plains, but until recently they have not attracted attention. Those on the west side of the Leven are not of a striking character, but the cave on the Limestone Reserve on the east side of the valley, officially opened this month by the Hon. the Premier, possesses spectacular merits which make it an undoubted asset from the tourist point of view. It deserves to be opened up on a still larger scale.

(5)—Igneous Rocks.

(a)—*Porphyroids.*

Ancient igneous rocks are strongly developed in the Leven Basin near Gunn's Plains. Along the course of the Leven River after it issues from the Plains various members of the Porphyroid complex are exposed. This complex comprises a series of dynamically affected quartz and felspar porphyries represented elsewhere in Tasmania at Mts. Farrell, Lyell, Jukes, Darwin, and other points on the West Coast Range. They range from distinctly acid types through subacid to rather basic varieties. The latter are characterised by abundance of pyroxene and comparative poverty in quartz.

A remarkable series of bedded tuffs is seen exposed for 400 feet along the roadside south of Hampton's cottage, in the Sugar Loaf Gorge. These are evidently contemporaneous with the conglomerate and slate, and are perhaps the oldest directly igneous rocks known in Tasmania.

These are soft, short-jointed, light-grey rocks, dotted with numerous specks of kaolin, yielding forms of felspars, which are usually lost in preparing slides for microscopical examination. Under the microscope the base appears as a pellucid glass, with numerous vesicular steam cavities. In this base is a confused groundmass of particles of ash and felspar microlites, with occasional grains and nests of quartz. It is evidently an acid tuff, and its position, interbedded with the slate and conglomerate series, points to a much higher antiquity of the porphyroid complex than has hitherto been ascribed to it.

The next members of the series to be considered are the clastoporphyroids. These are brecciated rocks, often gossanous, and enclosing irregular tuffaceous patches, with an occasional sprinkling of pyrite. They are characteristically calcareous, but have a partially vitreous and felsitic base, with much quartz, some of it secondary. In part they are probably fragmental tuffs. These rocks are strongly developed north of Brown's cottage, and again further on the road towards Wing's. The forms of calcite seen microscopically in this rock are rather suggestive of being pseudomorphous after felspar. Porphyroidal rocks which have been derived from tuffs, as well as altered porphyroid tuffs, are known under the name of clastoporphyroids, and these irregularly fragmental igneous rocks seem to belong to that type.

East of Wells' farm are some low hills, north of the road, which appear to be composed of a reddish hornblendic porphyroid, also met with on the west side of the Leven in the Sugar Loaf Gorge. The same rock occurs on the Forth River at the Waterworks building intrusive in slates, with an exposure of two or three chains in width. Numerous stones of the same rock are to be seen in the shingle on the beach at Ulverstone.

It is a granophyric quartz-felspar porphyry, with most of its porphyritic felspars triclinic, and approximates to the quartz porphyrites. Besides the phenocrysts of felspar there are others of corroded quartz, and some imperfectly preserved forms of green hornblende. The groundmass is an aggregate of quartz and felspar in granophyric intergrowth.

On the west side of the Leven, opposite Hampton's cottage, is a bluff of rock belonging to this group. The groundmass is a quartz-felspar aggregate. The phenocrysts are quartz, felspar (mostly triclinic), and a few doubtful remnants of ferro-magnesian minerals. The quartz phenocrysts have angular fragmentary outlines or are embayed.

Not far from the south end of the Sugar Loaf Gorge the road intersects a band of bluish porphyroid between slate on either side, 75 feet wide. This is a siliceous variety, quartz phenocrysts being abundant. These are either angular or with corroded boundaries. Orthoclase and plagioclase felspars are the principal remaining phenocrysts. A few remnants of a light-green hornblende can be detected.

Besides the acid and sub-acid rocks referred to, more basic varieties occur, to which it is hardly possible to give definite names until they have been more closely examined. In the meantime, they are designated pyroxenic porphyroids. They are essentially augite-plagioclase rocks with accessory hornblende, biotite, or quartz. The presence of these accessories is taken to indicate relationship with the porphyroid group rather than with our diabase and basalt, which they otherwise recall. One variety of this type is seen at the point of the road south of E. Wing's house. It is known locally as serpentine, owing to the development of asbestos on its joint-faces. It is very much decomposed, but the exposure along the roadside can be traced for 200 feet in width. On its south wall are conglomerate and breccia. Its north wall is concealed, but is probably slate, as the latter is exposed in the river opposite Mr. Wing's house.

Under the microscope the rock appears to consist of plagioclase felspar and augite, with accessory hornblende and biotite. Where there is any interstitial material in the groundmass, it is quartzo-felspathic, though it is doubtful to what extent the quartz is original. The idiomorphism of the augite is less than that of the felspars, the prisms of the latter frequently penetrating the forms of the pyroxene. To the naked eye the rock is dark, of granular texture, with no distinctive characteristics. It here evidently forms a dyke.

The next basic variety is the rock exposed in the roadside all the way up the Leven Hill from Clark's farm, 10 miles from Ulverstone. The general appearance, weathering, and occurrence, conform with those of a basaltic rock, and it might very well be mistaken for the usual Tertiary basalt of the North-West Coast. It contains, however, visible pyrite, and microscopical examination shows that there is a considerable quantity of granular quartz in its base. It is a plagioclase-augite porphyritic rock, with the augite crystals generally collected in nests, somewhat after the fashion known to petrologists as glomero-porphyritic. Microscopically, it shows signs of crushing, and must belong to the older rocks.

Future work on these rocks will show whether all of them can be included in the group which, using the term in a liberal sense, we are designating by the name of porphyroid. In Tasmanian geology the whole group bears the name of some of its most prominent members. Thus, strictly, porphyroid is dynamically-altered quartz-porphyry.

But in our quartz-porphyry complex we have a great variety of types, *e.g.*, granite, syenite, granophyres, felsites, porphyrites, quartz-diorite porphyrites, diorite porphyrites, and apparently some imperfectly understood more basic members.

The whole group at Gunn's Plains seem to be confined to the slate and conglomerate area, *i.e.*, infra limestone. Once the limestone country is entered upon, the porphyroid exposures are absent. Whether this is merely a coincidence or not is uncertain, but it is, to say the least, suggestive of the eruptive rock being older than the Ordovician limestone. The bedded tuffs certainly are older, but the other eruptives appear to be intrusive in the slates and conglomerates, and to have been dynamically affected in their own way as much as the slates have been in theirs. In this they differ from our Devonian granite, which is always uncrushed. The porphyroid group, therefore, must be Pre-Devonian. It seems to have been contemporaneous with the Cambro-Ordovician, and perhaps in part later than the lower members of the system.

In accordance with this view, we find the granite of which the porphyroids are modifications developed elsewhere in the island under conditions which point to it pre-dating our Devonian granite. Thus, on the Murchison River, Mt. Farrell, Mr. L. K. Ward (in his report on the Mt. Farrell field, Bulletin No. 3) mentions it as a medium-grained basic granite or syenite altered by dynamical stresses and merging into green porphyritic felsites. This is the rock that used to be called in Germany syenite-granite. In the Rosenbusch classification it would be termed amphibole-granitite, *i.e.*, a biotite granite containing hornblende. The hornblende varies in amount, and to its quantity, quartz and orthoclase (according to Rosenbusch) occur in inverse ratio, plagioclase directly, and the latter becomes more basic. In this way, complete passages to plagioclastic rocks are effected, on the one hand to the dioritic and tonalitic facies of granite, and to orthoclase rocks without quartz, or poor in it, on the other (the syenitic facies of granitite). In Tasmania, syenitic or dioritic modifications are frequent in connection with our porphyroidal granite.

Whether the Devonian is the only granite to which our ores are genetically related, or whether some of them are connected with the porphyroid series, is a question which is occupying the attention of the Survey, and cannot be definitely settled until more complete data are collected.

In any case the distribution of the latter group is acquiring increased importance in the geological scheme, and may prove to govern ore-deposition more directly than has been hitherto supposed.

An outcrop of porphyroid also occurs on the Alma Mine property, at the top of the hill above the mine works, where it forms a crag of hard projecting rock of reddish-brown colour.

(*b*)—*Serpentine.*

About $\frac{3}{4}$-mile south of the township of Hamilton, serpentine is exposed along the road, apparently for about a couple of hundred feet. It must extend to the north-west, as I am informed that it also occurs on Mrs. Jas. Smith's property at Westwood. Its boundaries are not clearly visible, but it seems to be between quartzite on the east and schistose, garnetiferous zoisite-amphibolite on the west. It is a handsome stone, and if any demand existed, could doubtless be worked for ornamental purposes.

Microscopic examination of it shows that the serpentinisation has proceeded pretty far. However, crystals of rhombic pyroxene can be clearly identified, and the forms of the other crystalline component (which is thoroughly serpentinised) point to this being olivine. The rock would accordingly be the olivine-enstatite peridotite known as harzburgite.

At surface it does not show any connection with gabbroid rock, and gabbro is not known in the vicinity, but the rock is, nevertheless, a product of the gabbroid magma. Rosenbusch, in his "Massige Gesteine,"* states:—"Peridotites and pyroxene rocks have no sovereign geological independence; they partake of the character of vassals, and in classification should be attached direct to the members of the gabbro family, of which they represent the non-felspathic forms."

Although at the Forth the serpentine appears not far from amphibolitic schist, no causal relationship has been established between the two at this spot.

(*c*)—*Granite.*

The granite of the Hampshire Hills and Housetop area extends northwards as far as the southern portion of the Rutherford Mine property between the Emu and Blythe Rivers, and its northern edge continues south-easterly

* 1907, I., p. 452.

across the intervening country to the southern boundary of Riana township. There is some granite also east of the Dial Range at Hardstaff's Mine, and there must be some also in the hill east of Copper Creek, as I picked up a piece in the bed of a small creek which flows east into the Leven at the Gorge.

The copper-ore lode at Hardstaff's—an ore-channel from 18 inches to 21 inches wide—is in the granite on the side of a hill, which is one of the slopes at the base of Mt. Duncan, a peak of the Dial Range.

None of the intrusive rocks exposed on the sea-coast between Ulverstone and Penguin belong to this division. Where they are granitoid they are connected with the porphyroid group, and not with the Devonian granite.

(*d*)—*Basalt.*

The Tertiary olivine basalt caps nearly the entire tableland south of the sea-coast for miles inland. The ordinary type has, under the microscope, hypocrystalline and doleritic structure. Occasionally the felspathic component disappears, and the micro-structure and mineral constitution indicate a limburgitic facies. This is noticeable in the basalt in the Forth Valley.

Amphibolite.

South of Bourke's land, about a mile from Hamilton-on-Forth, on the Wilmot-road, a hill range of amphibolitic schist skirts the road. Judging from the exposure of quartzite schist in the hillside at the back of Bourke's, the amphibolite would lie between that and the serpentine. An outcrop of it also occurs in the garden in front of the cottage. Apparently it belongs to the Pre-Cambrian series.

The rock is a zoisite-bearing garnet amphibolite, and may be placed in Grubenmann's order of meso-amphibolites. The three families composing this order [garnet amphibolite, plagioclase amphibolite and zoisite—(and scapolite)—amphibolite] are often geologically associated with one another, and passage-rocks are known. In the present instance we have a variety which unites the garnet and zoisite amphibolites.

The variety probably represents the metamorphism of a basic rock, the original pyroxene having contributed to the formation of amphibole, olivine and plagioclase being represented by garnet and zoisite. Grubenmann derives the garnet amphibolites from eclogites, and points out that the garnet of many eclogites changes in the middle zone into a mixture of hornblende and felspar (or of biotite and felspar), and subsequently into zoisite and epidote.

No felspar is present in this rock. The component minerals are hornblende, garnet, and zoisite, with granular quartz. The hornblende is pale green, the zoisite colourless to grey, giving fusiform sections with prisms parallel with the hornblende crystals and with each other. The garnet is in anhedral rounded crystals, pale pink by reflected light, colourless or pink-tinged in thin section. The structure of the rock shows the schistosity of recrystallisation.

Another amphibolite, coarser and non-schistose, occurs on the crest of the hills above and west of the Alma Mine. This was possibly originally a gabbro. It consists of large plates of hornblende pale green in thin section, crystals of colourless augite and cloudy felspar, in which lamellar twinning lines are well nigh obliterated. This rock seems to fall in the family of plagioclase amphibolites. Its geological occurrence cannot be properly known until more is known of its immediate surroundings. It does not occur in the crystalline schist area, but in the slate-breccia Cambro-Ordovician zone, and in the neighbourhood of porphyroid exposures.

V.—MINING PROPERTIES.

(A)—Copper Creek Mine.

This mine is situate on the Copper Creek (or, as it is named on the charts, Walloa Creek), about 1¼ mile from its confluence with the Leven River, at Mr. Wells' farm, Gunn's Plains. The section, 40-acres, No. 252-M, is charted in the name of Mr. W. R. Applebee. Besides this, three adjoining prospecting areas, of 80 acres each, have been taken up by the mine-owners, who have now registered their syndicate as the Copper Creek Mining Company, No Liability.

In the old days outcrops of copper ore were discovered on the banks of this creek by the late Mr. James Smith, and it is believed that he worked somewhere in the vicinity of the present mine.

An outcrop in the steep creek bank was discovered about seven years ago, and Mr. W. R. Applebee took up 40 acres for mining purposes. In 1903 a departmental examination of the creek was made, and a copper ore lode-formation with a calcite gangue was inspected a little below the present mine. Samples chipped from the outcrop were assayed in the Government laboratories, and returned 4·8 per cent. copper and 2 ozs. of silver per ton. Other samples taken to Launceston by Mr. Percy Harrison were assayed at the Mt. Bischoff Smelting Works and yielded 2·3 per cent. copper and 9 ozs. 16 dwts. silver per ton. The bands of copper-bearing calcareous slate were recognised as being in a favourable position for prospecting drives, and it was considered likely that further exploration would disclose something more payable.

Another lode was found to crop out on the hillside about 250 feet above the creek, and the present company has devoted its attention to this.

The work which has been taken in hand by the company in connection with this lode comprises the following:—

(1) Trenching on the gossan outcrop near the hut 300 feet above the creek.

(2) An open-cut into the lode outcrop on the hillside.

(3) An adit driven 60 feet into the hill, intersecting the lode at 39 feet in. This is 30 feet below the open-cut.

(4) A lower adit driven at creek-level for 28 feet, intersecting the lode in 200 feet of driving.

The above will now be described *seriatim*.

(1)—*Gossan Trench.*

A small cut has been put in at 40 feet south of the hut for 12 feet in a north-westerly direction on the course of a line of gossan which looks fairly promising. About a foot of gossanous material is showing in the trench, but the full width has not been ascertained. The company sent some of it to the Government Analyst, with a result of 0·75 per cent. copper and 1 dwt. gold per ton. My samples, assayed in the Government laboratories, yielded 17 grains gold and 18 grains silver per ton.

(2)—*Open-cut.*

An open-cut has been driven into the hill for 17 feet in a south-easterly direction, exposing the lode 3½ to 4 feet in width, vertical, widening underfoot, and striking about 15° east of south. The lode gangue is slate, calcite, and quartz, and contains bunches of specular iron ore, pyrite, and a little copper sulphide. The country rock is a light-coloured slate, which becomes harder as it approaches the lode.

(3)—*Upper Adit.*

Thirty feet below the open-cut an adit has been driven for 62 feet in a direction S. 65° W., cutting the lode at 29 feet. The bearing of the lode being here S.E., the adit has intersected it obliquely, and, in consequence, the width of lode passed through in driving is greater than its actual width. The apparent width is between 6 and 7 feet, but the true width is about 5 feet. The lode-matter consists of a siliceous slate gangue of greenish hue, and distinctly brecciated, well mineralised with pyrite, chalcopyrite, covellite, and specular iron ore. It is widening also in this adit underfoot, and the stone is of better quality than in the open-cut above.

My samples from this lode returned, in the Government laboratories, 2·9 per cent. copper and 2 dwts. 8 ozs. silver per ton. I am informed that the ore broken and sent away was of higher grade, and that the owners anticipate that it will be possible by selection to produce ore of marketable quality. It has been driven upon for a few feet south. Two and a half tons of ore from this point have been forwarded to the Mt. Lyell Company's smelters at Queenstown, but the quantity was too small for treatment by itself, and the ore sent has remained unsmelted.

Both the lode and strata underlie to the N.E., but a few feet behind the end of the adit a pug seam occurs, beyond which the slate dips S.W. into the hill. The underlay of the lode will cause it to be met with in crosscuts lower down at increasingly shorter distances.

(4)—*Lower Adit.*

A bottom adit has been put in to intersect the lode at the level of the creek. No surveys have been made of the surface features, and from the precipitous nature of the ground, it is not easy at a glance to see what positions the mine openings occupy in relation to one another. The bottom level, however, appears to be 150 feet or 200 feet below the upper adit. It has first been driven from the creek in a south-easterly direction across regularly cleaved slates, which have here a strike of N. 70° E. It would appear, therefore, that the strike of the strata differs considerably from that in the upper adit, and it could not be expected to intersect it by driving across these. After driving 90 feet into the hill, the direction of the crosscut was changed to south-westerly, and at 100 feet thereafter a lode-formation, 9 feet wide, with wet flucans on each side, and carrying about 3 feet of hard, ore-bearing stone, was crossed. It carries a sprinkling of iron and copper pyrites, and its gangue is calcite and slate, the latter inclined to be black and greasy. From its position and character it would seem to be the same lode as the one cut above, but absolute certainty on this point is not possible until a survey has been made.

The broken and steep country prevents a simultaneous view of the various outcrops and tunnel openings, and a comprehensive surface and underground survey would be extremely useful in giving data for reliable determinations of positions. The lower crosscut has been driven 80 feet beyond the intersection of the lode. At about 20 feet behind the end is a pug, slate, and quartz-formation, carrying no mineral, but yet indicative of some lode action. This might very well be tested to see whether it leads to anything. After passing through the main lode the country rock changes; it becomes harder and rougher, and a little behind the present end it merges into a breccia. The lode cut in this adit, though not so rich in copper as in the higher level, is not less strong as a formation. It has been strong enough to break through the strata in descending, notwithstanding their change of strike, and it appears to be going down unimpaired. The company states that the lode-matter yielded about 4 per cent. copper by assay. My samples returned 1·6 per cent. copper and 1 dwt. 15 grs. silver per ton.

The lode in the upper level will no doubt be tested first, and the pitch of the ore-shoot ascertained before driving aimlessly at the lower intersection. The company will probably obtain good advice as to whether it would be well to cut the lode a little lower than the present upper tunnel so as to avoid the shallow ground of the gully.

The lode has practically only been cut at the different points mentioned, but sufficient has been disclosed to justify further work, with a view of proving its value.

The section taken up by the company seems to comprise an ore-bearing channel of slate country between two belts of conglomerate or breccia. The lode in the bottom level is situated on a line where the country changes. The end of the drive is unmistakably in a bed of breccia. The face is tolerably dry, though a little water is dropping from the roof a few feet behind the end.

The breccia beds are, perhaps, not quite so favourable for defined ore-channels as the firmer slate country, but there is no reason for characterising them as barren. Some of these breccias are undoubtedly igneous in origin, and carry disseminations of mineral. Ore-bearing breccias are rather common along the flanks of the Dial Range, and are really an encouraging feature of the whole district. No valid objection can be urged against continuing this level into the breccia country.

Other lodes exist on the property, and although their exposures cannot be termed remunerative, taken together they establish the existence of a cuprifrous zone, in which exploration is highly desirable.

McDonald's adit, about 50 feet above the creek, has been driven for 30 feet into the hill across slate strata, striking N. 75° E. At the entrance a small puggy seam of copper ore was met with, and there is said to be another vein in the end, but standing water in the level prevented examination. The company states that some 11 per cent. copper pyrites was obtained here.

Below this adit, on the south side of the creek, is a vein with some copper pyrites and native copper; and still lower down the creek is a further cupriferous channel, from which the company quotes an assay as—copper, 3·6 per cent.; gold, 1 dwt. per ton; silver, 3 oz. 12 dwts. per ton.

Sufficient water-power exists in the creek for all purposes, and the creek route will, in the event of operations proving successful, no doubt be made the outlet to the property. At present a horse and bullock track winds its way up from the plain to the crest of the hill overlooking the mine, at a height of about 600 feet. Before considering the erection of plant, thorough prospecting and underground development must be carried out.

The belt of strata in which the Copper Creek lodes are situate evidently comprises the beds immediately below the Ordovician limestone, which creeps up the hill to within about 15 chains of the north boundary of Kent's block. These beds are consequently Cambro-Ordovician, or, if we regard the limestone as the base of the Ordovician, probably Middle Cambrian. They belong to the same series as the strata cut through by the River Leven in the Sugar-loaf Gorge. The conglomerate which plunges below the limestone on the west side of the creek can be traced right across to the Leven, but the slate belt has evidently been disturbed, most probably by the igneous intrusions of the porphyroid group, which occupy a considerable portion of the hill range between Copper Creek and the Leven.

Wherever in this district we meet with rocks of the group just mentioned, pyrite and a little disseminated chalcopyrite occur, under conditions which indicate the possibility of some ore-deposits being genetically related to this series of eruptives; but further study of occurrences is necessary before any definite conclusion can be arrived at.

About 3 miles north copper-ore lodes exist in the Devonian granite , and the usual reference of minerals in lodes in our stratified rocks exclusively to the granite batholith of that age rests on too broad and firm a basis to be easily shaken. Nevertheless, the constant association of copper ore with occurrences of the porphyroids claims careful consideration.

(B)—Radford's Reef.

On the west side of the Leven Gorge, opposite A. S. Brown's 30 acres, some mining ground has been taken up by Mr. H. J. Colbourn. About 25 feet above the river an open-face has been cut in the hillside, showing slate or shale, passing down into clay strata containing a good deal of manganese oxide at top, and sandstone at bottom, with an intermediate band, about 4 feet thick, of light-grey argillaceous sandstone carrying disseminated iron pyrites and little nests of specular iron ore and copper pyrites, the latter, especially on the faces of small cavities, lined with quartz in crystals. On the north side of the open-cut is a junction of the sedimentary rock with intrusive porphyroid, and this junction can be followed east to the river, where it can be well seen at the point, at which the slate is silicified and brecciated.

The same grey siliceous pyritiferous rock is seen round the point on the river, and a few yards north of it a trench has been cut 10 feet above the water and into the hill in a westerly direction. As far as can be seen the trench is in overburden, which is very deep here, and has fallen in, preventing examination.

The impregnation of the sedimentary strata with a little copper ore near their contact with the plutonic rock is not sufficient to justify further expenditure at this point. South-west of the open-cut the porphyroid reappears on the hillside at no great distance, so that the area of stratified rocks must be extremely limited just here. The whole hill is intersected by numerous intrusions of the igneous rock, and while ore deposits may possibly occur here and there, extreme variability within short distances is likely to be a feature of them.

(C)—Brown's Blow.

This is on the east bank of the Leven opposite Radford's Reef open-cut, and is a wide exposure of flinty slate, carrying a considerable development of quartz. A little specular iron is visible. There is no reef here, but apparently silicification of the slate has taken place near a contact with eruptive rock.

(D)—Colbourn's Show, on Road.

Beyond the point on the road north of Brennan's an excavation has been made in the solid edge of a large landslip, which has brought down a huge mass of rock bodily. The latter has parted from the standing cliff-face just east of the mine cutting.

The country is a gossanous breccia of the kind described in this report as clasto-porphyroid. The tuffaceous and igneous material contains disseminated pyrite, but the indications do not encourage much expenditure here. Mineral may be scattered through the rock-belt, but there are no signs of lodes or any definite channels in which ore-concentrations occur.

(E)—Heazlewood's Silver Mine.

This comprises some sinking and tunnelling done at an outcrop on the Leven River south of Griffin's 30 acres, 7 miles south-west of Ulvertsone. The discovery was made in 1891 by Messrs. Lines and Elliott. Mr. Lines informs me that some of the galena from it was sent to the Launceston Exhibition in that year, and that the assay went from 15 to 20 per cent. lead and 36 ozs. silver per ton. Definite information, however, is not available now. The show was idle for some time, and then between £300 and £400 were spent upon it; but I understand the country was loose, and there was a difficulty in getting into solid ground. Nothing can be seen now unless some preparatory work is done. A mile above this, I understand, a large gossan formation was found.

(F)—Preston Silver Mine.

Section 249, 80 *acres.*—This is situate in the Castra Parish, 4 miles south-east of Gunn's Plains, and is reached by the road running through from the coast to South Preston and Nietta. The road is metalled nearly to the turn-off to the mine. The tableland over which the main-road passes is capped with basalt and basaltic soil, but leaving the road, on the mine track to the south-east, the older rocks are soon met with. At a height of 1500 to 1700 feet above the sea is a felspathic (arkose) grit and conglomerate, which is probably of Permo-Carboniferous age. Descending from this to the creek where the mine is situated (one of the branches of the Gawler) the more ancient Cambro-Ordovician conglomerate crosses the creek in a direction east of south, where it adjoins metamorphic slate country on the west, dipping to the south-west at a very steep angle. A little gully on the south side of the creek appears to form the line of junction. In the slate on the west side of the contact are some parallel lode-lines, along which a little galena and zinc blende, with pyrite, have been deposited in the cleavage-planes and joints of the country. Some of the slate has been silicified by the lode-solutions, and is porous and mineralised. Veins of calcite are associated with the metalliferous bands. There is nothing very definite at surface from which conclusions may be derived. A small shaft has been sunk to 15 feet on the south side of the creek, and little pockets of pug were found, carrying galena in slugs. Mr. R. Lee first worked here three years ago, and afterwards Anderson and party. An assay is stated to have yielded 16 or 18 per cent. lead and 36 ozs. silver.

Locally some doubt exists as to the direction of the ore-channel, but a trench between the shaft and the creek should clear this. Indications point to the mineral zones running across the stream, parallel with the bearing of the slate. Other lodes are said to cross the creek higher up. A drive into the hill on the course of the main lode would develop the latter, and give facilities for crosscutting west for parallel lodes.

(G)—Rutherford Copper Mine.

The Stowport district was visited on the present occasion in order to co-ordinate the geological sequence there with that at Gunn's Plains. Enough was seen to correlate the strata and establish their *infra* Ordovician-limestone horizon.

The Rutherford Mine, on the 320 acres purchased block, has now been idle for some time. The financing arrangements appear to have been inadequate, and funds were exhausted before the prospecting work was properly completed. Ore was discovered in 1899 by the Messrs. Rutherford, who prospected the property in various directions. A tunnel was started, and a small gossanous lode cut just inside the entrance. This lode, yielding some fair quality copper ore, was followed down by sinking, and stoped at 16 feet and 32 feet. The total quantity of ore raised has been 100 tons, returning 10 per cent. copper, with negligible gold and silver contents. The bearing of the lode in slate country is north-east, and its dip north-west. Its width varies from 1 foot to 3 feet, but averages from a foot to a foot and a half. A main shaft was sunk 100 feet to enable the lode to be cut in depth. A crosscut east was opened out from the bottom for a length of 75 feet, and one west for 50 feet. At a distance of 30 feet in the east crosscut, a vein was intersected carrying 8 inches of ore, underlying towards the shaft. This was met with in a much shorter distance than was expected, and gave rise to doubts as to whether the lode had really been cut. The continuation of this crosscut, however, and also a crosscut west, showed nothing further, and the probability is that the lode has actually been intersected at a weak point. There is an obvious necessity here for the proprietors to continue the work of exploration to its legitimate finish by driving on the lode where it was cut in the bottom east crosscut. The west crosscut should also be continued to a formation which lies some distance ahead of the end.

The remarkable development of hematite on this property east of the lode, and running parallel with it, and on the direct strike of the large outcrop on the Blythe River, is an indication strongly suggestive of the deposition of copper and iron ores having taken place on parallel lines. Evidently the copper and the iron lodes in this field are closely related to one another. The copper mines which have been opened in this belt of country further north are on the lodes which are parallel with and near the strong iron lode of the Blythe. Coming south these lodes can be traced to the neighbourhood of the boundary of the granite. Both the copper lodes and the iron lodes are probably genetically related to the granitic invasion.

Local opinion is as strong as ever that these massive hematite outcrops cover lodes of pyritic copper ore. No sulphidic mineral, however, has yet been found, either in the hematite or directly below its outcrop. The most that has been observed is the presence of a few specks of chalcopyrite in the altered quartzitic rock, which is the wall-rock of the iron ore outcrop on Clark's land, north of the Blythe. This supports the view that the iron and copper lodes have mutual relations, but is also consonant with the supposition that they are structurally distinct.

Lode on Road at Turn-off to Dicker's.

On the Rutherford property, at the turn-off down to the Blythe Bridge, a strong gossan formation has been ploughed through in forming the road. This has been intersected obliquely for 6 or 7 feet, and appears to be running south-west, as is the case with the other lodes in the district, and to dip south-east. At one point in the road some hard quartzose veinstone was met with in this formation, consisting of quartz and solid arsenical iron pyrites. Only a few pieces of this solid stone have been turned up with the pick, but there is evidently a metalliferous lode here, upon which it might be worth while spending a little money to open it out and see what it contains. The absence of copper stains or secondary copper ores in the outcrop is an unfavourable indication. The samples which I took yielded 4 dwts. 21 grs. silver per ton, and a trace of gold.

The Blythe iron lode is supposed to pass here, and some loose blocks of porous limonite and hematite are seen on the hill south of the road. I am inclined to think, however, that the true course of that lode is further west, between here and the Rutherford Mine.

The lode on the road is in quartzite country, east of which lies conglomerate and slate, succeeded further east by the limestone on Addison's land. The changes in the strata are visible, but the actual contacts are not seen. This conglomerate, as already mentioned, continues north to the east of the Blythe River iron ore outcrop and to O. Allen's 100 acres; and still further north, behind Mr. Edwards' farm, it is likely that the siliceous conglomerate with white quartz pebbles and jasperoid stones exposed there in the bank descending to a creek is the northern continuation of the same belt. At the latter place it is plentifully sprinkled with pyrite, and copper pyrites is alleged to have been found in it.

From the observations made on this journey the fact emerges, established for the first time, that this set of slate, quartzite, and conglomerate strata, comprising the country between the Blythe and Forth Rivers, forms an infra-limestone geological group characteristically harbouring the copper ores of the coastal districts.

(H)—L. J. Clark's Lode.

Across the creek, below Mr. Clarke's house, at Stowport, a short and narrow adit has been driven west into the hill by Mr. Clark in a wide lode-formation, about 10 or 12 feet wide of lode-material, as far as can be seen. A little difficulty has been experienced in finding the directions taken by the lode, but eventually it was ascertained to be southerly. The formation is soft and oxidised, indicative of sulphides below. Black graphitic slate forms the footwall on the west. A little copper pyrites is visible in the stone, which, moreover, is coloured with copper carbonate and sulphate. A vein of hard pyrite was cut inside.

Owing to the configuration of the hill, there is hardly any use in continuing the adit, as no backs are obtainable, and no solid country would be met with. If any work is to be done here it must be by sinking. Probably some water will be encountered from the little creek close to the mine.

The position of the lode appears to be to the west of the western formation on the Rutherford property. The proximity of the granite is no doubt responsible for the series of lodes in this neighbourhood, and a little prospecting work on most of them is quite legitimate.

The present lode, from its width at surface, and its indications of copper ore, warrants some trial work being done on it, and a shaft should be put down to prove the sulphide, which, there is reason to believe, must exist in depth.

(I)—Alma Mine.

The Alma Prospecting Syndicate has been carrying on mining operations at the Alma, or old Barrington, Copper Mine, as it used to be called. This is situated about a couple of miles above the bridge over the Wilmot, and lies west of the Forth River, above its confluence with the Wilmot River, 10 miles from the sea-coast.

The approach to the mine is by means of the high road from Hamilton-on-Forth as far as the bridge, and then a turn-off through the forest. This road ascends the valley of the Forth River, which has carved its channel down through the basaltic sheet of the tableland into the ancient rocks below. Immediately south and west of the bridge at Hamilton-on-Forth a white saccharoidal Pre-Cambrian quartzite is exposed in craggy cliffs. At about ¾-mile from the township this emerges on the road against a cliff of basalt, on the west of which is a low boss of serpentine, not more than a chain wide. The bank at the back of Bourke's (formerly Field's cottage) shows an exposure of sericitic quartzite schist, striking 340° and dipping S.W. This belongs to the Pre-Cambrian schist series, members of which crop out on the sea-beach east and west of Ulverstone. Further south, along the road, this schist is succeeded to the west by schistose garnetiferous amphibolite. On Baulch's land the amphibolitic belt is succeeded to the west by mica schist, striking 335°, and still dipping N.W.; and further south, on Mr. Wood's farm, the strata are still micaceous and quartzitic schists, with the same trend. Graphitic and quartzitic schists continue until penetrated at Paloona by an intrusion of reddish brown hornblendic porphyry, belonging to the porphyroid group, and identical with the outcrop near Wells' farm, Gunn's Plains.

South of the waterworks building, just over the Wilmot Bridge, at the junction of the two rivers, a dark granular massive rock occurs, somewhat resembling an ancient metamorphic grit; but microscopic examination shows it to be a clastoporphyroid, a tuff of the Cambro-Ordovician series. Angular fragments of quartz and triclinic felspar, with chloritic residues of ferro-magnesian minerals, and with very little base, make up the rock. It is similar to some clastoporphyroids in the Leven Gorge and the North Dundas district.

The mine was originally registered February 15, 1881, and had about £1000 or £1200 expended upon it in those days. The output appears to have been very little, but a parcel of copper pyrites was sent away at one time, the results of which are not known to me.

Literature of the Mine.

The mine was reported upon by Mr. G. Thureau, Government Geologist, in December, 1881 (Report on the North-Western Mineral Deposits, House of Assembly Paper No. 43, 1882). This report stated:—

"Certain portions of the schists in the tunnel exhibit occasionally native copper in the joints. Heavy spar (barite) occurs in conjunction with copper pyrites (chalcopyrite) in small veins enclosed also by these schists, and some of the beds of rocks are slightly stained by green carbonate of copper.

"The workings made by the prospecting proprietary include the usual descriptions of cuttings from the surface on the course of the deposits, and a main tunnel driven in a north-westerly direction to a length of 281 feet. Two crosscuts extend from this tunnel to the west for a length of 33 feet and 32 feet respectively. . . . Throughout the whole length of this tunnel, and of the greater portion of the two crosscuts, black, hard, short-jointed schists prevail, in which the veins of barite occur, which carry a small percentage of copper pyrites. Similar veins are likewise found in similar rock about 6 chains above the mouth of the tunnel. At both ends of the crosscuts a new formation has been discovered—grey, hard, metamorphic sandstones, in which small rounded pebbles may yet be distinguished with some difficulty. . . . . Taking into consideration all the facts and features connected with the cupriferous deposits so distinctly indicated at the surface and underground, and comparing same with mines producing ores in quantity, attention should be drawn to the fact that regular walls are here altogether absent, and that the only reassuring feature on the ground consists in the recurrence of outcrops of gossan in quartzose veins, also containing barite (heavy spar) and carbonate of iron (siderite). These minerals are frequently found in connection with metalliferous deposits, and therefore I would suggest that the tunnel be extended a further distance of 200 feet, more or less, in the direction of and under the largest surface outcrop of ochreous gossan. It would be also judicious to crosscut further west from the tunnel in order to test the contact of the porphyries there with those of the metamorphic schists."

In July, 1905, the present writer reported on a visit to the mine (Report on North-West Coast Mineral Deposits, 26th July, 1905), from which the following is extracted:—

"Three crosscuts have been driven from the tunnel in a south-westerly direction. These crosscuts have touched a parallel belt of hard pebbly sandstone or breccia, which is also seen outside the tunnel entrance to the west. The first one intersected a flat vein 1 foot to 1½ foot wide, carrying a little copper pyrites associated with barytes and siderite, as well as vughy quartz. This was followed for some distance by a drive parallel with the tunnel. A crosscut 50 feet ahead of the end of this drive failed to pick up anything; and a crosscut was driven from the tunnel north-easterly to see whether the mineral continued in that direction. Nothing, however, was met with beyond a little barytes and specks of pyrite. I am told that 9 cwt. of copper pyritic ore were obtained. . . . The occurrence of mineral here cannot be well understood without a knowledge of the geology of the country west of the breccia formation, as the latter may possibly be a shattered contact zone bordering an intrusion of some eruptive rock. . . . . . . Some sort of lode action has evidently taken place at this mine and produced the lode minerals, barytes, siderite, and copper pyrites. The latter may be seen scattered in the breccia, but so far all the prospecting has not revealed anything in the shape of a solid lode. The prevalence of pyrite in the country rock may account to some extent for the abundant gossan. . . . As said above, there is an unknown factor which may yet lead to some discovery in the breccia belt."

Description of the Mine.

About 400 feet west of a small creek running north on the property, and at about 150 feet up the hillside, a small shaft has been sunk to a depth of 35 feet in a strong body of gossan. This gossan line continues at surface from the shaft down the hill to the creek in a S.E. course, and is parallel with the general strike of the strata. The shaft was first started 16 or 17 years ago, when the gossan appears to have been lost; but it has been since recovered, and a drive extended for 22 feet from the bottom of the shaft in a direction S. 26° W., cut across the gossan for 18 feet, and passed into light-coloured pyritiferous wall-rock. The gossan underlies S.W., at between 60° and 70°.

The old main adit was driven into the hill from the creek at a point about 400 feet east of the shaft in a direction a little south of west, and three crosscuts were driven out south, passing through slate and entering pebbly sandstone or breccia. My report of 1905 shows that only a flat vein was followed in a drive from the first of these crosscuts. This vein was from 1 foot to 1½ foot wide, and cut across the slates, carrying a little chalcopyrite in a gangue consisting of loosely combed quartz with barytes and siderite. Lately the adit has been extended further west with the view of reaching the lode supposed to be represented by the gossan in the shaft. At the 327-feet point in the adit its direction was deflected towards south-west, so as to intersect the gossan line below the shaft on its underlay at that depth in the shortest possible distance. According to the plan there is still a distance of 20 feet to drive to reach the lode. At 13 feet behind the present end a lode of barytes 10½ feet wide has been passed through, carrying a little iron and copper pyrites. The adit intersects it obliquely, so that its true width would be about 8 feet. Beyond it the country rock changes from slate to hard conglomerate or breccia, which continues to the end, the lode occurring at the contact. There appear to be several bands of conglomerate and breccia in this hill, and the band which is now in the end of the tunnel must be crossed before the downward continuation of the line of gossan is reached. If, therefore, the idea is to prove the gossan lode in depth, driving must be continued, and when it is reached it should be driven on. A little driving should be also done on the barytes lode when funds are available, with a view of seeing whether its copper contents hold out any prospect of improving.

Barite is a common gangue mineral in spathic copper veins, and being almost insoluble it is not likely that the gossan outcrops seen at surface will pass down into barytic lodes. Gossanous outcrops of such lodes occur only when these are heavily charged with pyrite, and even then indications of the barium mineral are visible at surface. It is probable in the present instance that if some trenching were done on the hillside below the shaft the outcrop of this barytic lode would be found, and would make it absolutely certain that the gossan lode is still ahead of the main end, though if the survey is correct there can be very little doubt of it.

The Devonport tunnel is a short adit about 4 chains south of the main adit driven into the hill from the creek for about 50 or 60 feet in a north-westerly direction. It has been driven across black slate towards the contact of the latter with breccia. The lode-matter, consisting of black slate with barite and disseminated iron and copper pyrites in a puggy channel, has been left on the north side of the entrance.

A good deal of barite exists on the property. About a hundred yards higher up the creek from the Devonport tunnel a broad belt of slate is exposed in the bed of the stream, carrying bunches and veins of barite for an aggregate width of over half a chain. Much of this appears to be crystalline and pure. In other parts it is stained superficially by iron-bearing solutions percolating from the creek banks. A hundred feet up the hill to the east a cut for about 10 feet has been put across a rather solid outcrop of barytes, a little discoloured by iron oxides, but not sufficient to spoil it for exploitation. A sample assayed in the Government laboratories showed the iron contents to be only 0·9 per cent.

Barite is a mineral, the consumption of which has increased greatly in recent years, owing to the expanding requirements of the paint and rubber trades. The best of the crude ore is worth from 16s. to 20s. a ton in America. The ore raised in England has a value of 20s. a ton also, and the selling price of the manufactured article is about £3 10s. per ton in London, ranging from £2 5s. to £5 per ton, according to quantity, quality, and package. As there is a duty of £2 per ton on imports of the latter into the Commonwealth, the trade value in Australia would be about £6 per ton, *i.e.*, for ordinary lots of average commercial quality. Precipitated barium sulphate is chemically pure, and commands much higher prices, being quoted in London at £6 to £7 10s. per ton. No statistics are yet available as to the quantity of barytes consumed in the Commonwealth, but the tonnage cannot be very great. The world's production is not easily obtainable, as the article is frequently included in the statistics under other heads. The production of crude ore in the United Kingdom in 1907 was 42,646 tons, and in the United States 65,579 short tons. Germany exported 111,209 tons of barytes in the same year.

The principal impurities in crude barite are iron oxide and calcite. Where calcite is the main accessory, it can be removed by jigging, but iron oxide is not so amenable to wet treatment. The ore after crushing has to be bleached with sulphuric acid, with more or less success. This process removes all traces of iron. The product is then washed with water, levigated, or "floated"; the floats or lightest particles being the best. The bleached material has then to be dried and mill-crushed to a fine powder.

The porphyroid and breccia on the property show that the rocks are members of the Dial Range metalliferous group. As regards copper ore possibilities, the ore already won demonstrates that some deposition has taken place, and the persistent gossan line, which has been traced for a long distance at surface suggests the desirability of continuing the prospecting work which has been begun.

(J)—Lucas and Perry,s Lodes.

About a couple of miles south-west of the Alma Mine are some outcrops of gossan which have lately attracted attention. Two of these have been opened upon by Messrs. Lucas and Perry on Crown land south of W. H. Lucas' 100 acres, 1½ mile west of the Forth River. Its bearing is N.W.-S.E., and the country rock is slate, apparently belonging to the Cambro-Ordovician system. A shaft has been sunk 38 feet, and is still in gossan. A good deal of manganese oxide enters into the composition of the gossan. I am informed that an assay of the lode-stuff made at the Mt. Bischoff smelting works returned 6 dwts. silver per ton.

Two chains to the west is another line of gossan 20 feet wide, and a shaft has been sunk on this also to a depth of 40 feet. The two lodes are identical in character. Samples which I took from the latter one were assayed in the Government laboratories, and contained 2 dwts. silver per ton.

It is difficult to predict what these gossan lodes will eventuate in in depth, as no minerals which can be used as criteria are present in the outcrop. It is desirable to prove them below the unoxidised zone, which, however, will probably extend to a considerable depth.

(K)—Crawford's Lodes.

On Mr. A. M. Crawford's farm, at Alma, about 14 chains west of the road, is a 20-feet seam of mixed gossan and slate, with a small band of pug a few feet wide in the middle. The formation strikes N.W.-S.E., and dips to the S.W. Twenty feet lower down the creek to the west is a formation consisting of country rock veined with calcite and charged with disseminated pyrite.

Opposite Mr. Crawford's gate, on the road, is a long lode-line of limonite gossan, which has been opened upon for 4 or 5 chains at intervals. It has a kindly appearance, but the samples which I took, and which have been assayed in the Government laboratories, yielded only traces of gold. The remarks made above with reference to proving these gossan outcrops apply here too.

VI.—RAILTON.

This district is in the Mersey basin, 7 miles south of Latrobe. To the north of it is the Dulverton coalfield; to the south of it is the Dasher River district, which has yielded gold indications; to the west of it is the high ground of the Badgers, also mineral country; and at Railton itself, east of the railway-line, some land has been taken up for Tasmanite shale.

The country forms roughly the eastern boundary of the Alma and Leven mineral belt, and its potentialities, owing to the general absence of mining works, cannot yet be strictly defined. An examination of its geological features, however, shows that it is part of a zone within which it is perfectly legitimate to seek signs of ore-deposition.

The Ordovician and Cambrian strata are developed here in an instructive manner.

The limestone at Railton yields generally the remains of the genus of extinct cephalopods Actinoceras, as determined by Mr. R. Etheridge, Jun., of the Australian Museum. It corresponds in geological position with the limestone of the Gordon River, which is also rich in Orthoceratidæ, accompanied by Raphistoma, Orthis, Rhynchonella, Euomphalus, according to Mr. C. Gould (in 1862). The Gordon River limestone has always been considered as equivalent to the Lower Silurian (Ordovician) of Europe. Mr. Gould referred it to the very base of the Lower Silurian of Europe, though he placed the base of the system in Tasmania still lower, so as to include underlying grits and conglomerates, which, according to what can be seen at Railton, appear to be of Cambrian age.

This rock is in the shaft and bore which were put down some years ago, about 100 feet west of the railway-line, near the station at Railton, in a futile attempt to discover coal measures below the Ordovician. The width of the belt is about a mile, for the limestone appears again at the quarry worked by Mr. J. Blenkhorn east of the railway.

Mr. Thomas Stephens, M.A., in 1874, recorded the discovery of beds at Caroline Creek containing casts of trilobites, and in 1882 some of these were determined by Mr. R. Etheridge as Dikelocephalus Tasmanicus (sp. nov.) and Conocephalites ? (now Ptychoparia) Stephensi (sp. nov.). With the tribolite remains were those of small discoidal or planorbicular univalves, which, according to Mr. Etheridge, presented all the appearance of the genus Ophileta. On the strength of the Dikelocephalus, Mr. Etheridge was of opinion that it appears more than probable that the age of the beds is that of the Lingula flags or Menevian beds of Great Britain and the Potsdam sandstone of North America. To show the significance of this reference, the following correlation of the Cambrian groups in Great Britain and North America is inserted here:—

	Great Britain.	North America.	Tasmania.
Ordovician, Lower	Arenig group of Wales	Calciferous group of New York	Limestone at Gordon River, Denison River, Florentine Valley, Junee, New River, Blythe, Gunn's Plains, Beaconsfield, Mole Creek, Chudleigh, Don, Railton
Upper Cambrian (Olenus and Dikelocephalus fauna)	Lingula flags of Wales	Potsdam sandstone	Caroline Creek Beds, Railton; Florentine Valley and Humboldt Divide with Dikelocephalus
Middle Cambrian (Paradoxides fauna)	Menevian group of Wales	Acadian	? Cherty breccia and conglomerate with slate at Gunn's Plains, Dial Range, North Dundas
Lower Cambrian (Olenellus fauna)	Harlech and Llanberis group of Wales	Georgian	White pebbly sandstone and conglomerate at Railton and Denison Range

In 1902, Mr. Stephens discovered stone at the head of the Florentine Valley containing another form of Dikelocephalus, which Mr. Etheridge named *D. florentinensis.*

The occurrence of the Ordovician limestone at Mr. Blenkhorn's quarry at Railton shows that this rock rests upon the Dikelocephalus sandstone. The exposure of the latter on the track from the quarry is not sufficient to enable it to be seen whether the Ordovician and Cambrian are conformable. Both have a steep dip to the S.W., and strike N.W. A thin band of laminated cellular clay stone intervenes between the limestone and sandstone. The sandstone further east passes into yellow and purplish clay slates, alternating with purple or chocolate-coloured sandstones.

An exposure of these occurs on the railway-line near the bridge over the Caroline Creek, about 4 miles nearer Latrobe. Near here the sandstones are also trilobite-bearing. We have consequently a development of the Cambrian for at least 4 miles in a north-westerly direction roughly parallel with the railway-line. About three-quarters of a mile west of the line at Railton near the Methodist church yellowish sandstones and grits are exposed, from which Mr. Blenkhorn obtained a cast of what Mr. Etheridge considered to be raphistoma, a univalve with a geological range from Cambrian to Silurian. These beds, sometimes vertical, appear to have a general steep dip to the N.E. About half a mile S.E. of the quarry hard pinkish, white, pebbly quartzites, weathering into a fine-grained conglomerate, compose a hill near the rifle-range. The rock resembles similar strata, which form Mt. Wright and the east front of the Denison Range, in the Valley of Rasselas, and occupy a similar position with regard to the limestone there. These quartzites would appear to be geologically lower in the Cambrian than the Dikelocephalus sandstones.

(A)—Tune's Reef.

About a mile south of the railway-station, at the summit of a hill, some mining work has been carried on at intervals during the last 18 or 20 years in the way of prospecting quartz veins alleged to be gold-bearing. Trenches and shafts occur at several spots, one of the latter 70 or 80 feet deep; but beyond colours, nothing seems to have been obtained. The country is a coarse yellow and white friable sandstone, belonging, apparently, to the Cambrian system, and is intersected by frequent veins of white quartz. There is no geological reason why some of these veins should not be gold-bearing. A shaft has been sunk at the summit of the hill to a depth of 25 feet, and at the bottom a drive has been put in 20 feet to a lode, and 10 feet further, to the end, in a direction N. 20° E. The bearing of the lode is north of east and south of west, and its dip towards the north. The lode or lode-channel consists of sandstone veined with bands or lumps of white unmineralised quartz of a vitreous appearance. Sometimes the stone is dense and compact, and again loose and vughy. The stone continues in veins and patches from where it was first struck, right through to the end. I have not been able to detect any gold in it.

Railton Resources.

In some of these veins at Railton I believe gold will eventually be found. There has been very little prospecting, and no reliable information can be said to exist as to the reef occurences which are met with at various points. The possibilities of copper ore-deposits in the neighbourhood should not be overlooked. At present the principal mineral product is lime. Mr. Blenkhorn is manufacturing this, and crushing it fine, so as to encourage agriculturists to use it with their seed. Bricks, too, are being made at his kilns.

VII.—CONCLUSION.

The present investigation has resulted in an important advance being made in our knowledge of Tasmanian geology. It has laid the foundation for a more correct appreciation of the geological age of the ore-bearing strata on the North-West Coast. It has tended to disclose the very important part which the igneous porphyroids play in connection with the distribution of several hitherto ill-understood ore-occurrences on the Coast. Incidentally, it has thrown some light on the age of the North Dundas slate series by enabling a correlation to be made. Further information has been gained in respect of the stratigraphical relations of the Early Palæozoic systems with the Pre-Cambrian platform, as well as collateral confirmation of observations made last year in the Gordon and Florentine valleys.

The study of the mineral indications presented in these pages will, it is hoped, be of service to those interested in mining. It will be seen that the deposition of copper ore has been very general all along the Coast, but in no instance has work on the lodes been pushed to a conclusion. Either work has been suspended before cutting the lode, or the lode, when cut, has not been driven upon, or when the ore-shoot which was first cut has been worked out operations have been suspended. The value of the Coast as a mining field has consequently not yet been proved. It is difficult, however, to believe that with so many ore-occurrences there are not some which, when proved, will be worth exploitation. There is still a great field open here for prospecting work. Owing to the trivial nature of many of the indications progress will probably be slow, but there is some justification for anticipating eventual discoveries of value.

W. H. TWELVETREES, Government Geologist.

Launceston, 26th January, 1909.

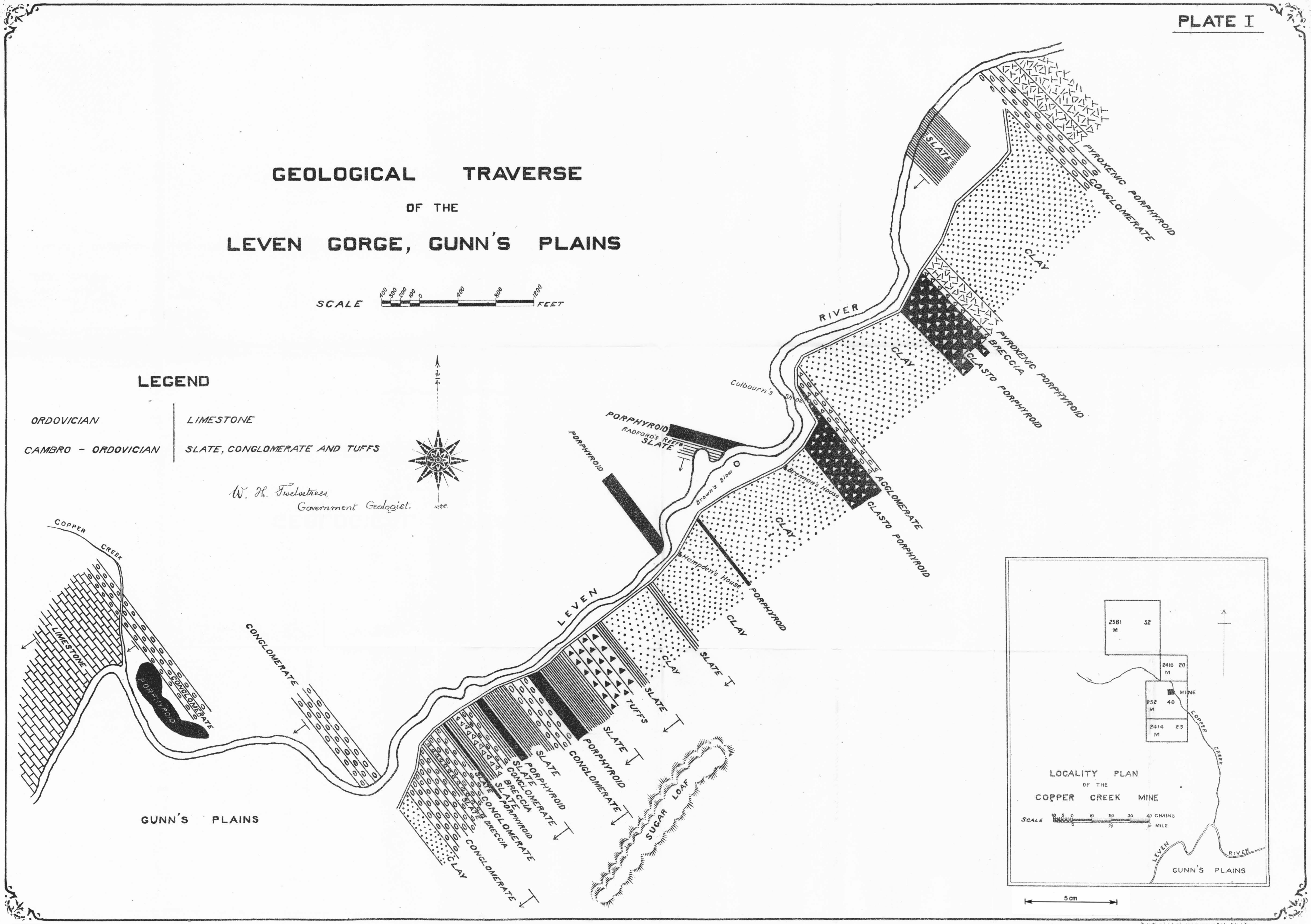


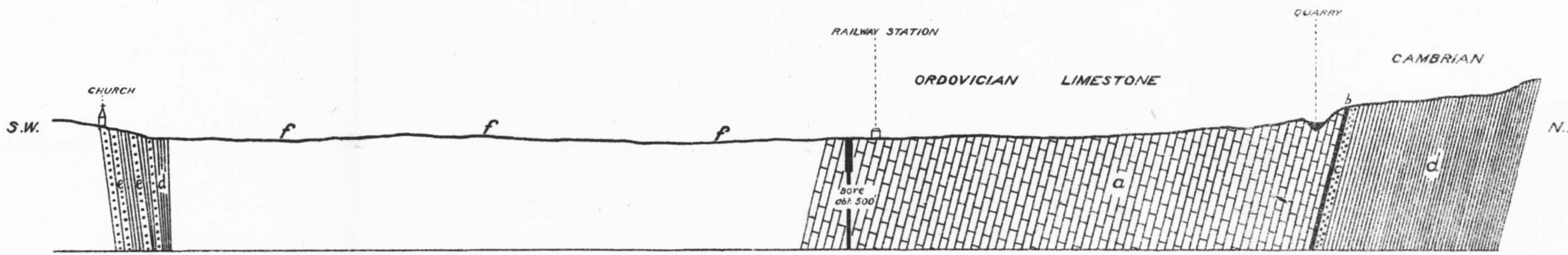
PLATE I
GEOLOGICAL TRAVERSE
OF THE
LEVEN GORGE, GUNN'S PLAINS
SCALE
400 300 200 100 0 400 800 1200
FEET
LEGEND
ORDOVICIAN
LIMESTONE
CAMBRO - ORDOVICIAN
SLATE, CONGLOMERATE AND TUFFS
W. H. Twelvetrees,
Government Geologist.
COPPER CREEK
LIMESTONE
PORPHYROID
CONGLOMERATE
GUNN'S PLAINS
LEVEN
RIVER
SUGAR LOAF
CLAY
SLATE
BRECCIA
PORPHYROID
TUFFS
Hampden's House
Brown's Blow
Brennan's House
RADFORD'S REEF
Colbourn's Shaft
AGGLOMERATE
CLASTO PORPHYROID
PYROXENIC PORPHYROID
LOCALITY PLAN
OF THE
COPPER CREEK MINE
SCALE
CHAINS
MILE
2581 M
52
2416 M
20
252 M
40
2414 M
23
MINE
COPPER CREEK
LEVEN
RIVER
GUNN'S PLAINS
5 cm

PLATE II

GEOLOGICAL SECTION OF COUNTRY AT RAILTON

— SCALES —

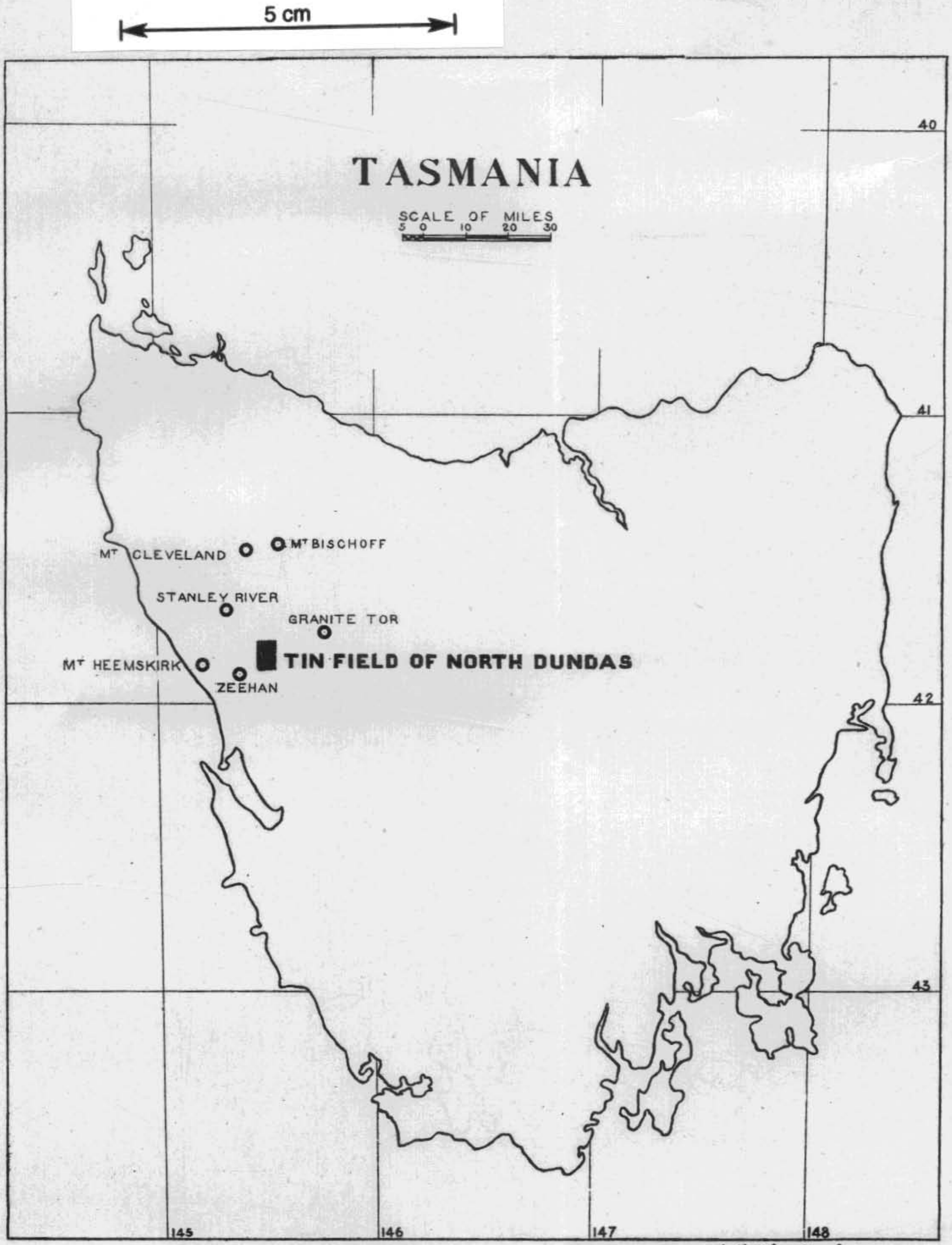
W. H. Twelvetrees.
Government Geologist



LEGEND

- a ACTINOCERAS LIMESTONE
- b CELLULAR CLAYSTONE
- c SANDSTONE WITH DIKELOCEPHALUS, PTYCHOPARIA AND RAPHISTOMA
- d YELLOW AND PURPLE SLATE
- e PEBBLY GRIT WITH RAPHISTOMA
- f ALLUVIAL AND DETRITAL COVERING

Photo Algraphed by John Vail Government Printer Hobart Tasmania.



L. Keith Ward
Assistant Government Geologist.
12 . 2 . 1909.

LOCALITY PLAN

Photo Algraphed by John Vail Government Printer Hobart Tasmania.

THE TIN FIELD OF NORTH DUNDAS.

I.—INTRODUCTION.

(1)—General.

The tinfield of North Dundas possesses some features which are not quite normal, and much of the following report has been written with a view to the exposition of those geological features, which are in themselves not quite apparent when any single occurrence is considered apart from its neighbours.

The writer can conscientiously go no further, in many cases, than state what appears to be the probable structure of the ore-body under consideration and its probable relationship to other ore-bodies of the district. The reason of this is that so little systematic development work has been done on the lodes. The present condition of the district as regards development is undoubtedly backward. In some cases, in the centre of the field, the abnormal character of the lode-structure has contributed towards this condition, but in other cases no such excuse can be proffered.

Nevertheless, in spite of the meagre amount of the information to be obtained from many occurrences of ore there are certain generalizations which may be made provisionally. There are, at least, certain features which may be presented to the mining community for consideration in the planning of necessary development work.

It will be noticed, in the course of this report, that in several instances the management have formed an erroneous conception of the structure of the lodes, and that the work which has been done is apparently wasted. These failures to attain the immediate object in view are by no means without their use, and the negative results have a positive value; for the non-productive work has in several cases given definite facts concerning structural details which would otherwise have been unavailable.

The important thing to be kept in mind by the several mining companies called upon to deal with the more complex structural problems is this: every single detail of occurrence (including quantitative details regarding the distribution of ore) should be faithfully recorded and made available for reference on the mine. Unfortunately, this has not been the practice in all cases, and if the progress of the property has not been seriously impaired for want of such information, my examination has at least been to some degree hampered.

In the geological survey of a mining field of this character an officer of the survey must necessarily rely on the management of the companies for full and unreserved information concerning the properties entrusted to their charge. It is neither practicable nor expedient to systematically sample all ore-bodies examined; for the geological survey of a district is not intended to include such matters as the calculation of ore reserves. Yet, by unreservedly placing at the disposal of the geological survey all the information available, any single company may offer information of considerable value.

The immediate application may not be possible to the company affording the information, but assistance may be given in this way towards the solution of other questions in other neighbouring mines. Any benefit that may accrue to any one mine in the district is of indirect, but real, benefit to all the other mines.

The above remarks are not of general application, and I have pleasure in acknowledging the very ready assistance which has been afforded me in almost every instance.

In some cases it has been quite impossible to gain any information whatever concerning abandoned or disused workings. The leases have been held temporarily and abandoned by several different parties in succession. The records have in several such cases become little more than traditions, handed down from one lessee to another, or pieced together from the information afforded by those who were on the field in its earlier days.

Under such circumstances, it is necessary to insist that the views here put forward by the writer must not be considered to be in any way a final judgment. Still, I have had the opportunity of studying the field as a whole in far greater detail than has any member of the geological survey hitherto.

The reasons which have contributed to retard the due recognition of the field are set forth at some length in the following pages, and will be seen to be chiefly these:—

(1) The geographical position of the field.

(2) The unusual mineral composition of many of the lodes, and the consequently abnormal gossans which are the outward manifestations of the presence of many of the lodes.

(3) The complex character of the structure of many of the lodes on the field.

Though these several causes may have for so long a period kept mining development in a backward condition, in no way do they constitute any reasons for future inactivity. The field is now accessible; and it is hoped by the writer that this report may assist to explain some of the features which caused perplexity.

It appears that the interest of investors has now been duly aroused, and that the district will be a centre of progressive mining activity.

(2)—Geographical Position.

The area which may be considered to constitute the tinfield of North Dundas is of very irregular shape, and its boundaries are a little difficult to define. In a later portion of this report it will be seen that there is a considerable development of river-borne alluvial matter forming high-level terraces on either side of the Pieman River. These older river terraces carry a small proportion of tin ore, and it may therefore be expected that from time to time occurrences of tin ore will be reported from localities beyond the area mapped and treated of in this report. It is, however, believed that any such occurrences are not likely to prove of great importance.

The central area of this tinfield, and that from which the greater portion of the tin ore of the old river terraces has been derived, is located in the strip enclosed between the Ring and Argent Rivers. These are two of the main tributaries of the Pieman River.

The outskirts of the field stretch southwards as far as the township of Dundas, and eastwards to the deserted site of Ringville.

On the northern side of the Pieman River, and just below its junction with the Huskisson River, some alluvial tin ore has been found, but so far not in payable amounts.

The most important of the neighbouring mining centres is that of Zeehan, distant some 9 miles to the south-west.

Rosebery and Mt. Read are closer still, and are situated to the eastward.

The western coast-line is 18 miles away, and approaches most nearly to this area at Trial Harbour, near Mt. Heemskirk.

Geographically, the tinfield of North Dundas is seen, therefore, to be located in the centre of the mining fields of Zeehan, Dundas, and Mt. Read, which are areas in which deposits of silver-lead predominate.

On the locality-plan prepared for this report, the positions of the nearest tin-bearing districts are shown; and from the following report it will be seen that the tinfield of North Dundas is genetically related with the other occurrences of tin which are shown on this map. The nature of this genetic relationship is fully discussed below.

The Emu Bay Company's railway-line passes through the northern portion of the field, and forms the main line of communication and transport.

The principal track connecting with the railway-line follows the Renison Bell Creek, and crosses over the saddle between the Renison Bell and Dreadnought Hills. This saddle is a little over 400 feet above the rails, and a much better gradient might well have been secured by starting the track some little distance further to the eastward. At present all material for all the mines other than the Renison Bell has to be dragged on sledges over this steep track, and progress is consequently slow and transport costly. The tin ore is packed out on horses to the railway. Yet the construction of this track by the Government has been of immense service to the mining community, which had been hitherto dependent upon the rough pack-track to the south of the Renison Bell Hill.

The southern portion of the field is much nearer to the North-East Dundas Tramway, and there are two connecting tracks. Of these, that which leads to the Confidence Saddle will be much the more serviceable when the projected repairs have been effected. Deviations which will secure better grades can easily be effected, and facilities for transport will be very greatly improved when this has been done. The principal tracks are shown on the topographical map accompanying this report.

II.—PREVIOUS LITERATURE ON THE FIELD.

The first official report published which makes mention of this field* is that by Mr. A. Montgomery, and is dated from the Geological Surveyor's Office, Launceston, on April 11, 1893. This is an interim report dealing with the state of the mining industry on the West Coast at that period. It contains a mention of the tin-bearing river

* A very brief note concerning the gossan outcrop on the Renison Bell lease is included in Mr. Montgomery's "Report on the Progress of the Mount Zeehan and Mount Dundas Silver-lead Fields," November 25, 1890.

terrace above Star Creek, and of the occurrence of the tourmaline-bearing quartz porphyry.

The detailed report which followed this latter is dated May 20, 1893, and is entitled "Report on the Progress of the Mineral Fields of the County of Montagu." In it mention is made of the general geological features of the district, and a brief account of the workings on the Ring River and Dalcoath Creek.

Mr. Montgomery published a later and more detailed report on May 15, 1895, which deals at some length with the alluvial ground and lodes which were being worked at that time. The mining activity was restricted mainly to the area traversed by Gormanston Creek and the lower portion of Dalcoath Creek. A brief account is given of the Renison Bell Mine, but the country lying between this and the Dalcoath Creek was at this time unprospected.

The next official visit paid to the field was during the early portion of the year 1900, when Mr. Twelvetrees made a brief examination of the Renison Bell Mine. His report, entitled "Report on the Mineral Districts of Zeehan and Neighbourhood," was dated from the Government Geologist's Office on October 27, 1900. The portion of this report which deals with the district is not considerable, but affords an account of the state of development of the Renison Bell Mine at that time.

In the year 1902, Mr. G. A. Waller issued a "Report on the Tin-ore Deposits of North Dundas," which is dated from Zeehan on March 8. This report gives a brief account of the geology of the district, but is concerned mainly with an account of the several mining properties of the field. In the discussion of the features presented by the lodes, Mr. Waller gives a short account of the geology of the areas being worked.

More recently Mr. Twelvetrees paid a short visit to the northern end of the field, and his observations are embodied in the "Report on the Renison Bell Tinfield," which was issued from the Government Geologist's Office on December 18, 1906. Since this visit very little alteration in the state of the Renison Bell Mine has taken place, but other discoveries have been made in the immediate neighbourhood.

The abovementioned reports constitute the officially-published literature on the field.

Besides these, Mr. Waller, in a paper, entitled "Some Modern Theories Concerning Ore-deposits," read before the Australian Association for the Advancement of Science in

1902, makes reference to the pyritic tin-lodes of North Dundas, and discusses their bearing on the general aspects of ore-deposition.

The only other publication which makes mention of these tin deposits is Mr. Donald Clark's "Australian Mining and Metallurgy," 1904.*

III.—PHYSIOGRAPHY.

(1)—Topography.

The topography of the northern portion of the area mapped shows a marked contrast to that of the central and southern portions.

In the north there still remain very well-marked remnants of a broad plain of erosion. On the borders of this plain, now deeply dissected by the rivers of to-day, lie several notable prominences.

Mt. Black, the Colebrook Hill, and the hills indicated on the topographical map published herewith form the principal heights on the southern limit of the plain.

To the north and north-west the dissected plain extends to the base of Mt. Ramsay and the Parson's Hood.

The width of this flat belt is clear proof that the whole region has remained at a constant level for a period sufficiently great for the erosion to have attained a mature stage. The old Pieman River has gradually, by lateral planation, established a broad valley, and as the gradient has diminished it has been unable to remove the detrital material. Thus, a broad plain has become filled with alluvial material, the composition of which shows that the principal tributaries flowed into the old valley from the east and south-east. This latter statement holds true for at least the eastern portion of the old Pieman Valley.

This stage in the physiographical development of the region seems to have been attained at a period during which the action of water has been assisted by that of ice. Few traces now remain, but the occurrence of huge erratics in the alluvial material indicated at the extreme north of the area mapped must be regarded as sure signs of the contribution of glaciation to this stage of erosion.

From the fact that the materials of this period of deposition cover the diabase dyke found in the tinfield, the period of the development of the alluvial deposit on the old valley floor would seem to have been later than Mesozoic.

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* Page 221 *et seq.*

At a still later period, the whole district has suffered an uplift, and the rejuvenated rivers have cut down their channels deeply into the former alluvial plain.

The latter, therefore, is marked at the present time by disconnected areas, of which the general level is noticeably constant.

The present-day rivers and their tributaries have not yet attained a stage of maturity, and their beds are marked by falls and rapids.

The higher country of the tinfield proper is deeply dissected by the processes which have been continuous in their action from the beginning of the cycle of erosion which culminated in the formation of the older alluvial terraces right up to the present time.

The steep slopes of the present hills and ridges, and the ungraded streams and rivers, have prevented the accumulation of any considerable alluvial deposits of recent date. Those which do occur are shallow and local.

The nature of the warping of the crust which has given rise to the rejuvenated river system of the Pieman cannot be decided by the study of one portion of the basin apart from the others. To determine exactly the sense of the warping the heights of a large number of points on the basin must be accurately obtained. These facts are not yet available.

However, according to the aneroid measurements made during the geological survey of the tinfield, it was found that—

(1) The former elevation of the southern border of the valley of erosion of the Pieman River was about 700 feet above sea-level.

(2) The present level of the river is about 240 feet above sea-level.

We may conclude, therefore, that the warping has caused an uplift of this southern portion of the old flood-plain which amounts to more than 460 feet. (It cannot be the exact 460 feet which make the difference between the present river level and the higher terraces now visible; for the deposition of the terrace gravel took place at a period when the older river system had been duly graded, whereas the present rivers have not yet attained their base level of corrosion. The uplift must, then, be the difference of level now measurable, *plus* the depth to which the Pieman must yet corrode its present bed before reaching the base level.) These figures are based on the assumption that there has been a movement in one direction. No evidence of any other movement than that of an uplift was detected in the area examined. Yet there are clear signs to show that the River Pieman has temporarily attained its base level, only for a further movement to entrench it once more in its levelled floor.

Remnants of the lastformed terrace are to be seen near the junction of the Argent River with the Pieman. The railway-line to the east of the area shown on the map follows the River Pieman on the level of this terrace. With this evidence may be compared that of the terraces observed by the writer in the valley of the Mackintosh River, at Mt. Farrell.*

Mr. Montgomery, in his report on the Corinna Goldfield, published in 1894, makes mention of the gravels of the West Coast, and their bearing upon the evolution of the physiography of that region. His conclusion that they are of marine origin cannot, in my opinion, be supported by any of the facts yet known. It is by no means necessary to postulate a submergence of the area with which this report deals below sea-level in order to account for the deposition of gravels such as those met with. They would be deposited on the valley bottom of the former river when the gradient of the valley had been so reduced that the diminished velocity was insufficient to maintain the transportation of material to the sea.

A comparison of the topographical with the geological map of the North Dundas tinfield will show how small has been the influence of geological structure in the modification of the physical features by the processes of weathering and degradation. For when we turn from the dissected alluvial plain of the old Pieman River, we find no separate physiographical units coinciding in distribution with particular rock types. The hills and valleys each present a marked variety of geological structure, and the same rock types stretch from hill to hill across the gorges.

The contribution of ice action towards the moulding of the topography of this district has not been great. Formerly there may have been signs of ice action visible in the more elevated portions of the region; but the long continuation of the general processes of weathering has produced surface features which retain no trace of ice action.

Embedded in the gravels of the old Pieman Valley, on the northern side of the present Pieman River, and close

* Geological Survey Bulletin No. 3, "The Mount Farrell Mining Field, 1908," p. 4.

to its junction with the Huskisson River, there are to be seen huge masses composed of blocks of the West Coast conglomerate and the porphyroid so characteristic of the Mt. Read and Mt. Black districts. These cannot, in my opinion, be regarded as of any but glacial origin; and they must be considered in connection with the similar erratics of the Farrell siding, and other points in the Mt. Farrell district.*

The streams which flow northwards into the Argent or Ring Rivers belong to the drainage system of the Pieman River. Those which flow southward join and find their way to the sea by the valley of the Little Henty River. The divide between these two drainage systems passes above the Argent Tunnel along Serpentine Hill to the high ridge which lies to the south-east of the area shown on the map.

In conclusion, the physiography of the region considered is that of one which has passed through a mature cycle of erosion. The nature of the surface before this cycle attained its maturity is not discernible, for there remain no traces of sediments which may have existed in the region in the long period between Early Palæozoic and Late Cainozoic time. The Late Tertiary alluvial terraces rest directly upon Cambro-Ordovician slates.†

The physiography resulting from this erosion cycle has been seriously modified by an uplift of at least 460 feet. The streams, rejuvenated by the latter movement, have cut down deep gorges into the hills and valleys of the older surface, and this cycle still continues in active operation.

(2)—Meteorology.

The rainfall in this district may very reasonably be considered to appproximate closely to that of Zeehan. Mt. Read is not so far distant, but its elevation is greater.

The total rainfall and the distribution of the rainfall for a number of years are shown in the following tables:—

The Rainfall, 1*st October to* 30*th September* (*in inches*).

	1899–1900.	1900-1.	1901-2.	1902-3.	1906-7.	1907-8.
Mt. Read	..	..	77·91	83·61	126·95	122·28
Zeehan	101·33	106·00	94·50	105·31	100·33	100·33

* Geol. Surv. Bulletin No. 3, "The Mount Farrell Mining Field, 1908," pp. 5 and 26.

† *Vide infra*, p. lxx.

Distribution of Annual Rainfall at Zeehan.

Year.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April.	May.	June.	July	Aug.	Sept.
1899–1900..	8·66	15·84	7·27	6·19	5·61	6·96	8·91	7·54	10·95	9·62	9·56	4·22
1900-1901..	13·61	4·29	10·41	8·28	2·35	7·78	9·91	7·80	13·96	7·77	7·02	12·82
1901–1902..	12·48	4·58	4·43	8·92	10·65	3·08	5·86	8·94	7·19	9·23	8·07	11·07
1902–1903..	5·71	6·07	5·28	8·04	7·30	8·79	12·49	10·68	10·78	11·79	13·04	5·34
1906-1907..	10·90	8·36	3·49	3·04	2·71	6·18	11·14	5·87	5·30	13·72	12·89	16·73
1907-1908..	10·02	2·63	11·17	3·74	5·11	11·15	5·74	14·74	9·96	8·99	9·53	7·55

Assuming that these figures may be applied to the neighbouring area of North Dundas it will be apparent that the rainfall is heavy, and that it is not negligible in any single month of the year. The greatest precipitation takes place between June and October, while December, January, and February are comparatively dry months.

This question of the distribution of the rainfall is one which should attract the careful attention of the several mining companies on the tinfield. The slopes of the high ground are very steep, and the rain will rapidly leave the hill sides. Yet an appreciable quantity can always be relied upon throughout the year.

Snow falls occasionally, but only the higher part of the region is seriously affected by a fall. The slow melting of the snow gives a more steady supply of water to the streams than is obtained from a mere fall of rain, and on that account is, on the whole, of benefit to the mining community.

The degradation of the higher country by the operation of the surface water is materially hampered by the very dense vegetation with which almost the whole region is clothed.

Only in a few small areas, on the old alluvial plain of the Pieman River, is the denser vegetation replaced by button-grass.

The timber obtainable in the district includes many useful varieties. This is being ruthlessly destroyed in the endeavour to open up the mineral-bearing country. There is some splendid pine on Pine Hill and its vicinity, and on both the banks of the Ring River, near Star Creek, there is a notable growth of blackwood. The destruction of these is certain and unavoidable with the expansion of the mining industry. It seems a pity that the timber should be wasted for lack of enterprise, for it is at present being burnt by the fires necessary for clearing off the scrub round the centres of mining operations.

(3)—The Effect of the Topographical Features on Mining.

Prospecting and Exploitation.—The Ring River and its tributaries have played a most important part in the discovery and development of the mining field. It was in the Ring River in 1890 that tin ore was first discovered, and in the prospecting of the contributing streams the alluvial deposits of the eastern portion of the field were first found. Of these tributaries, the Dalcoath and Gormanston Creeks have been the most continuously and systematically worked. The Ring River itself has one lode exposed upon its banks,* but otherwise has not yet proved to be of any material assistance to mining.

A considerable portion of the Great Northern Creek has been worked for alluvial tin. This fact has led to the location of the parent lode, just as the discovery of tin in the Dalcoath Creek has led prospectors southward, until the lode-bearing zone round Pine Hill has been found.

The other tributaries of the Ring River which have been worked for tin ore, viz., Star Creek and Isaacson's Creek, have not indicated the position of any lode-matter, since they have derived their tin ore from formations which were already of a secondary nature.

The Argent River cannot be said to have materially assisted prospectors. It cuts through one large lode-system, which is more noticeable for its gossan than for the river-bed exposures.

A small tributary of the Argent which flows into the river from the west at a point distant some 25 chains north-west of the Renison Bell Siding contains tin ore, and the lode-formation which has shed the tin ore has undoubtedly been located, but no further prospecting has been done.

The same remarks may apply to the lode running southwards over the high ground which forms the southern limit of the Melba Flat. This was discovered as a result of prospecting for the source of the alluvial tin recovered from the vicinity of the sawmill on the Melba Flat.

In Dundas the tin ore was first found in the shallow alluvial ground forming the banks of the Dundas Rivulet.

The creeks have therefore played an important part in prospecting operations.

In actual exploitation the gorges carved out by various members of the river systems have served to afford convenient low-level sites for the mouths of tunnels. Thus, the Argent River bed has been of great assistance to the Renison Bell Company in the work of attacking their main lode-system in depth.

In the case of Dalcoath Creek, also, the depth of the gorge has been a very great incentive towards the exploration of the lodes by low-level tunnels. Unfortunately these latter commendable efforts have not yet been

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* *Vide infra*, p. clxxxviii.

attended by successful discoveries of lodes which are likely to give adequate returns for the expenditure incurred.

The discussion of the structure of a large number of the occurrences of ore in this district will show how the mere driving of tunnels is quite insufficient to give any idea of the amount of ore available.* In fact, in some cases the tunnel exposures of ore are extremely meagre. Yet, in other cases it has been possible to make great use of tunnels, where the slopes are steep and the lode-structure is more normal, or at least more adapted towards development by adit levels. In some cases the amount of possible backs available from adit drives of reasonable length is remarkable.

So little actual work has yet been achieved in the mining area that it can hardly be granted that the irregularities of the surface offer facilities for mining which may outweigh the difficulties placed in the way of transport. More feasible routes from the central mineral sections to the railway-line can be marked out, and the transport difficulties thus minimised.

The dissection of the old Pieman Plain has placed serious obstacles across an area which is nevertheless, on the whole, markedly level.

Yet in the creeks which traverse the dissected plain occur the secondary concentrations of ore which have been worked.† The greater portion of the alluvial deposit, though carrying a certain amount of ore, has hitherto proved unworkable.

Water-supply.—The stage attained by the cycle of erosion in the mining field has resulted in a fairly uniform distribution of the rainfall among the several streams.

The fact that the principal occurrences of ore have been found on the higher ground has in some measure lessened the possible uses to be made of the water.

In the earlier days of the field the stream-beds only were worked, and the water question was not vital. At the present stage of development of the field the different mines are very differently situated as regards their requirements.

On the Pine Hill the necessity for the removal of the widespread overburden of quartz porphyry talus makes the question of water-supply most important.

As regards the central block of sections, where the surface detrital deposits of tin ore are being worked by

* *Vide infra*, p. civ., and Plate V., Fig. V. † *Vide infra*, p. cxiii.

sluicing methods,* the question of water-supply for sluicing is more important to-day than it will be after a few months; for the amount of ore which can be treated in this way cannot be expected to be large.

The mines which are carrying on sluicing operations cannot obtain large supplies, although, as shown on the topographical map, the races are of considerable length. The hills and ridges have no large areas at high levels available for the catchment of rainwater, with the one exception of the Commonwealth Hill. Part of the catchment on this latter hill is being utilized by the Montana Company.

From the statistics given above with regard to the amount and distribution of the rainfall it will be seen that a race round the upper portion of this hill would supply a large amount of water to the mining companies. It is the only readily available source of water to the high country around Pine Hill. In connection with a reservoir excavated at the saddle between Pine Hill and the Commonwealth Hill, such a race would be of great value.

The ore-bodies on the eastern fall of the Dreadnought and Stebbins' Hills are not adapted to sluicing methods. Nor can water be conveniently introduced in quantity by way of the high saddle connecting these hills with the Renison Bell Hill.

Any scheme for introducing water from the south over this saddle must involve very long race-cutting to avoid interference with present water-rights, and a high-level intake. The ore can be more advantageously carried to the Ring River and concentrated there.

The new discoveries of tin ore near the town site of Dundas are partly at a low level—on the banks of the Dundas rivulet, partly at a considerable elevation above this stream. The working of the higher ground has been seriously hampered by lack of water, which has been obtained from the slopes of the Razorback ridge. Here a very considerable length of race will be necessary to obtain a larger supply, and the work will not be of much use unless there is a larger excavation made for a reservoir.

Power.—Up to the present practically no advantage has been taken of the configuration of the district in order to obtain a supply of water at a high pressure for the purposes of either sluicing or motive-power.

The Argent River possesses a bed which is far from graded, and offers special facilities for the development of a power

* *Vide infra*, p. cxxxi.

scheme. From the topographical map it may be seen that the river-bed rises very rapidly between the Argent Tunnel and the eastern extremity of Serpentine Hill. Moreover, at the latter spot the gorge narrows remarkably between two spurs, and above this dam-site there is flat country on both sides of the river. A capacious reservoir may be erected here, and the upper waters of the Argent River temporarily stored.

Lower down the Argent River a considerable fall is obtainable, but it cannot be turned to account with such advantage. Moreover, there seems to be no satisfactory reservoir sites available.

The Ring River, also, has a steep gradient in that portion which came under my examination. Between Star Creek and a point about a mile further up stream there is a difference of level of 200 feet. Thence the grade is gradual to Ringville. This section of the river will be of great service to those companies which decide to treat their ore at the low level.

The only other water-channel which may be considered as a source of power is the Dalcoath Creek. Many portions of its bed are very steep, and at two points there are notable falls.

The upper of these is situated just above the junction of the Gormanston and Penzance Creeks with the main stream. Some short distance above this place a dam could be built, by which a fair quantity of water might be impounded.

The other falls are situated immediately above the workings in Section 496-M. The amount of the drop is about 90 feet, and at this point some use has been made of a portion of the power available. Mr. A. Kemp has a pipe-line carrying the water to the bed of the creek in which his workings are situated.

IV.—GENERAL GEOLOGY.

(1)—The Rock Types Represented in the North Dundas Field.

A.—The Igneous Rocks.

The igneous rocks which are represented in the field fall naturally into four separate groups, which are here considered apart.

(1)—*The Porphyroid Group.*

This large group of massive and schistose porphyries is much more abundantly represented in the area which lies a few miles to the east and north-east of the area mapped. A few outlying isolated occurrences were met with at North Dundas.

The areas covered are small, and the importance of the series, from the economic standpoint, is small also.

These occurrences, however, serve to confirm the observations of the writer in the Mt. Farrell field with regard to the conditions under which solidification has taken place.* Moreover, it is important to distinguish clearly between these older porphyroids and the latter intrusions of a more acidic type—the quartz porphyry dykes which are genetically connected with the occurrences of tin ore on the field.

There are both intrusive and effusive types present at North Dundas, as at Mt. Farrell, but no plutonic representatives were met with.

In the north-western corner of Section 1273-M there is a very small outcrop. The rock is of a dark greenish-grey tint, and when weathered has a brown crust. Abundant quartz phenocrysts are distinguishable to the unassisted eye. The rock is obviously much more decomposed than any of the masses of quartz-porphyry described below. Its colour is darker than the average porphyroid, and the constituent minerals less easily distinguishable.

Microscopically it is seen to consist of a thoroughly chloritized ground-mass, in which are set altered phenocrysts of quartz and felspar. The quartz is without crystal outlines, and is deeply embayed by the corrosive action of the magma. The felspars are idiomorphic, and are surrounded in some cases by aureoles of micropegmatite. All the felspathic material is completely replaced by kaolin and chlorite, and no extinction angles could possibly be measured. Ilmenite, now converted into leucoxene, is abundant. Some veins, filled by silica and of secondary origin, penetrate the rock.

A very similar type is present in the larger mass which lies mostly within the boundaries of Section 2212-M. The chief difference noticeable between this rock and that described above is the lack of quartz. The felspars and leucoxene are in this rock the notable minerals. Quartz is sporadic and poorly developed. Nevertheless, the general

* Geol. Surv. Bulletin No. 3. "The Mount Farrell Mining Field," 1908, pp. 11-17.

character is identical, and decomposition has produced the same kind of alteration.

The two rocks are closely related in origin, and the mere difference between the quartz contents is of no great moment. In other places* the gradual passage from quartz porphyry to quartz-free felspar porphyry has been noticed.

Both the masses which have been mentioned belong to that portion of the igneous magma which has forced its way through the slates, *i.e.*, they are intrusive rocks. Whether any contact metamorphic effects were developed at their borders is not now discernible, since the exposures are so greatly weathered.

The other rock-mass included in this group is entirely different in appearance and structure. It crosses the Penzance track from Section 1178-M to Section 774-M. To the unassisted eye it is a dark compact rock, which is noticeably different from the slate in which it occurs. The weathered surface is clean and hard, while the surrounding slate is converted to kaolin. The only mineral which can be distinguished in it is quartz, in the form of irregular glassy blebs. In thin section the true character is apparent. The rock is at first sight a porphyry, since there appears to be a ground-mass studded with phenocrysts. But the larger crystals have not crystallized in their present positions, nor are they idiomorphic. The most notable feature revealed by the microscope is the presence of numerous rounded fragments of an igneous rock constituted of glass, in which are set numerous microlites possessing a straight extinction.

These rock fragments, together with the fragments of quartz and oligoclase felspar, are set in a sericite-chlorite aggregate.

The whole mass constitutes a consolidated tuff, to which the term 'clastoporphyroid' may be given.† There is no doubt whatever but that this particular rock must have been formed during the period of sedimentation of the the Dundas slate series.

That is to say, the porphyroid intrusion was contemporaneous with portion of the period of sedimentation, and later than another portion of that period, inasmuch as both *intrusive* and *effusive* types are represented.

This evidence is of value in establishing firmly the age of the porphyroid group, and in confirming the observa-

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* *Ibidem*, p. 11. † *Ibidem*, p. 17.

tions recently made by Mr. Twelvetrees in the Leven Gorge,* and by the writer at Mt. Farrell.

The period of this intrusion is to be referred to that which preceded the deposition of the Gordon River limestone, and until further evidence is available should be termed Cambro-Ordovician.

(2)—*The Basic Group.*

The most important, in the matter of bulk, of the igneous rock groups present in the North Dundas tinfield is also the most variable. The one constant character is that of the uniformly low percentage of silica and the predominance of the ferro-magnesian constituents.

Although isolated masses, which are to be referred to this group, may consist of only one rock-type, in other cases (especially in the larger outcrops) there are a number of different rock-types represented in the one geological unit.

The variability of type is due either to the relative increase or decrease of felspar, olivine, orthorhombic, or monoclinic pyroxenes, or to the effect of secondary processes by which the original types have become considerably modified. No hard and fast lines can be drawn between the types, yet it is convenient to look upon them here as—

(*a*) Gabbros and norites, the modifications of which are gabbro-amphibolite and saussurite norite.

(*b*) Pyroxenites and peridotites from which the serpentines have been derived.

(*a*) *The Gabbro Group.*—The gabbro proper is seen in its freshest form at the south-eastern corner of Section 3370-M, near the junction of Dalcoath Creek with the Ring River. The rock is coarse in grain and remarkable, even to the unaided eye, for the development of large areas (up to three-quarters of an inch in diameter) of the ferro-magnesian constituent as a continuous crystalline growth about the other minerals.

From the mode of occurrence the exposures here seem to be the upper limits of a deep-seated mass, the exact shape of which is not discernible. The work of the denudation of the overlying slate has not reached a further stage than that necessary to barely uncover the uppermost portions of the intrusion.†

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* Geol. Surv. Bulletin No. 5, "Gunn's Plains, Alma, and Other Mining Fields, North-West Coast," 1909.

† See Plate III.

Microscopically, the rock does not prove as fresh as it appears. The texture is holocrystalline and coarse, and there is a marked poikilitic growth of diallage about the felspars. The latter are all clouded by kaolin, and the extinction angles are not recognizable. There are both orthorhombic and monoclinic pyroxenes present. Of these, the earlier crystals are orthorhombic, and are either partially or wholly surrounded by the larger areas of diallage.

The orthorhombic forms are much altered, and for the most part are represented by areas of serpentine and uralitic hornblende. This is the case even when there is a complete envelope of unaltered diallage surrounding the crystals. The serpentine is faintly tinted green, and the secondary amphibole pale yellow to light bluish green. Brown biotite is also present.

Of the iron ores, ilmenite in patches, which show the characteristic partial decomposition into leucoxene, is abundant.

This same type of rock is found in the area which occupies the western portion of the crown of Commonwealth Hill. It also constitutes the southern portion of the dyke which crosses the Argent River, and is cut several times by the Montana Company's water-race. The northern extremity of the dyke is constituted of a finely-grained rock which is, in all but texture, similar to that described.

Other portions of the basic masses are very similar to the gabbro described above, notably the area lying to the west of the Emu Bay Railway-line, near the Melba Flat, the area lying to the north-west of Section 453-M, and the area between Pine Hill and the Confidence Saddle.

The monoclinic pyroxene is not so well developed as in the exposure near the Ring River and Dalcoath Creek, and the rocks are strictly norites, rather than gabbros. Yet they are to be regarded as part of the gabbro family.

Modifications of these rocks are formed by the further progress of the alteration of the pyroxenes into amphibole. In the rock described above, this process was in its incipient stages. In other cases the alteration has been so complete as to produce a rock which may best be termed a "gabbro-amphibolite."

An excellent example of this rock is the mass which constitutes a broad dyke-like intrusion along the course of Dead Man's Creek. The alteration from a gabbro is best marked at the point where the Government track crosses the intrusion. The character is not outwardly altered in the least degree, and the paramorphic change from pyroxene into amphibole is only to be determined with the assistance of the microscope.

The hornblende occurs in two forms. The massive crystal plates are coloured green to greenish yellow. The smaller scales and tufts appear bluish green, green, or greenish yellow, according to the direction in which the light traverses the crystals.

In several cases it is possible to find the centres of large plates unaltered diallage, while the outer portions are completely converted into massive hornblende. When the orthorhombic pyroxene has been replaced by hornblende the character of the unaltered mineral is indicated by the existence of the numerous inclusions which are so characteristic of bronzite. The diallage of these rocks appears to be free from such inclusions.

The more fibrous forms of amphibole are associated with almost colourless chlorite and epidote.

The felspars are almost completely replaced by the mineral aggregate termed saussurite. Ilmenite, with its usual decomposition product, leucoxene, is abundant.

Near the Emu Bay Railway line, and about a quarter of a mile south of the Argent Tunnel, there is a type which appears different from any of those described, as it possesses a high proportion of a pale-coloured constituent, which is the more noticeable on account of the coarseness of grain.

Microscopically, the rock proves to be a saussurite-norite rather than a saussurite-gabbro, since the orthorhombic pyroxenes are largely in excess over the monoclinic.

The distribution of the ferro-magnesian constituents and the saussurite aggregate indicates that the former were later in the order of crystallization. The pyroxenes are very fresh in this rock.

There is yet another rock type which seems to belong to this group. The area covered by it is large, for it extends from the Gormanston Creek right over the high spur lying to the eastward and across the Ring River.

Macroscopically the rock has the appearance of a diabase, on which a limonite-stained crust is produced by weathering. Its mode of occurrence is not readily determined on account of the vegetable cover and the poverty of outcrops. As far as could be ascertained it forms the outer fringe and most easterly extremity of the gabbro proper.

In thin section the rock is seen to differ considerably from the gabbro, both in mineral constitution and structure.

The structure resembles that of some of the finer-grained diabases of Tasmania, but the constituent minerals are amphibole, plagioclase (with high extinction angles), and abundant interstitial quartz.

The felspars are partly enclosed in the hornblende. The latter is markedly devoid of crystal boundaries, and has every appearance of being secondary. It is strongly pleochroic, the tints assumed being green, bluish-green, and greenish-yellow. The quartz contains numerous acicular inclusions, which have an oblique extinction, but the exact character of which could not be ascertained.

Epidote is present in scattered grains, and as the filling of cracks. Magnetite is abundant in the form of equidimensional grains.

The reasons for classifying this apparently more acidic type with the gabbros are based on the signs of secondary processes (notably that of the paramorphism of some pyroxene into hornblende) and the close association in the field with the normal members of the gabbro group.

The rock closely resembles that obtained from the Whyte River Mine, where, too, it is associated with a member of the basic series—serpentine.

The relation of this rock to the other members of the group is discussed below.

(*b*) *The Pyroxenites and Peridotites.*—With the progressive decrease of the felspathic constituent the gabbros become rocks consisting only of ferro-magnesian minerals. Those in which only pyroxenes are present are termed pyroxenites, and where olivine occurs they are called peridotites.

A notable development of the pyroxenite facies is present near the south end of the Argent Tunnel, on Serpentine Hill.

In some specimens a few sporadic patches of an opaque mineral, resulting from the alteration of the felspathic constituent, remain, and mark the passage between these rocks and the norites. The rocks possess the characteristic bronze-like lustre which results from the high proportion of the orthorhombic pyroxene present.

Microscopically the types represented are seen to be either websterites or bronzitites, according as they consist of both bronzite and diallage or bronzite alone.

The websterite varieties show the usual phenomena regarding the relative rate of weathering of the two pyroxenes; the diallage remaining almost entirely fresh, while the bronzite is converted into bastite and serpentine. This latter change may have been the cause which led to the distortion of some of the crystals of diallage, and the fracture and dislocation of the crystals of chromite; for the passage into the hydrous condition would be accompanied by an increase of bulk. Numerous cracks filled with serpentine occur, and there is often relative displacement of the walls of the cracks.

The pyroxenes are often intergrown with one another, but diallage is frequently wholly enclosed in the bronzite. This order of crystallization, therefore, differs from that observed in the gabbros described above.

There are numerous granules of chromite scattered through these pyroxenites. Most of them are wholly enclosed in the bronzite, but a few crystals of chromite have a serpentinous core. This would appear to be due to the alteration of enclosed crystals of olivine or pyroxenes within the chromite.

Intermediate between these pyroxenite rocks and the serpentines, which show no trace of the original constituent minerals, there are varieties which exhibit a markedly banded structure.

There are few signs of the banding on freshly broken surfaces, but the weathered faces of the rock show bands in which large crystals of altered pyroxene (from one quarter up to three-quarters of an inch in diameter) are studded in a homogenous mass of serpentine, alternating with bands quite devoid of these larger crystals. In other varieties the banding is shown by differences in the number and size of the pyroxene crystals or the proportion of these crystals present in the successive zones.

These phenomena are exhibited by a portion of the basic mass outcropping at the southern end of the Argent Tunnel. The best development of the banding, however, occurs at the northern extremity of the mass extending from Dundas towards the Melba Flat.

With microscopic assistance little more information can be gathered. The nature of the serpentine, which forms, as it were, a groundmass with respect to the defined crystals of pyroxene, is not to be definitely determined.

The original mineral, which is now converted to serpentine, may have been olivine, in which case the rock would be a serpentinized hartzburgite; or it may have been pyroxene. The bastite-serpentine which replaces the large crystals of orthorhombic pyroxenes has retained its characteristic structure, and the crystal outlines are fairly well defined. Hence it would appear that the other serpentine results from the hydration of some different mineral. Chromite crystals are abundant, and much fine-grained magnetite of secondary origin is present in the serpentine.

The banding of these rocks seems to the writer to be due, in all probability, to fractional crystallization. It was not possible to gather any data which might serve to support this hypothesis. Yet the variations appear to be due, not so much to variations in the composition of the magma, as to variations in the physical conditions under which solidification has proceeded.

The rocks, which certainly appear to have been peridotites before their conversion into serpentine, are closely associated in the field with those just described. In colour they are usually dark green on freshly broken surfaces, like the varieties carrying the bastite crystals. They differ in being homogenous and massive, or in appearing schistose. This latter phenomenon is due apparently to the expansion of the rock as hydration has proceeded. Wavy parting planes with smoothly polished surfaces of serpentine are frequent. The only mineral other than serpentine to be detected with the unaided eye is chromite.

This type is visible in the railway-cutting at the south end of the Argent Tunnel, on the Confidence Track, to the south-east of Pine Hill, and at Dundas.

Microscopically the rock is seen to be constituted of serpentine for the most part. A little pale chlorite is present in tufted aggregates. Crystals of chromite are prominent, and much magnetite dust, resulting from the process of serpentinization, is present.

In many cases there are a number of small grey specks in the serpentine, which are seen in thin section to be small aggregates of calcite and dolomite.

The serpentine is usually dark in colour, but at one point on the North Dundas-road, close to the Melba Flat, the yellow translucent variety occurs.

It is reported that the peach-blossom-coloured chlorite mineral kämmererite is present in the serpentine near the Argent Tunnel. I did not observe any at this place, but found it abundant near the Adelaide Mine in Dundas, a little to the southward of the area mapped, but within the boundaries of the same mass of serpentine as that shown on the geological map.

The kämmererite occurs irregularly distributed through the serpentine, and is built up of a number of scales with a pearly lustre.

In thin section it is seen to form tufted aggregates, and in many cases the tufts are disposed radially about nuclei of chromite.

Reviewing the basic group as a whole the characteristic features are the variability of the different types and the close interassociation of different types in the field. Variations are most commonly caused by differences in mineral composition, but are also marked by changes of texture, while the mineral components remain the same.

The intrusion was in almost all instances unaccompanied by any great shattering of the surrounding rock. Only one well-marked dyke was detected.

The contact metamorphic effects produced were very slight, being restricted to a slight silicification of the slate. This can be seen at the southern entrance of the Argent Tunnel.

One noticeable point about the intrusion is the variable height above present sea-level at which the exposures of portions of the basic mass are to be found. For instance, there is gabbro at the top of the Commonwealth Hill, and a similar type exists near the junction of the Ring River and Dalcoath Creek. In the latter case the surface of the igneous rock is barely exposed. In the former case there has already been some loss of material through denudation, so that the present height may be considerably lower than at an earlier stage in the erosion cycle.

Between the two outcrops there is a difference in altitude of 1300 feet. The difference may be due in part to subsequent warping of the crust, but when other outcrops are taken into account beside the two cited, it becomes apparent that the upper surface of the original intrusion must have been an extremely irregular one; and the irregularities have been reduced rather than accentuated by the progress of denudation. The several exposures of the basic rocks must necessarily be regarded as possessing continuity in depth; and the slate of the greater portion of the field is therefore resting upon an igneous foundation, the upper portions of which are exposed at the surface here and there.

There are considerable developments here and there of iron ores in connection with the serpentines. These are due to the progress of weathering, and are mentioned again below.*

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* *Vide infra*, p. cxvi.

(3)—*The Acidic Group.*

The acidic igneous rocks which are represented at North Dundas are hardly so varied as the basic; yet if a wide view be taken of the limits which may be allowed for the definition of an "igneous rock" there is a considerable variety of types represented. It would thus be found that, not only are there the types of rocks which are usually found as dykes, but there are, in addition, mineral aggregates which are usually regarded as vein-stuff rather than as the typical products of consolidation of an igneous magma. The difficulty arises from the absolute impossibility of distinguishing between a *vein* and a *dyke* in such cases as those under discussion.

Here, however, only the types which are more usually regarded as dyke-rocks are considered, and the varieties which have not hitherto become quite familiar as dyke-rocks are left over for discussion in the chapter on the economic geology of the district.

The typical dyke-rock, which is derived from a granitic magma, is termed a "granite-porphyry," and it is this rock which is the principal representative of the acidic group in the tinfield of North Dundas. The most typical development of the rock, and that which is most free from subsequent alteration, is to be found on the northern slopes of the high saddle between Commonwealth Hill and Pine Hill.

It is essentially a porphyritic rock, in which the phenocrysts consist of quartz, felspar, muscovite, and biotite, while the groundmass is a crystalline mixture of quartz and felspar. The mica crystals are less prominent than those of quartz or felspar. The idiomorphism of the quartz can easily be detected in weathered specimens without microscopic aid.

In thin sections it became apparent that the groundmass varies considerably in grain. In a few cases it is microgranitic, but more usually it is cryptocrystalline, and the rock assumes the habit of a quartz porphyry.

The long dykes which have been charted on the geological map herewith are almost wholly constituted of this quartz porphyry facies of the granite porphyry. It is only near the larger exposures of the acidic mass that the typical granite porphyry habit predominates.

The felspars are in all cases altered to some degree. Orthoclase, in the form of carlsbad twins, can still be recognized, and in addition to it there are crystals with the outlines of felspars, but completely converted into pinite.

The difference between these and the orthoclase suggests that they were originally plagioclase.

The biotite crystals are chloritized; muscovite is not abundant.

Besides these constituents there is often a certain amount of tourmaline present, as well as fluorite, sericite, cassiterite, and pyrite, in various portions of the dykes. These minerals, however, must be regarded as of secondary rather than primary origin, and the changes effected in the rock by the lode-forming processes are dealt with below.*

The granite porphyry (and the quartz porphyry facies thereof) must be very closely connected with some narrow dykes of pegmatite on Pine Hill. These were not observed *in sitû* on account of the cover of the talus of quartz porphyry which conceals the bedrock in that area.

There are a fair number of fragments among the talus of these narrow dykes, the constituents of which are quartz and felspar in crystalline intergrowth. The longer axes of the crystals stretch transversely across these dykes from wall to wall (the dykes or veins are up to 4 inches in width).

The other closely connected dykes of quartz-tourmaline rock are treated of in connection with the economic geology.

The distribution of these rocks through the tinfield is not very regular.

The central area from which the main dykes radiate is situated a little to the north of the apex of Pine Hill.

The longest dyke crosses over the Renison Bell Hill almost at its highest point, and can be traced to a point in the creek near the north-eastern corner of Section 2765-M. Here it becomes lost to sight, but an entirely similar dyke-rock is visible in the creek bed near the northern boundary of Section 3240-M. This outcrop may be connected with the other, or again it may be a faulted portion of the other large dyke.

There is a shorter dyke crossing the southern boundary of the Montana Company's Section No. 1342-M, near the south-eastern corner. It can be traced from the creek through the stripped ground in 1963-M, but not beyond that point. However, the similar rock found alongside the pyritic cassiterite lode in Dead Man's Creek is very probably a continuation of the same dyke, or at least connected with it.

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* *Vide infra*, p. xcviii.

The third main dyke runs in a direction about S. 35° E. from Pine Hill, and can be seen at a number of points along the track which lies immediately below the North-East Dundas Tramway, but appears to die out before Great Northern Creek is reached.

The dip of all of these dykes cannot be ascertained for want of the necessary sections. The longest one would not, however, appear to depart widely from the vertical position, since there are no notable deflections introduced by variations in the topography.

The direction of these dykes varies between 28° and 45° west of north.

On the northern slopes of Pine Hill—the locality whence these dykes radiate—there is a more complicated system of intrusions. Here the talus formed by the disintegration of the rock conceals the dip. But the workings, especially those on the eastern bank of Penzance Creek, prove that there is a dip in a south-easterly direction. The strike is variable and hard to determine, as there appears to be several intrusions connected with each other. One main dyke which runs down the spur strikes in a N.E.-S.W. direction.

This structural feature is the more noticeable on account of the resemblance offered to the structure of some of the lodes themselves in the district. The lode system on the boundary between Sections 271-M and 5101-93M exhibits entirely similar structural characters to the system of dykes in the vicinity of Penzance Creek. The longest dykes runs north-west, and is more or less vertical, and joins almost at right angles with a stouter dyke dipping to the south-east. If we compare with this the structure of the lode system described below* the resemblance is extraordinarily marked.

(4)—*The Diabase Dyke.*

The remaining igneous rock-type present in the field is quite distinct from any of those mentioned above, and also younger than any of the other igneous rocks.

Three main outcrops are shown on the geological map, and it is more than probable that all three are one and the same dyke. In the centre of the field the main outcrop can be traced almost without a break from the hill slope to the east of Dalcoath Creek to the junction of the

* *Vide infra*, p. cli.

Dalcoath and Gormanston Creeks. Thence it can be traced without serious gaps through the battery site of the Boulder Mine to a point near the centre of the Montana Company's section. Here it disappears, to be seen again on the western slope of the Dreadnought Hill. Although it apparently died out at this spot, it reappears on the northern side of the button-grass plain, not far from the north-western corner of Section 3621-M.

The typical specimens from this dyke have a greenish-grey colour, and the cryptocrystalline groundmass carries soft black phenocrysts of biotite.

The rock is fairly fresh in most places, but near the Boulder Company's battery it has weathered into a soft condition, and exhibits spheroidal structure.

At the point where the dyke is crossed by the Government track in the Montana section, the texture is much finer, and the dark phenocrysts of biotite are not visible.

The normal type when microscopically examined exhibits a texture resembling that of other Tasmanian diabases, which are found in dyke form. The main portion of the rock is constituted of a felted aggregate of plagioclase and augite. There is a fair proportion of residual glass. The augite crystals in some cases partly enclose the felspars, but the typical ophitic structure of our diabases is absent.

The phenocrysts are a strongly pleochroic biotite (green to yellow), and a mineral which was probably felspar, but now is replaced by the secondary aggregate known as pinite.

The finer-grained variety also contains residual glass, and a felted aggregate of augite and plagioclase in the base. But the felspars are in an embryonic stage of development in the groundmass.

The phenocrysts in this variety are felspars, converted into pinite as in the coarser rock, and olivine. A little pyrite is present here and there.

The rock, as a whole, presents characters most closely resembling those of the dykes of diabase found in various parts of the island.

It is, therefore, presumably of Upper Mesozoic age, if we may regard it as a portion of the diabase, which covers a large area in Tasmania. The nearest outcrops of the massive form of the diabase are at Mt. Dundas, where it forms the capping of the mount; and in the area lying to the north-east of Mt. Heemskirk.

(5)—*The Sequence and Relationships of the Igneous Rocks.*

The four main groups of igneous rocks thus described as occurring in this one field attained their respective positions in the order in which they have been described, but the intervals between the periods of invasion were very unequal.

After the Cambro-Ordovician eruption of the porphyroid, with both intrusive and effusive phases, there was an absence of igneous activity until the close of the Silurian period, or perhaps even some portions of the Devonian.

At this period the basic rocks were erupted, and the acidic ones followed closely upon them. The relation between these two groups requires special investigation, on account of the great importance of both when considered from the economic aspect.

It is now known that in several different localities in Tasmania the outcrops of granite, granite porphyry, quartz porphyry, or aplite, are accompanied by a fringe of basic or ultra-basic types—gabbro, pyroxenite, norite, peridotite, or derivative serpentines.

The granite *massif* of Mt. Heemskirk has two such marginal developments of basic material—one at Trial Harbour, and the other a little further to the north-east, in the Comstock district.

The granitic area of the Meredith Range shows a development of serpentine at its south-eastern extremity. To the northward, at the Magnet Range, and in the Heazlewood district, the basic types are well developed.

In the North Dundas tinfield the geological map herewith shows that the same two rock groups are present; but here the basic types cover a much larger area than the acidic ones which penetrate them.

Elsewhere in the island, also, the same association has been observed. At Anderson's Creek, near Beaconsfield, rocks wth granitic affinities have been observed to be intrusive into the serpentine.* Mr. Twelvetrees draws attention to the fact, and suggests magmatic differentiation as the cause of the juxtaposition of acid and basic types.†

Where any differences in age between the members of the acidic and basic groups have been definitely deter-

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* W. H. Twelvetrees, "Report on the Mineral Resources of the Districts of Beaconsfield and Salisbury," 1903, pp. 7-9.

† *Ibidem*, p. 54.

mined the acidic rocks are the younger. The localities (in addition to that of Pine Hill, North Dundas) in which the rocks derived from a granite magma have been observed to penetrate the serpentines and gabbros are Trial Harbour and Anderson's Creek.

Yet no case has yet been recorded in which the acidic rock that penetrates the basic types is itself a typical plutonic type. On the other hand the dyke-rocks of granitic origin have been observed cutting through the serpentine.

Now, it is known that a granitic mass is itself often traversed by dykes of acidic composition, viz., by granite porphyries and aplites.

The intersection, therefore, of the serpentine or other basic rock by an acidic dyke-rock does not prove that the basic rock is older than the accompanying granite.

It remains to be stated that both acidic and basic groups exhibit within their own borders characters which, in the case of groups so closely associated in the field, cannot but suggest a common origin, through the operation of the processes of differentiation.

For, to take the acidic group first, it is recorded that the granite masses of Mt. Heemskirk and of the Heazlewood district are characterised by a more basic aureole. It is, of course, possible that the granite is younger, and that during its intrusion a certain proportion of the basic rocks now occurring at the margin of the granite has been assimilated, with the production of a rock of intermediate character. But no evidence of this granitic intrusion has yet been adduced.

The characters of the several rock-masses which occur at Anderson's Creek, and which are thought to have been derived from a granitic magma, are strikingly peculiar. These rocks seem to be products of the crystallization of several sub-magmas rather than the consolidation products of a single undifferentiated magma.

Further, the process of differentiation in the case of the acidic rocks has not ceased with the extrusion of the normal dyke-rocks, but has continued until a quartz-tourmaline rock has been produced. These phenomena are presented by the acidic rocks which occur both at Heemskirk* and at Pine Hill†, North Dundas.

* G. A. Waller, "Report on the Tin-ore Deposits of Mount Heemskirk," 1902, pp. 5-8.

† *Vide infra*, p. xci.

The complex character of the group of basic rocks is well marked at each locality, where large exposures are to be found. The group invariably includes several types which are distinct from each other. Yet types of intermediate character exist to mark the inter-relationship.

Microscopic examination affords more satisfactory evidence than does macroscopic. Yet even in the field the absence of defined boundaries between dissimilar rock types is noticeable, though the progress of serpentinization has in some cases masked the original character of the rocks.

This differentiation is always visible over and above the minor variations of mineral character, which would seem to be due to fractional crystallization under varying physical conditions.

Certain modifications of the gabbroid varieties have been effected by the conversion of the pyroxene into amphibole, but this alteration has nothing to do with the processes of differentiation. It is commonly effected by dynamic metamorphism, but in the present case there has been very little, if any, actual crustal deformation. In seeking for the cause of the transformation of the pyroxene to hornblende, the writer has come to the conclusion that the stresses have their origin within the rock-mass itself. It seems, therefore, that the explanation may possibly be found in the processes of alteration which have gradually converted considerable masses of basic igneous rocks into serpentine. This serpentinization would be attended with a considerable increase in bulk, and the rocks associated with the serpentine would share in the small differential movements which occur within the basic mass.

This explanation would account for the presence of the gabbro-amphibolite with the serpentine on the borders of the granite areas, whatever be the relation of the granite to the basic types.

The exposures on the Trial Harbour-road and at Dead Man's Creek, North Dundas, appear to the writer to prove conclusively that the gabbro-amphibolite belongs in origin to the basic group, and is only a secondary modification of the gabbro proper.

In attributing, therefore, these phenomena to the operation of the process known as magmatic differentiation, the writer is influenced by the following considerations:—

(1) The constant recurrence of the association of acidic and basic types.

(2) The small difference in age between the two types.

(3) The fact that, where one type intersects the other, the acidic is of later date.

(4) The areas in which the rocks are found together contain undoubted evidence of some change in the composition of the magma at different stages during the process of solidification.

All these signs point to the operation of some definite and regular process or processes along similar lines. Accidental groupings could not be expected to produce such uniformity of character in widely separated localities.

The diabase which occurs in the dyke crossing the centre of the field is not related to any of the other igneous rocks of the district.

B.—THE SEDIMENTARY ROCKS.

There are several groups of sedimentary rocks present in the North Dundas field, but only one of these forms a consolidated rock-mass.

(1)—*The Dundas Slates.*

The greater part of the North Dundas tinfield consists of slate, together with the coarser-grained sediments—sandstone, grit, and conglomerate. The whole are to be considered as one series, and to them the term "Dundas slates" has been applied, since the typical rock-type is a slate.

Lithologically there is a considerable variation in the series from point to point, but the slaty cleavage is prominent in all varieties.

The slates themselves are green or purple where fresh surfaces can be examined, and all varieties weather to a brownish clay.

The coarser and more siliceous varieties are various tints of brown, and weather white.

The original bedding-planes can very often be seen, and the evidence, when collected together, is very conflicting. No regular angle of dip or direction of strike can be assigned to the formation as a whole.

It appears rather that the original bedding-planes have been disturbed by the operation of external forces irregularly applied. Doubtless the great invasion of the igneous material has had much to do with the crumpling of the slates. But a still greater effect was produced at an earlier date by the crustal movements which must have preceded the main igneous invasion of basic and acidic material, since these are free from all signs of dynamic metamorphism.

The age of the slate series cannot be determined from the stratigraphical evidence of the Dundas field alone. There it can be shown that the slate is partly intruded by the porphyroid, partly imbedded with the clastoporphyroid; so that the time of the invasion of the porphyroid group coincided with part of the period of sedimentation. Beyond this nothing definite can be adduced to show either the lower or the upper limits of age.

The floor upon which the slates were laid down is not visible in any part of the field.

The next succeeding sediments above the slate series are those of the old Pieman terraces, which are post-Mesozoic, since they cover the diabase dyke.

Palæontological evidence concerning the age of the series has been obtained and recorded in the proceedings of the Royal Society of Tasmania.*

One of the localities whence the graptolites were obtained was examined, but no trace of the fossils was found on this occasion.

The age of the formation, on the graptolite evidence, must be regarded as Early Palæozoic, but no more can be deduced than this.

However, if it be granted that the Dundas slates are part and parcel of the slates which are found in the gorge of the Leven River on the North Coast of Tasmania, we can arrive at a much closer approximation to the age of the series. The slates in the Leven Gorge are lithologically similar to those of Dundas, and are associated in the field with the intrusive and effusive members of the porphyroid family. Hence we may, in my opinion, with safety regard them as formed during the same period of sedimentation as those round Dundas. Mr. Twelvetrees has recently obtained proofs of the age of the slates in the Leven Gorge, having found that they underlie the Ordovician limestone of that district.†

The Dundas slates may therefore be of Upper Cambrian or Lower Ordovician age, and until further evidence is available may be referred to as Cambro-Ordovician.

Their exact relationship to the West Coast conglomerate still remains to be determined.

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* T. S. Hall, "Evidence of Graptolites in Tasmania," 1902.

† Geol. Surv. Bulletin, No. 5, "Gunn's Plains, Alma, and other Mining Fields, North-West Coast," 1909.

There are certain peculiarities which are noticeable in certain portions of the formation, and which are not characteristic of the series as a whole.

The effect of the intrusion of the igneous rocks has been very slight. There has been, of course, a shattering of the rock-mass, and in some places new minerals have been developed. But no sign of appreciable metamorphism of the slate by contact with the heated rocks was detected. The development of new minerals in the contact zone took place only along certain directions, which were probably determined by physical conditions. The rock, as a whole, is not metamorphosed.

Towards the southern limits of the area examined, and represented on the map herewith, a fresh feature is very noticeable. It is the development of very hard siliceous bars or zones in the slate.

No expression of opinion can be given as to the mode of formation of these dense cherty zones, which extend southwards beyond the township of Dundas. Detailed investigation is necessary in that area before their significance and origin can be determined. The only place where the cherty variety of slate occurs *in sitû* in the area here dealt with is in the Section 1897-M.

Some of the more siliceous bands in the slates exposed in the Emu Bay Railway cuttings near the Renison Bell Mine show an impregnation by silica; but the quartzitic bands do not form any considerable proportion of the slate formation at this place.

The coarse-grained sediments of the series are rather varied, and the origin of the several varieties is probably somewhat different.

The grit and conglomerate in the Renison Bell lease and its neighbourhood are typical aqueous sediments, and so too is that conglomerate near the Confidence Saddle.

But the other occurrences, at Ringville and on the high ground between the Melba Flat and Dundas, are, at least in part, distinct. These are especially characterised by the angular shape of the larger fragments; that is, the rock partakes of the character of a breccia.

There are always present some rounded or subangular fragments, so that this rock-type may be termed a brecciated conglomerate. Two main varieties occur. In one the fragments are for the most part white, and the cementing material black or dark grey. This is not so common as the variety which has a prevalent greenish tint.

In all cases the fragments are very largely composed of silica; and in the green rock the silica is nearly always tinted green or red. These fragments are sometimes of jasper or chalcedony, but more often are of a cherty nature. Calcite is also present.

Microscopically the rock proves to be an aggregate of fragments of chert, chalcedony, and an igneous rock, which seems to belong to the porphyroid group. The interstitial cement is also of complex composition, and contains fragments of quartz, felspar, and muscovite, together with calcite, chlorite, and kaolin.

The presence of the fragments of porphyroid and of felspar seems to suggest that there has been some contribution to the rock-mass by volcanic action.

The chert may have been derived largely from the hard bands in the slate referred to above.

This green brecciated conglomerate forms all the high-level country examined between Dundas and the Melba Flat, save where denudation has laid bare the igneous intrusion of serpentine.

The conglomerate is covered by no other formation, and its formation may have marked the close of the Cambro-Ordovician period of sedimentation.

Lithologically the rock is very similar to a conglomerate from the Dial Range.

(2)—*The Older River Terraces.*

The unconsolidated river gravels forming the dissected high-level terrace of the Pieman River have been partly dealt with above in the chapter on the physiography of the region.*

The total depth attained by this extremely broad deposit of gravel is not known with certainty, but does not appear likely to prove considerable. Practically no work has been done to prove its thickness, and an estimate can only be formed where a creek has cut its way through on to the slate bottom. Moreover, the bottom over so broad an expanse cannot be expected to be regular. At no point in the area examined does it seem probable that a thickness of 20 feet would be obtained, and in the great majority of cases the slate bottom is less than 6 feet from the surface.

The constituents of the gravel are mainly well-rounded pebbles of quartz, quartzite, quartzitic schist, and porhy-

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* *Vide supra*, p. xliv.

roid. These have evidently been derived mainly from the country lying to the eastward of that represented on the maps herewith. The many varieties of quartzose pebbles are derived from the West Coast conglomerate, which is well developed in that region.

In addition to these constituents a few pebbles of the tourmalinized quartz porphyry were recognized.

In the lower portions of the gravel bed there is always a certain proportion of chromite present, and with it fine flaky colours of gold, and in some places sporadic colours of iridosmine.

Tin ore is present in small amount in every portion of this gravel formation which was examined.

The huge erratics on the northern side of the Huskisson River, formed of massive blocks of the West Coast conglomerate and porphyroid lie embedded in these gravels, and their presence has led the writer to regard the age of the formation of the gravels as, approximately, Pleistocene.

(3)—*The Recent Alluvial Deposits.*

The more recent deposits of alluvial material are very variable in composition, their constituents being usually of local derivation.

However, at the confluence of the Ring River with Dalcoath Creek there is a recent gravel, which very closely resembles that of the higher terraces. It has no doubt gathered the greater portion of its material from the dissected terraces.

There are a number of pebbles in this gravel which seem peculiar to the Ring River. They are of a much altered lava of basic composition, but the exact character of the rock cannot now be determined. It may be termed an amygdaloidal melaphyre.

On the westward border of the strip of alluvial ground at the junction of the Ring River and Dalcoath Creek the constituent pebbles consist mainly of the characteristic rocks of the Pine Hill area; chiefly acidic igneous rocks carried down by the Gormanston and Penzance Creeks.

The recent gravel benches on the banks of the Pieman River are of similar composition to the older high level gravels.

The alluvial deposit of the Melba Flat carries an entirely different kind of material. The coarser fragments are not so completely rounded, and are mainly formed of the brecciated conglomerate mentioned above.

With them are some rounded boulders of serpentine, but these are not numerous, as the basic rocks seem to have disintegrated completely in almost all cases.

There are many semi-rounded boulders of a quartz-epidote lode-stuff.

The bottom of the alluvial deposit, where visible through sluicing operations, is serpentine.

Much of this alluvial material has been worked for gold and tin, but little now remains untouched in the upper portion of the Melba Creek basin.

(4)—*The Quartz Porphyry Talus.*

On all the slopes of Pine Hill there is a dense cover of angular or subangular blocks of the acidic rock-mass. The blocks and smaller fragments have not moved far from their places of origin, and lie accumulated about the outcrops of massive quartz porphyry.

The depth of this formation is extremely variable, being as much as 20 feet in places. The irregularities in depth are to be explained by the variation in the depths of the gullies carved in the steep slopes of the hill.

The various gullies on the northern slopes have been all filled, and even obliterated, by the gradual downhill creep of the talus, with the exception of Gormanston Creek and Penzance Creek, which have survived.

The spur between these creeks is for the most part covered by the talus, save in places which have been stripped by mining operations.

On the southern slopes of Pine Hill the talus has spread for some distance south of the Penzance boundary.

The variations in the grain and the lack of sorting are characteristic of a talus deposit traversed by minor streams.

Some portions of this talus have been worked for tin ore.

(2)—The General Sequence of Events Leading to the Present Geological Structure.

1. *The First Period of Sedimentation.*—The geological history of the field begins with the period of sedimentation which produced the members of the slate series. This period must needs have been that between Cambrian and the limestone epoch of Ordovician time.

From observations made in other parts of the West Coast region of Tasmania, it may be inferred that these Cambro-

Ordovician sediments were laid down upon a floor of quartzite and quartz-mica schists of Pre-Cambrian age. The bedrock below the slate series is, however, not here visible.

The upper members of the slate series seem to show a tendency to become coarser in grain, so that we may infer that during sedimentation the area was undergoing an uplift. The effect of this has been the covering of the infra-littoral by the littoral deposits.

2. *The First Period of Igneous Invasion.*—During the later stages of this sedimentation igneous activity became very pronounced. The intrusive types were forced between the beds already formed, and the fragmental types became interbedded with the sediments. From the succession of the slates above the horizon of the fragmental igneous rocks we may infer that the clastoporphyroids represent, in part at least, submarine tuffs consolidated by subsequent pressure, and that the conditions of sedimentation were similar both before and after the porphyroid eruption.

The central area of the tinfield appears to have been situated near the western limits of the district invaded by the porphyroid. The central line of this great igneous invasion lies a short distance to the eastward of the area mapped, and the members of the porphyroid group extend for many miles northwards and southwards.

In the neighbourhood of Dundas the slates are capped with a brecciated conglomerate, which seems to have been formed partly by igneous, partly by aqueous, agency. Whether this brecciated conglomerate extended over the district which lies to the north of the Melba Creek cannot now be determined.

3. *The Folding of the Region in Ordovician Time.*—The evidence gathered from several points on the West Coast indicates that the Cambro-Ordovician sediments were seriously affected by dynamic stresses between the time of their formation and that of the deposition of the Silurian sediments.

It is probably at this time that the slaty cleavage was developed in the Dundas slates; and possibly also the folds and fractures in the formation date from this period. Nevertheless, there has been far less deformation of the slates in the area here considered than in other neighbouring districts.

The period of crustal movement appears to have followed closely upon that of the porphyroid eruption; and the district lying to the eastward of that under consideration is apparently more seriously affected by the dynamic stresses.

4. *The Second Period of Igneous Activity.*—There are no rocks representative of the succeeding periods in the tinfield until, ascending the geological column, we come to the Devonian.

The great igneous complex of basic and acidic rocks is assigned to this period on evidence which has been fully stated by the writer elsewhere.*

The texture and structure of these igneous rocks suggest the former presence of some considerable thickness of superincumbent sediments, since removed by weathering agencies.

The igneous material penetrated upwards into these sediments, attaining a varying height in different localities.

This was the period during which the tin ore was introduced into its present position throughout the whole field. The fissures serving as loci for ore-deposition may possibly have been created by the mechanical stresses accompanying the igneous invasion.

The filling of the fissures with vein-matter has taken place during the latter stages of the period, since the igneous rocks themselves form the country enclosing some of the lodes. Whether all the lode-filling was introduced at a later date than that of the consolidation of the youngest member of this igneous group cannot yet be stated.

5. *The Invasion of the Diabase.*—The single dyke of diabase made its appearance during the upper portion of the Mesozoic era. It can be seen to cut through the ore-deposit at one place on the Boulder Company's northern section, and it is covered by the older alluvial terrace gravels.

Little, if any, effect upon the geology of the district has been caused by this rock, which is now of small importance in the field. The upper portions have been completely removed by denudation, and there is nothing left to indicate whether the vertical dyke was connected with any sills such as occur in other portions of the island.

6. *The Development of the old Pieman River Plain.*—A long cycle of erosion must have followed the events chronicled above. This cycle culminated in the development of a broad plain of erosion at the northern end of the field. The southern portion was suffering a continuous

* Geol. Surv. Bulletin, No. 3, "The Mount Farrell Mining Field," 1908, pp. 37 and 38.

dissection and degradation. Ultimately the grade of the older Pieman River became so flat that the material brought into it by the tributary streams could not be carried downwards to the sea. Then the alluvial gravels were formed.

Towards the close of this period there was a contribution of very large boulders to the alluvial deposit by glacial agency.

During the building up of the alluvial gravels the streams entering the Pieman from the tinfield carried in stanniferous material, and distributed it far and wide through the gravels.

Chromite and iridosmine were simultaneously brought in by the streams which traversed the basic igneous rocks. Gold is also present, but its origin was not determined during the present visit to the district.

7. *The Uplift of the Region.*—The district, as a whole, has experienced an uplift after the formation of the alluvial deposit above mentioned. The rejuvenated rivers and streams have cut their way down once more, and a large portion of the alluvial gravels have been removed by the newly formed tributaries and by the River Pieman itself.

The uplift has not been one which consisted of one simple movement, for there are evidences of terraces along the banks of the Pieman River, which mark periods at which the base level of corrosion was attained by the river system.

The principal river systems have, as a rule, cut down their channels deeply into the surface, and the grade of these channels has for the most part prevented the accumulation of recent rock-waste.

V.—ECONOMIC GEOLOGY.

(1)—The General Relationships of the Ore-deposits of North Dundas.

Mention has been made on a previous page* of the geographical relationship of the tinfield of North Dundas to the surrounding mining fields. The explanation of this relationship is given by the geology of these districts.

With regard to the comparison between this field and the other *tinfields* whch are nearest to it in position, the one feature common to all is the presence of the acidic igneous rocks in the immediate neighbourhood of the ores.

* *Vide supra*, p. xlii.

The country-rocks which form the walls of the lodes may be sedimentary rocks of Silurian or of Pre-Silurian age, or they may be themselves of igneous origin. Still, in all cases there will be found the common feature—the presence of acidic intrusions.

The exact acidic type represented is not always the same. The following examples show this variability of type:—

At Granite Tor the tin ore is found in a mass of coarse-grained granite.

The lodes of Mt. Bischoff are associated with dykes of granite porphyry, and within a radius of 5 miles the plutonic type—granite—is to be found.

In the Stanley River field* and at Mt. Heemskirk† both plutonic and dyke-rocks occur together, and their relation to the ores has been described by Mr. G. A. Waller.

The occurrence of tin ore at Zeehan differs in some respects from those in the other fields mentioned. The tin ore is stannite, and is found with sulphides of copper, iron, and bismuth, and sometimes with wolframite in close association with lead ores.‡ Yet there are in the neighbourhood dykes of quartz porphyry§ which are undoubtedly apophyses from a granitic magma.

The granite porphyry and quartz porphyry of the North Dundas tinfield are the local representatives of this group of rocks; and there is a close resemblance between these rocks and the corresponding types from the other localities cited.

There are signs also of a genetic relationship between the tin-ore deposits of North Dundas and the occurrences of *other ores* in the neighbouring mining fields.

The relationship is expressed in several ways:—

(1) There are vein-types common to North Dundas and the outlying districts. As examples, brief mention may be made of—

(*a*) The limuritic vein-type which occurs at the Colebrook Mine and in the Boulder Company's lease at North Dundas.||

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* Report on the Prospects of the Stanley River Tinfield, 1904, pp. 1-2.

† Report on the Tin-ore Deposits of Mt. Heemskirk, 1902, pp. 2-8.

‡ G. A. Waller, "Report on the Zeehan Silver-Lead Mining Field," 1904, p. 55. H. Conder, "The Occurrence of Stannite in Australia," Aust. Min. Stand., Nov. 18, 1908.

§ G. A. Waller, *loc. cit.*, p. 21.

|| *Vide infra*, p. xcv.

(*b*) The pyritic lead-veins which exist at Zeehan* and Mt. Farrell† and at many different points throughout the North Dundas tinfield.

(2) There are occurrences of mineral groupings which exhibit a character intermediate between well-defined vein-types, and which thus connect the tin ore with ores of other metals, as regards origin.

The occurrence of lode-matter, which appears to be a transitional stage between the pyritic lead veins and the pyritic tin veins is described below.‡

(3) There are gangue minerals in the outlying districts which have certain definite affinities with a granitic magma. The examples which may be cited are:—

(*a*) The axinite, datolite, and danburite, occurring in the limuritic vein-type of the Colebrook Mine.

(*b*) The tourmaline and fluorite in the tourmaline-gold-copper vein-type of the Mt. Black Mine.§

(*c*) The fluorite associated with the lead ore of the Thomas' Blocks Mine at Mt. Farrell.||

Therefore we cannot but regard both the tin ores and the other ore-deposits of which mention has been made as being in intimate genetic relationship with the acidic igneous rocks.

Neither can we regard these acidic igneous rocks as a separate unit; for, as has been fully discussed above, the acidic rocks are so constantly associated with basic types that a common origin has here been assigned to both groups.

We are compelled, therefore, to refer the ores of tin and the other metals above mentioned to an igneous magma from which both acidic and basic types have resulted by the process of differentiation.

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* G. A. Waller, *loc. cit.*, p. 13.

† Geol. Surv. Bulletin No. 3, "The Mount Farrell Mining Field," 1908, p. 48.

‡ *Vide infra*, p. xciii.

§ G. A. Waller, "Report on the Ore-deposits (other than those of Tin) of North Dundas," 1902, pp. 11-15.

|| Geol. Surv. Bulletin No. 3, "The Mount Farrell Mining Field," 1908, pp. 48 and 101.

The question which naturally presents itself is this: "Are the tin ores and the other genetically-related ores derived from the parent magma by the same processes which have produced the various igneous rock-types?" That is to say, are the ores themselves to be regarded as extreme products of the processes of magmatic differentiation? Much, of course, depends upon the conception which is taken of the legitimate limits of this term "differentiation." Nevertheless, it cannot, in my opinion, be denied but that some of the tin-ore deposits of North Dundas are definite differentiation products. Reference is made to this matter in a later portion of this report.* But the relation of these latter differentiation-ores to the other ore-deposits of the field cannot yet be regarded as fully defined.

However plain may be the fact that the several ores have, speaking generally, a common origin, there yet remain a number of important questions to be solved by later investigations. Some of these problems are:—

- The sequence of the several ores.
- The relation between the vein-type and the proximity to the igneous source, especially with regard to the different types of tin ores.
- The explanation of the distribution of the different ores which may be genetically referred to the same igneous source.

It is as yet too early to formulate any such complete theory regarding the genesis of these ore-deposits of the West Coast of Tasmania as could explain all the problems here indicated.

(2)—The Relationship of the Ore-bodies of North Dundas to the Several Lithological Groups.

The investigation of the geological map of this field will indicate the fact that the primary ore-bodies are distributed through the several rock-groups which are prior in date to the dyke of diabase which crosses the centre of the field.

The members of the Dundas slate series constitute the greater part of the field, and the majority of the ores are to be found enclosed within these slates.

Moreover, it is natural that these ores should be usually found in this slate series rather than in the igneous rocks. For, as has been already indicated, the ores owe their posi-

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* *Vide infra*, p. xci.

tion to the action of uprising vapours and solutions which have transferred the mineral content from the igneous magma below, and deposited it in certain cavities in the superincumbent slates when the pressure and temperature were lessened to such a degree as to permit of a precipitation.

Nevertheless, in the Pine Hill district, we do find that the tin-ore veins may exist in the igneous rocks. And this may be explained by the fact that the impregnation with tin ore at that place occurred at the very end of the processes of igneous intrusion. In fact, not only had the basic rocks solidified, but also the acidic dyke-rocks described above had become quite solid. Hence it is that we find the tin ore enclosed within walls of gabbro, or even granite porphyry. Doubtless, also, if we could but follow the ore-bodies which now are seen at the surface to be enclosed within members of the slate series, we should find the lode-channels continuous through the upper portion of the igneous *massif*, which seems to underlie the greater part of the tinfield.

In the immediate neighbourhood of all of the tin-ore deposits in the main portion of the field there are acidic intrusives. The "Dreadnought-Federal" line of lode may seem an exception when compared with other portions of the field; but even so, the distance from the quartz-porphyry dyke in the Montana Company's section is not considerable. And, if the surface cover of soil and vegetation were removed, this dyke might possibly be traced still further in the direction of this lode-system.

A much more remarkable occurrence is that of the tin ore near the Dundas township, where the only igneous rock visible is serpentine.

This association of tin ore with serpentine, coupled with the association of the Limuritic ore of the Colebrook Mine with serpentine, is, to my mind, one of the strongest links in the chain of evidence which may be adduced to prove the essential unity of origin of the basic and acidic rocks.

The seemingly anomalous nature of this occurrence is satisfactorily explained by the known relationship of the serpentine to the acidic igneous rocks.

Although these ore deposits are closely associated in the field with the igneous rocks mentioned, they are, nevertheless, not "contact deposits" in the strict sense of that term.

It has been realized by the management of some of the mining properties that there is a close dependence of the ore upon the acidic rocks, and the assumption has been made that, if the planes of contact between the igneous rocks and the sediments be exposed, ore-bodies will be found.

Some little work done on the northern slopes of Pine Hill has proved the inaccuracy of this hypothesis. But this work has been of great value in that it has exposed a considerable face of the quartz porphyry at its junction with the slate, and has shown clearly what the structural characters of the ore-body really are at that point. The veins form a reticulating system, and the principal members of this system cut igneous and sedimentary rocks alike, in a direction perpendicular to the line of contact.

Yet it must not be considered that a "contact deposit" must coincide with the surface of junction between any two dissimilar rock-formations. The term "contact deposit" is now limited in its application, and only employed in the description of certain ore deposits which exhibit the following characteristics.*

They are usually irregular in form. They occur near or along the boundary between plutonic igneous masses and stratified rocks; most commonly where the latter are limestones.

The gangue minerals are characteristic, and are usually garnet, wollastonite, epidote, amphibole, pyroxene, vesuvianite, quartz, and calcite.

The ore minerals are haematite, magnetite, bornite, chalcopyrite, pyrite, pyrrhotite, and sometimes galena and blende.

Thus, it appears that tin-ore deposits do not appear among those which are typical contact deposits. But this does not preclude the possibility of such an occurrence, and one occurrence of tin ore in a contact deposit has been recorded in Tasmania.†

The garnet-actinolite lode, which very nearly coincides in position with Gormanston Creek, is of the nature of a "contact deposit," if the term be extended slightly beyond the limits of the strict definition. This matter is treated of below.‡

* *Vide* W. Lindgren, "The Character and Genesis of Certain Contact Deposits"; trans. A.I.M.E. 1901. R. Beck, "The Nature of Ore-deposits"; Weed's translation, p. 582.

† G. A. Waller, "Report on the Tin-ore Deposits of Mount Heemskirk, 1902, p. 46.

‡ *Vide infra*, p. xciv.

It is quite certain that the country rock has had little or no influence upon the composition of the lodes, since dissimilar lodes are to be seen side by side within the same formations.

The variability of lode-type is due to the alteration in the character of the mineralizing solutions which have traversed the lode-channels at different times.

Moreover, as has been indicated already in this chapter, veins of tin ore can be seen on the northern fall of Pine Hill cutting across the slate and the quartz porphyry without change of character.

Changes in the mineral composition of the pyritic-cassiterite veins are very noticeable when the different lodes are reviewed together; but this is a characteristic displayed by different varieties of veins in every mining field. The presence of "shoots" in which one metal or another predominates is not due to the direct influence of the adjoining country rock in this tinfield.

The positions of the several lode-systems (called "systems" because simple lodes are rather the exception than the rule in this field) have been determined by the presence of fracture-systems which possessed the continuity in depth necessary for the admission of the metalliferous solutions from the magmatic hearth. And the details of the fracturing have determined the form of the lode-systems.

It is not possible to discern any evidence which might disclose an essential change of either composition or structure in the lode-matter when an ore deposit is enclosed in wall-rocks which vary from point to point.

The reticulating veins in the quartz porphyry in the neighbourhood of Pine Hill and Penzance Creek are, perhaps, a special case, where the igneous origin of the rock has influenced the form of the vein-system. For during the cooling of the quartz porphyry a number of contraction fissures have been developed, and the tin ore has been introduced into these joints.

One problem which naturally arises at this point concerns the matter of the differences between the two vein-types which constitute the ores which are being worked for tin on the field. It is important to know whether the differences between the pyritic-cassiterite veins and the quartz-tourmaline-cassiterite veins are due to their proximity to, or remoteness from, the plutonic source.

For it is certain that the two types are derived from one source and the relation between the two needs investigation.

Unfortunately there is very scanty information to be obtained from the underground workings, and thus far the mineral character cannot be examined with respect to its behaviour as vertical depth is attained.

We may say, regarding the two lode-types, that the quartz-tourmaline veins are restricted to the area which surrounds the main centre of the acidic intrusions at Pine Hill.

Yet, as Pine Hill is approached, there are no lodes which show a gradual passage from the pyritic to the quartz-tourmaline type, nor are any intersections between representatives of the two types available for examination.

For the present, therefore, it is impossible to state the relationship between these types, and the order of their derivation from the plutonic source cannot be settled.

But even if the relationship can never be ascertained at North Dundas, it is possible that the necessary information may be gathered from other mining fields in Tasmania where the same vein-types are represented.

With regard to the ore-deposits which have a secondary origin the proximity of certain rock-types has in some cases an important bearing on the grade of the deposit or the nature of the minerals present. The most marked case is that of the deposits of iridosmine, which are workable only where they lie upon or in immediate proximity to the parent rock—serpentine.

(3)—The Primary Ore-deposits of North Dundas.

While the mineral district of North Dundas is primarily a tinfield, there are to be found within its limits ore-deposits containing other metals.

These are here considered apart. Also, separate mention is made of the different mineral groupings or vein-types which contain the same metal; and these several types are grouped together under the headings of the metals of which they constitute the ores.

A.—Tin Ores.

There are exceedingly few localities in which it is necessary to draw a sharp line of distinction between the different vein-types of tin ore. But at North Dundas there are two well-marked types which are strongly contrasted, and each type is developed independently of the other.

Mr. G. A. Waller has given, in his report on Mt. Heemskirk*, a brief description of the several types of tin veins, and has there established four main classes which he terms "quartz-tourmaline veins," "pinitoid veins," "greisen veins," and "pyritic veins."

Of these groups the first and last mentioned are important in the tinfield of North Dundas, but there are signs of the presence of the "pinitoid" type in several portions of the field. No true greisen was observed.

The Pyritic-Cassiterite Deposits.

The following may be given as a definition of the mineral constitution of these deposits:—

The metallic minerals of the vein-type are pyrrhotite, pyrite, arsenopyrite, chalcopyrite, with a certain amount of galena, sphalerite, and bismuthinite.

Wolframite is present in most deposits.

The tin ore occurring with these is cassiterite, but stannite has been observed in some rare cases.

Of the gangue minerals the most abundant is quartz, and with it occurs dolomite. In smaller proportions the following minerals also are present:—Tourmaline, chlorite, epidote, and fluorite. Apatite has also been recorded.

The prevailing structure of the vein-filling is massive.

In further explanation of this vein-type, which has hitherto not been, as far as the writer is aware, very fully defined, the following detailed account of the North Dundas deposits is given:—

The most abundant of the metallic minerals by far is pyrrhotite, and it is frequently accompanied by a quantity of pyrite. The former is, as in most occurrences of the mineral, massive, but the pyrite is often seen to be well crystallized, especially upon the weathered surfaces of the lode-matter. In some places within the lodes the pyrite predominates.

Arsenopyrite is very irregularly distributed, and was most noticeable in the old "Cornwall" workings on the boundary between the two sections held by the Boulder Company, and in the lode-matter at the junction of Gormanston Creek with Dalcoath Creek.

In the latter place it forms, at one place, the bulk of the lode-matter.

* G. A. Waller, "Report on the Tin-ore Deposits of Mount Heemskirk," 1902, pp. 8-10.

Chalcopyrite is very widely disseminated, but never becomes so abundant as to entirely displace the other minerals.

Galena and blende are usually to be seen in the vein-matter in most of the lodes. They are most frequently seen where dolomite and fluorite are unusually prominent in the gangue.

Bismuthinite has not been recorded at North Dundas.

Assays made from different portions of the lodes have shown a fairly wide distribution of small quantities of silver. Whether the distribution of silver corresponds to that of the galena is not yet determined.

The presence of gold has been recorded from one or two points, but so little sampling and assaying has been done that it is not yet known whether there is a wide distribution of it.

Wolframite was not observed at North Dundas.

The tin ore present is cassiterite, and the writer found no sign of stannite in the ore which he examined at North Dundas. The cassiterite is usually grey in colour, and in a fine state of division. It is almost always crystalline and granular. But in the old workings of the Cornwall Company the tin oxide is usually of a deep brownish colour, and at one point occurs in the fibrous form, constituting radiating crusts and associated with arsenopyrite.

The distribution of tin ore in the massive lodes is very irregular. Extremely rich pockets and bands occur, and as yet the conditions governing the distribution of these shoots are not knwn.

Systematic sampling and assaying are wanted, in order to provide the data necessary before a solution of this difficult problem can be attempted.

The reasons which may account for the occurrence of the tin ore as cassiterite rather than stannite, especially in view of the presence of sulphides of iron and copper, are at present undetermined.

Of the gangue minerals, quartz is much the most abundant, and it frequently forms the bulk of the ore which occurs on the Dreadnought-Federal lode-system.

In the typical massive sulphide ore the quartz takes many forms, and occurs most frequently in the form of reticulating acicular crystals, the outlines of which only become apparent on weathering.

Chalcedonic silica is present in several places, notably on the northern side of the Argent River, in the gossan outcrops which appear to result from the oxidation of lodes of this type. A little greenish opal was also observed.

Next in importance to the quartz is dolomite, which in most places is ferriferous. It is always present, even in those compact portions of the lode which appear to the naked eye to be aggregates of quartz and pyrrhotite only. And in places the dolomite predominates over the other lode minerals, notably in the main river tunnel and at the northern end of the "big blow" workings on the Renison Bell lease. It is noticeable that in many cases an increase of the proportion of dolomite in the lode is accompanied by an increase in the proportion of galena and sphalerite.

Tourmaline seems to be invariably present, although it is only visible to the unassisted eye in one or two places. It occurs in some quantities in the ore of the Dreadnought Mine.

Fluorite is not commonly seen. It appears to be most often seen where an unusual proportion of galena and blende occur.

Chlorite is usually present in the form of radiating tufts, but can seldom be seen with the naked eye.

Epidote was found to be abundant in the form of crystalline grains in one slice cut from a specimen rich also in dolomite. It is not common in other specimens, and was never observed without microscopic aid.

Apatite has not yet been recognised on this tinfield.

Where the minerals which have been mentioned were free to crystallize out (*i.e.*, in the more massive portions of the lode-systems rather than in the interstices between the separate constituent grains of the more porous beds in the slate*) the structure of the vein-matter closely resembles that of an igneous rock. This structure seems to indicate that crystallization must have taken place in spaces which were open. The open cavities may have been formed by the action of the lode-bearing solutions rising under conditions of high pressure through the necessary fissures. The pressure under which the solutions ascended may have distended the walls of the fissures, and the deposition of the lode-matter may have filled the cavities and prevented the closing together of the walls when the period of circulation of the mineral solutions was at an end.

The order of crystallization of the principal lode minerals, as determined by a number of thin sections, is—

* *Vide infra*, p. ciii.

tourmaline and epidote; then tin ore, followed by quartz, chlorite, pyrite, pyrrhotite, and dolomite, in the order named.

The internal structure of the lodes varies widely from point to point, according to the conditions of deposition.

Most usually the central portion of the lodes has a massive structure, referred to in the preceding paragraph. On either side of the massive portion there are usually zones showing an ill-defined banded structure. These zones are probably due to the metasomatic replacement of successive strips of the country rock.

This banding is remarkably well defined in the lode situated on the boundary between the two sections of the Boulder Company's lease.

Crustification is sometimes seen, but it is not usually well defined.

One matter regarding the lode-structure requires further investigation, viz., the question whether the lode-structure has a determining influence in any particulars over the mineral constitution of the vein-stuff.

The observations of the writer point to the fact that pyrrhotite is only present in the more massive portions of the lode systems.

Where the mineral-bearing solutions have penetrated the country rock alongside the fractures, the only sulphide of iron deposited by them is pyrite. This observation, however, needs to be checked at all points as development proceeds.*

The greater part of the tin ore now being won at North Dundas is being derived from the oxidised portions of the pyritic-cassiterite lodes described.

The tin lodes of the central mining area are of this character in all cases, although the variations from point to point would appear to mark a change of lode-type. The lode-formation, as a whole, must be taken into consideration in such cases.

Some further mention must be made of these lodes in treating of the secondary alteration which they have suffered. The forms assumed by the ore-bodies are also described below.

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* **Note.**—A variation of mineral constitution with a variation of lode structure has been recorded with regard to the lead veins of the Mt. Farrell district (Bulletin No. 3, Geol. Surv. Tas., pp. 43, 44, 48, and 79-82). The influence of physical structure upon the mineral constitution of lodes is imperfectly understood.

There are lodes of this type developed in other tinfields, but at North Dundas the separation from the more usual type is so distinct that the description can be given with special detail and certainty.

The same mineral grouping is quoted by W. Lindgren* from W. von Fircks' description of the Mt. Bischoff ore-deposit.

Mr. Waller has recorded veins of this type in his report on the tinfield of Mount Heemskirk,† and mentions the presence there of antimonial silver ores, stannite, and wolframite, in addition to those mentioned above, as occurring at North Dundas.

Messrs. J. B. Hill and D. A. MacAlister have recorded many instances of this vein-type in the tin mines of Cornwall.‡

The Quartz-Tourmaline-Cassiterite Veins.

This second type of stanniferous veins is by no means so uncommon as that type already described.

At North Dundas the exposures of the vein-matter which should be classified here are restricted to the surface and a few shallow trenches and high-level tunnels around the Pine Hill area.

A full definition of the vein-type is therefore difficult to obtain from the evidence of this tinfield alone, inasmuch as those minerals which can be oxidised, or otherwise altered in such a way as to form soluble compounds, have very probably been removed in solution.

Mr. G. A. Waller, in his report on Mt. Heemskirk,§ defines these stanniferous quartz-tourmaline veins in the following terms:—

"These veins consist essentially of a tabular mass of quartz or quartz-tourmaline, containing in the centre a vein, from which the country on either side has become mineralized. Either the vein-rock or the vein-stone may carry tin, but usually the vein-stone is the richer of the two. Tin appears to be associated with both black and green tourmaline; but I think that, of the two, the green is the more favourable. This is also the case at Mt. Bischoff. A little iron, copper, and arsenical pyrites is often present, either in the vein-stone or in the vein-rock,

* "Metasomatic Processes in Fissure-veins." Genesis of Ore-deposits. A.I.M.E., p. 543.

† *Loc. cit.*, pp. 9-10.

‡ "The Geology of Falmouth and Camborne." Memoir Geol. Surv. of England and Wales.

§ *Loc. cit.*, pp. 8-9.

and in all probability these minerals will be found in all the veins in depth, their absence from the upper portions of the veins being due to the oxidising and leaching action of surface waters. To this list must be added small quantities of bismuth sulphide, wolframite, and, rarely, molybdenite."

This definition answers very closely to that which might be framed to deal with the North Dundas representatives of the type. There is, however, this difference—that the ore of North Dundas is of simpler composition, *i.e.*, quartz, tourmaline, cassiterite, and pyrite. However, as has been indicated, further prospecting may reveal more variety in the composition.

Another portion of Mr. Waller's definition does not appear to stand true before the evidence given by *all* occurrences, although it is almost universally true—the remarks concerning the mineralization of the country rock alongside the veins.

Where the country rock traversed by the stanniferous quartz-tourmaline veins happens to be granite porphyry, this mineralization of the wall-rocks is admirably shown; but the phenomena do not appear to the writer to be of such general occurrence as to justify inclusion in the definition of the vein-type.

Another striking similarity between the occurrences at North Dundas and those at Mt. Heemskirk is the presence in both places of dykes or veins of quartz-tourmaline rock.

It has recently been urged by many writers on ore deposits that there is no essential difference between "dykes" and "veins" of certain types.

In the case of these quartz-tourmaline intrusions the impossibility of making the distinction is admirably shown.

The criteria by which we judge a tabular mineral aggregate to be a "dyke," rather than a "vein," are not definitely established, nor can they be established in such a way as to limit both classes by hard and fast lines.

In the latter stages of consolidation, the residual portion of the magma from which the acidic rocks are derived becomes progressively more siliceous and more aqueous. And when finally the still liquid material is forced out through the cooler rocks, there results a rock which often possesses the characteristics of material which has crystallized out from *solution*. Thus the phenomena of crustification are visible in these rocks.

At Pine Hill the writer did not find any instances of pegmatite veins *in situ*, but fragments showing this crustification were observed. Moreover, the quartz-tourmaline rock which has been referred to has a marked tendency towards the development of this structure. Intrusions of the quartz-tourmaline rock were observed, the outer portions of which consisted of a granular aggregate of the two minerals, while the central portions of the vein showed marked comb-structure.

Nevertheless, these "dykes" or "veins" show, as a rule, only the granular texture.

While tin ore was not actually observed in the latter quartz-tourmaline rock, the writer is fully convinced that the quartz-tourmaline-cassiterite vein-stuff is precisely the same material with tin ore added. That is to say, the tin-bearing veins of the Pine Hill area are merely special cases of the quartz-tourmaline intrusions.

Precisely this conclusion has been arrived at by Mr. Waller for the very similar veins at Mt. Heemskirk.*

Where the stanniferous veins of this class have penetrated the granite porphyry there has in most cases been a very complete alteration of the porphyry rock, and especially of the felspathic constituents of the rock. The felspars are in many cases replaced by an aggregate of quartz, tourmaline, and cassiterite, with, at times, a little pale mica.

The proportion of quartz to tourmaline in the veins of this class is as variable as the content of cassiterite. At times the veins are predominantly quartzose, and the granite porphyry alongside is silicified. Again, the veins may be almost wholly of tourmaline, and the porphyry walls may be tourmalinized.

There is frequently a little pale mica to be seen in the neighbourhood of these veins, and in one place the adjoining porphyry was found to be almost wholly replaced by a micaceous aggregate.

The mica attacks first the felspar phenocrysts, and then replaces the groundmass in exactly the same way in which the tourmaline acts.

These micaceous varieties mark a passage towards the pinitoid-cassiterite veins of Mr. Waller's classification.

In one place on Pine Hill pyrites was seen in the slate traversed by these veins, but it is not certain that the pyrite belongs to the same period of impregnation. It may belong to the period of the formation of the actinolite veins which are present there.

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* *Loc. cit.*, p. 2.

B.—LEAD AND ZINC ORES.

Pyritic Lead Deposits.

A brief mention is here made of the ore-bodies which contain lead and zinc for the reason that a little prospecting work has been done from time to time upon them.

There has never been any regular output of ore from any of these deposits, which are situated within the limits of the tinfield.

Outcrops which show both galena and sphalerite are quite common, but the bodies of ore appear to be narrow, and to lack continuity.

The ore of these outcrops is usually of a massive character, and the metallic minerals strongly predominate over the non-metallic.

The association of the minerals in these deposits is that characteristic of the "pyritic lead deposits."

In most respects the ore corresponds to R. Beck's definition of that vein-type.* But pyrrhotite is usually an important constituent, and fluorite is always present.

In one case (that of the lode located on the western bank of the Ring River, in Section 3658-M) the texture of the ore is quite identical with that of the average pyritic-cassiterite ore, and the non-metallic gangue minerals are well developed.

It is doubtful whether these ores should be considered apart from the pyritic-cassiterite deposits, which, as has been already indicated, contain a small amount of galena and zinc blende. The ore-body in the Ring River valley just mentioned exhibits to a remarkable degree the characters connecting the pyritic lead deposits with the pyritic cassiterite ones.

This being so, any local increase in the amounts of lead and zinc minerals should be regarded, in my opinion, as a local variation in the character of this type of tin veins, rather than as a separate ore-deposit of different origin and character.

While this view of the origin of this class of ore does not imply the belief that no bodies of lead ore of any size may exist, it may account for the abrupt termination of the lead-bearing ore and the reappearance of the more normal (tin-bearing) type.

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* Bulletin No. 3, Geol. Surv., "The Mount Farrell Mining Field," 1908, p. 48. R. Beck, "The Nature of Ore-deposits"; Weed's translation, Vol. I., pp. 235 and 236.

The proportion of the metallic minerals present in these lodes is very variable, and those which predominate at the various points are indicated on the geological map.

The Garnet-Actinolite Vein.

There is a rather unusual vein of very large dimensions traversing Gormanston Creek at a narrow angle. It is considered in this place for the reasons that it carries in some places a notable amount of zinc blende, and it may be connected in some way with the axinite-actinolite vein-type, which is the next one treated of here.

The vein does not yet appear to be in itself of commercial importance; but it extends into the tin-bearing region of Pine Hill and the phenomena of vein-formation become rather complicated in consequence.

The mineralogical character of this vein is that of a contact deposit.

The predominant minerals are garnet and actinolite, which show a tendency to separate into bands or zones consisting of one or other of these minerals. Other bands of the lode-matter contain quartz, fluorite, calcite, and epidote. These latter are apparently of slightly later date, and have partly replaced the garnet-rock of the previous crystallization.

There is a fair amount of zinc blende in the actinolite in Section 317-M, and in one place galena was observed enclosed within quartz.

Pyrrhotite is common, and in a few places specular haematite was seen in association with garnet crystals. Copper pyrites is also present in small amount.

The structure of the lode seems to account for the zonal arrangement of the constituent minerals. There appear to have been a series of parallel fractures in the slate country along which the vein-matter has entered. By metasomatic replacement of the walls of these fractures a broad lode-formation has resulted, and bands of slate still remain unreplaced.

The cover of the quartz porphyry talus prevents the detailed examination of this vein occurrence, since the outcrops are not well exposed, save at one point.

In the immediate vicinity of this lode a number of narrow veins and lenses of axinite are to be seen in the slate. These may belong to the lode-formation under discussion, and if so they serve to link this vein with that which is next dealt with. It seems highly probable that the two are very closely related genetically, and they possess one very prominent constituent in common—actinolite.

Before passing on from this description it should be remarked that the slate which forms the walls of this lode does not appear in any way different from the normal slate of the district.

No analysis has been made of this slate, which is usually green in colour, but it certainly does not give the impression of being a highly calcareous variety.

The presence of the silicate minerals which carry a high percentage of lime is therefore striking. The conclusion to be drawn is that a large proportion of lime was introduced in the vein-forming solutions, rather than derived from the wall-rocks.

The chemical composition of the garnet in this lode-formation may prove it to be a manganese-bearing variety. This being so, another connecting link with the axinite veins would be established.

C.—COPPER ORES.

The Axinite Veins.

There are a number of occurrences of vein-matter in the North Dundas tinfield in which the prominent vein-material is axinite. Only one of these veins attains considerable dimensions—that which is located near the southern boundary of the northern section of the Boulder Company's lease.

These veins are here classed as copper ores, for the reason that the type is remarkably well developed at the Colebrook Mine, which is situated at a distance of about 4 miles from the centre of the tinfield, and the metal sought in that mine has been copper.

The occurrence at the Colebrook Mine has been opened up to a considerable extent by mining operations, and, in consequence, the vein-type can best be defined from the information gathered at that place.

This has been done by Mr. G. A. Waller,* and a brief summary is here given of his description.

Of the metallic minerals present the most abundant is pyrrhotite, and with this occur pyrite, arsenopyrite, marcasite, and chalcopyrite. Small quantities of galena, sphalerite, and tetrahedrite have been observed. A small amount of gold and silver is present in the ore.

* "Report on the Ore-deposits (other than those of Tin) of North Dundas," 1902, pp. 1-5.

The non-metallic minerals are axinite and actinolite in most cases, and with them occur smaller amounts of datolite, danburite, calcite, and quartz.

The structure is usually banded, the ore consisting largely of bands, in which axinite and actinolite alternately predominate.

The locality was visited by the writer for the purposes of comparison with the occurrences in the tinfield of North Dundas, and the information gathered was sufficient to establish the essential identity of the vein-types of the two districts.

In the tinfield, however, the work done has been very little, and there is not so much opportunity of examining different portions of the lode-stuff. Moreover, the only deep workings, beside the Government track at the southern end of the Boulder Company's northern section, are now full of water, and the material on the tip is much weathered.

However, the mineral composition seems to be a little simpler than that of the described type.

Axinite is the main mineral represented, and small radiating tufts and aggregates of actinolite are visible in it. The principal sulphide is pyrrhotite, and a little pyrite, arsenopyrite, and chalcopyrite were observed with it.

Numerous other veinlets of axinite in the slate were observed in other places, viz., in Gormanston Creek, and on the eastern bank of the Ring River these veinlets were seen enclosed in gabbro-amphibolite rock.

There are probably a number of such minor occurrences throughout the district, and they do not appear to be of commercial importance.

In all cases the veins appear to belong (with those mentioned above as garnet-actinolite veins) to the great class of "contact deposits."

In this connection it is of interest to compare the remarks of A. Lacroix upon "The Granite of the Pyrenees, and its Contact Phenomena."† Lacroix gives a full description of these axinite rocks, or "limurites," as they have been termed, and compares the Colebrook rock with that of the Peak of Arbizon.

He also mentions that the limurites sometimes merge, on their borders, into garnet-idocrase rocks.

† Bulletin des Services de la Carte Géologique de la France, No. 71, Tome XI., 1899-1900, pp. 56-61.

There are no available analyses of the country rocks alongside these veins, but from their general aspect the writer has drawn the conclusion that they are likely to prove other than highly calcareous. In fact, it is highly probable that they are richer in lime near the lode by reason of the introduction of lime-bearing minerals by the vein-forming solutions.

This is a question which requires solution by the aid of a series of chemical analyses.

The relation of this axinitic rock to the pyritic-cassiterite veins is shown in the old Cornwall workings. There the tin vein is intersected by the axinite vein, and seems to be even a little displaced by the fracture, which is now filled with axinite. Moreover, the tin vein, which is strongly banded at this place, has apparently been split along the direction of the banding near the cross fracture, and axinite is to be seen forming, as it were, a separate band or zone in the lode.

The other occurrences of copper ores on the tinfield are, in my opinion, to be regarded as merely portions of the pyritic-cassiterite lodes, which are locally rich in copper. Such being the case, there cannot be expected to exist any continuous body of the copper-bearing stone.

(4)—The Alteration of the Wall-rock of the Lodes by the Mineral-bearing Solutions.

The solutions, which have been the means of transporting the metallic contents of the lodes from their plutonic source to the position which they now occupy, have to some extent altered the country rock alongside the lodes.

As will be seen, these solutions have penetrated the country rock for some distance on either side of the actual fissures.

In the case of the ordinary varieties of the slate little alteration has been caused by the introduction of the pyritic-cassiterite ore.

The chief change effected is the development of tourmaline along the planes of the more siliceous, and therefore the more porous, bands of the slate. Pyrite accompanies this tourmalinization, and in many cases tin ore. Pyrrhotite does not appear, except in the actual filled cavities in these slates, its place being taken by pyrite where there is actual replacement along the bedding-planes.

In the case of the grits belonging to the slate series, there is a marked development of sericite in some places at a considerable distance from observed fractures. The sericite penetrates the quartzose pebbles, first in the form of numerous needles with a centripetal disposition, and finally replacing them altogether. It is accompanied by pyrite.

Where the quartz porphyry dykes have been attacked by the solutions which introduced the pyritic-cassiterite ore the alteration is very much more marked.

The prominent feature of the alteration is the development of sericite, accompanied in many cases by tourmaline, fluorspar, pyrite, and sometimes a little blende.

This alteration is noticeable, even where the dykes are some chains distant from the ore-bodies; and is due to the ascent of a portion of the mineralizing solutions along the planes of weakness developed by the igneous intrusions. Tin ore is said to have been recovered by panning crushed specimens of this altered quartz porphyry.

The other type of tin ore, characterized by a quartz-tourmaline gangue, is accompanied by a more complete alteration of the walls.

Where the veins occur in the slate the rock in the neighbourhood of the ore is silicified and tourmalinized. Hence it is very much harder than the unaltered slate.

In the case of the quartz-porphyry the alteration is shown first by the replacement of the felspars. Then the groundmass is attacked, and finally the whole rock may suffer replacement.

Where the alteration has proceeded simultaneously from a number of fissure-planes a broad belt of the rock is altered. Moreover, the alteration in successive bands is not exactly the same, since the mineralizing solutions have varied from point to point.

Thus it is that some bands of the altered porphyry are indurated by silicification only. Others are hard and dense, but carry both green and black tourmaline, in addition to the introduced silica. Others show only a replacement of the felspar by aggregates which consist of quartz and cassiterite, tourmaline cassiterite and mica, tourmaline and mica, or mica alone.

In the case of one prominent vein of this type which was enclosed in the gabbro in Section 3650-M, no alteration of the basic rock was observed.

With regard to the other vein-types and their effect on the wall-rocks little information could be gathered for want of exposures. It was observed, however, that the slate alongside the garnet-actinolite vein carries needles of actinolite.

(5) The Structure of the Lodes.

Taken as a whole, the tinfield is remarkable for the complicated character of the lode-structure.

All of the primary ore-bodies have resulted from the deposition of mineral material by solutions rising along circulation-channels which have been formed at a date prior to that of the period of ore-deposition. These circulation-channels are in reality fracture-planes caused by the actual rupture of the earth's crust. The nature of the fractures depends upon the direction in which the strain is applied, the character of the strain itself (whether it partakes of the nature of tension, torsion, or compression), and the behaviour of the various rock-masses under the strains developed.

The various phenomena presented by the different ore-bodies will first be discussed separately.

(*a*) *The Pyritic-Cassiterite Lodes.*—These are extremely complicated in structure in some places and simple in others. The reasons for the complexity are that the slate has proved somewhat readily fissile, along the bedding-planes, and the fracturing has been itself of a rather complex character. The more intricate structures can best be explained by proceeding from the investigation of the simpler structures to those which show many variations from the simple fractures.

(1) The simple "fissure-lodes"* are themselves not common. Certain apparently simple fissures are found to be, at some point in their course, slightly complex, and are therefore grouped in the next class.

The examples which may be cited in this group are the gossan lode in the north-western portion of the area mapped, the greater part of the long lode south of the Melba Flat, and perhaps the greater part of the Dundas occurrence.

(2) The branching fissures are common.† They consist of a main fissure, from which one or more branch fissures extend outwards towards the surface.

The main fissure commonly cuts across the bedding-planes of the slates, and the branch or branches conform for the most part to these bedding-planes, as shown in the diagrammatic section.

* For the sense in which this term is used see Geol. Surv. Bulletin No. 3, "The Mount Farrell Mining Field," 1908, pp. 55-56.

† See Plate V., Fig. I.

As examples of these branching lodes may be cited:—The "big blow" and the more vertical lode associated with it on the Renison Bell lease; the lode situated in Dalcoath Creek (near its junction with Gormanston Creek), and the narrow lodes exposed in the underground workings at that place; the gossanous ore-bodies in the centre of Section 4550-93M; and the lodes on the Renison Bell lease between the Argent River and the railway-line.

The gossanous bodies which cross the boundary-line between the Boulder Company's northern section and the Section 1273-M (known as the Federal Section) are also very probably two more or less parallel branches connected with a more vertical body.

These occurrences are more fully described in a later portion of this report.

Little work of any kind has been done upon several of these branching systems named, but the constant features presented by them has led the writer to describe them thus.

The more vertical member of the branching system is marked by an irregular gossan, which sheds its fragments on either side. The gossans of the more horizontal members of these systems present in all cases a bluff or wall, away from which the fragments have usually rolled. For the dense gossans have exerted some control upon the topographic features, and as a rule follow the course of the spurs.

(3) The complex "lode-systems" are much more difficult problems. The term "lode-system" is employed, for the sake of convenience, to apply to a number of seemingly separate ore-bodies which belong to the same period of ore-deposition and to a single "fracture-system," rather than to a simple fracture. There are two of these lode-systems developed on the field, and the total area embraced by each will be seen, on reference to the geological map, to be large.

The extent of each of these systems is shown on the map, but further work may show that the boundaries should embrace a still greater area.

There appears to be one point of marked structural difference between the two systems—the difference between the relative proportions of the horizontal and vertical components of each system.

In the Dreadnought-Federal system the more vertical components seem to predominate, while in the Renison Bell-Montana-Boulder system the more horizontal components on the whole are the more important.*

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* Contrast Figs. II. and V. of Plate V.

The strike of both systems is similar--about north-west and south-east.

The differences between these two lode-systems are due to the differences in the details of the fissuring.

In the Dreadnought-Federal system the separate fractures which constitute the fissure-zone are, for the most part, approximately parallel to the direction of the system as a whole. Between these separate fractures minor cross fractures exist; and the blocks of slate in the shattered zone have been displaced in all directions, so that the bedding-planes of adjacent blocks dip at different angles, or even in opposite directions.*

The lode-system, as a whole, seems to dip to the north-east at a steep angle.

Such being the correct reading of this structure, the prospecting of the system at various points can most advantageously be carried out by a series of tunnels connected by drives on the ore-body.

Both of the present tunnels which have crosscut this lode-system may yet prove to be started from a point inside the north-eastern boundary of the system.

The generalized view here presented of the system as a whole should be always borne in mind by those engaged in the work of opening up the deposits. For the work of mining tends to cause a concentration of attention upon phenomena which may prove to be only locally important.

The Renison Bell-Montana-Boulder lode-system is still more extraordinary, and it is difficult to find examples with which the system may be compared.

In the writer's experience the most closely-related structural features are presented by the gold-quartz "floors" or flat seams of the Red Hill, Kanowna, Western Australia. But the origin of the structure cannot be identical for both cases. In Kanowna the flat seams connected by vertical "feeders" appeared to me to be due to the impregnation of an igneous rock along a series of contraction joints, the most important of which followed the periphery of the igneous rock.†

The somewhat similar structure in the lode-system under discussion has resulted from the operation of forces having their origin outside of the slate mass.

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* See Plate V., Fig. II.

† Compare the cross section through the Zinnwald granite stock shown by R. Beck, "The Nature of Ore-deposits"; Weed's translation, Vol. I., p. 165.

Whether there has been actual torsion or whether a compression of the crust has caused the complicated series of fractures* cannot, in my opinion, be definitely decided. There is actual displacement between the rocks on either side of some of the fractures of the system, and in some places a wrinkling of the bedding-planes was observed in the neighbourhood of fractures.

Whatever may be the origin of the disturbing force the result has been the production of a lode-system which consists of these component parts:—†

(i) Floors or flat seams of variable thickness inclined at angles varying from 0° to 45° from the horizontal. These are of relatively large extent, and carry the bulk of the ore of the system.

The more important ore-bodies which are to be classed here are—the lode of which the surface is being worked at the Renison Bell Mine; the exposure of pyrites at the south end of the railway cutting on the same lease; the several lodes on the slope towards the Renison Bell Creek in the north-western portion of the Montana section; and the lode of which the surface has been worked in the north-western portion of the northern section of the Boulder Company's lease.

There may be more than one of these "floors" in any part of the system, and certainly two (perhaps three) can be seen at the head of the Renison Bell Creek on the Montana lease.

(ii) "Feeders," or more nearly vertical bodies, which must be regarded as the result of the filling of the spaces or channels whereby the mineral-bearing solutions have risen from the lower portions of the crust, and from "floor" to "floor." For these "feeders" comprise, not only the main bodies which fill the more continuous fractures, but they comprise also the minor veins which connect the different "floors."

The continuity of these bodies, which, taken by themselves, seem simple lodes, does not in some cases seem to be great. They terminate

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* *Ibidem*, pp. 170 and 171.

† Illustrated diagrammatically in Plate V., Fig. V., at the end of this report.

abruptly, both as regards length and depth, in the great majority of cases. Moreover, they are small when compared with the bulk of the "floors."

Examples are to be seen in the railway-cutting on the Renison Bell lease; in the north-western portion of the Montana lease between the "floors" mentioned above; in the tunnel driven under the "floor" in the north-western corner of the Boulder lease; and the highly productive lode in the southern portion of the Montana lease.

The relationship of these feeders to the floors is essential since the solutions which have spread laterally along the floors must have ascended along either a single fissure or a number of smaller fissures, which are connected. In short, the continuity of the system, as a whole, in depth must be regarded as certain. The floors may not be succeeded by other floors in many cases, but yet the lode-system must continue downwards in some form.

The visible major feeders may themselves be the main distributing channels, but this can only be ascertained by further work upon the ore-bodies.

The belt of slate impregnated by veins of pyrite in the railway-cutting at the Renison Bell Mine illustrates most excellently the structure of this lode-system. The scale is very small, but the structure is identical.

(iii) The zones of impregnated slate which accompany the feeders and floors, and arranged usually in the form of a fringe about these other members of the system.

Small fissures occur in the walls of the floors and feeders, and run in all directions through the slate. They are usually filled with lode-matter of the same character as that in the major bodies; and from these cracks and crevices the solutions have penetrated the slates themselves.

It is most noticeable that the impregnation has followed the bedding-planes and almost wholly those of the coarser layers. This is, of course, what would be expected, since the interstitial space in the coarse bands would be greater and the solutions would most easily find their way along them.

This impregnated slate has formed, on weathering, a considerable proportion of the detrital ore which has been worked on the Renison Bell, Montana, and Boulder leases.

Moreover, the whole of the face worked by Messrs. Duncombe and Maddox in the north-eastern portion of their lease presents this character. There is as yet little sign of the presence of the more massive ore-bodies in either floors or more vertical feeders at this place.

Between the several small fissures in these zones of impregnation the different blocks of the slate have their bedding-planes dipping at different angles, and in all directions.

The prospecting which has hitherto been carried out upon the several portions of this lode-system serves to show that tunnelling is of very little value. Both on the Renison Bell Mine and on the Boulder lease tunnels have been driven into the hillsides in the direction of the pyritic-cassiterite ore-bodies, but have gone under them, clearly showing the character of these "floors."

Sinking is the only course open for adoption by the companies desiring to prospect for the presence of other possible floors below those which are visible at the surface.

The writer is of the opinion that such floors will be found if sought; but at what depth below the known floors it is impossible to say.

Therefore, the matter of prospecting by diamond-drilling suggests itself. The diamond drill core would serve to indicate the presence or absence of lode-matter along the path followed by the drill.

It has been already indicated that the distribution of cassiterite in the lode-matter of this type is irregular, so that but little reliance could be placed upon assays of possible ore from a bore core. The core might be from a relatively rich or a relatively poor portion of an ore-body.

Again, the dimensions of an ore-body could not be judged from a core which might represent a boring from a "feeder" or a "floor."

Whether it be decided to bore or to sink a shaft at any point on the lode-system, it would be wise, in the opinion of the writer, to work in a direction at right angles to the known floors at the spot where work is started.

In those cases which could be most satisfactorily examined the "floors" of ore are parallel to the bedding-planes of the slate in which they occur. In this respect they resemble the "branches" of the branching-lodes described above, and in fact the direction of the bedding-planes is in both cases the controlling structural factor.

The lode-system of the variety here described is not essentially different in character from one of the branching lodes, it is merely a little more complex in detail.

Both structural types result from the filling of fissures which have been formed in a rock which has been broken by the operation of external forces, and which has simultaneously opened up along the bedding-planes on account of its ready fissibility in those directions.

Another noticeable structural feature is presented by the lodes on the boundary between the two sections of the Boulder lease. There there are two intersecting veins of the same character, and hence probably occupying fissures which are contemporaneous.

One of the veins follows the bedding-planes of the slate, and the other crosses these at right angles. The former is a flat vein, whilst the latter appears to be nearly vertical. The disposition of these two veins is almost exactly that of the long dyke of quartz porphyry and the shorter (but stouter) arms of the same rock which cross it at Pine Hill.

The suggestion offered is that both the acidic igneous rock and the ore-bodies are the fillings of similar planes of weakness caused by the same crustal stresses.

(*b*) *The Quartz-Tourmaline-Cassiterite Veins.*—These are, on the whole, rather more simple in structure, but yet show some points of resemblance to those mentioned above.

The reticulating veins in the porphyry at Pine Hill are due to a fairly regular jointing of the igneous rock during the progress of contraction consequent upon cooling. The vein-matter has been introduced along the joint-planes, and the rock on either side of these has been impregnated by these solutions.* The chief values, certainly, lie in the filled joint-planes, but there are undoubtedly zones of the impregnated rock which would pay for crushing.

The principal lodes of this district run in a north-east—south-west direction, and have thus far been very little

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* See Plate V., Fig. III.

prospected. At one point, near the mouth of the tunnel which is being now driven into Pine Hill, there is a suggestion of the existence of a cross-fracture traversing the main one almost at right angles. The slate is certainly indurated along a direction nearly north-west and south-east; while the main vein at that place strikes north-east and south-west.

(*c*) *The Other Veins.*—The strike of the other lodes is shown where possible on the map. None of the occurrences are of great importance, and very little work has been done upon them.

(6)—The Secondary Alteration of the Lodes.

By the operation of meteoric water upon those portions of the ore-bodies which are at or near the surface of the ground certain chemical changes have been wrought. The result is that the outcrops of the ore-bodies are altered from the above-described primary condition. On the whole, the structure and texture remain, but the mineral composition is altered.

The pyritic-cassiterite ore suffers the most obvious changes. By inspecting the various exposures along the Renison Bell-Montana-Boulder lode-system the processes of alteration can be studied in all their stages.

The chief feature of the early stages of alteration is the change of pyrrhotite into marcasite and limonite. Marcasite is always present on the surface of the exposed "floors" of ore, but the writer failed to recognize any in the primary ore. The conclusion arrived at was that the formation of marcasite marked an intermediate stage in the processes of alteration. Moreover, since pyrrhotite is absent in the crust containing marcasite, and whereas it is the most abundant constituent of much of the primary ore below, the marcasite is formed from the pyrrhotite.

The marcasite itself rapidly decomposes and is carried away in solution, leaving first a honeycombed quartzose lode-stuff in which well-defined cubes of pyrites wrap round many of the quartz crystals.

The pyrite itself finally disappears, and there remains a honeycombed aggregate of acicular quartz crystals, in which tin ore is sometimes visible. Where the quartz crystals are numerous, and to some extent intergrown, the lode-matter retains its original texture, but where the primary ore has been more pyritic and less quartzose there results a friable mass of quartz crystals which readily crumbles away.

The oxidised ore which is sluiced off the surface of these weathered floors consists, then, in part of minute granules of tin ore and small acicular crystals of quartz.

There may result in this way a certain concentration of tin ore, by the gradual removal of those portions of the ore-bodies which are susceptible to alteration. It should, however, be remembered that, as far as the tin ore is concerned, the concentration is entirely of a mechanical nature. The tin ore is not dissolved and reprecipitated upon the horizon where it is now found in the same way as some ores of lead and copper are.

The tin ore in these weathered floors represents (with the exception of that portion of the ore which is carried away by the streams) the tin contents of the disintegrated lode-stuff above it. In many cases the depth of disintegrated ore cannot be large, and yet the returns on sluicing the surface floors have been highly profitable. The conclusion to be drawn is that the tin contents of the yet undecomposed portions of the floors are far from negligible, although no attempts have yet been made to sample the pyritic bodies systematically. This must be done by the present companies working on the oxidised ore, for the oxidised ore cannot be expected to give more than a temporary supply of ore for treatment.

The zones of impregnated slate which occur in the lode-system which has been mentioned, have, in the weathered zone, lost their content of pyrites, and carry, along the bands of coarser grain, cubical cavities after pyrites crystals.

Since these impregnated zones of slate also carry tin ore in places it follows that the unoxidised pyritic slate should be sampled and assayed. There is absolutely no doubt but that this slate, with the cubical cavities distributed along the bedding-planes, has been charged with pyrite. In spite of the statements made to the effect that actual pyrite has not been seen, there is no possibility of doubt; for in some of the larger cavities the characteristic striæ of the pyrite crystals can be seen to have left their imprint upon the walls of the cubical cavities.

While it may be granted that the great bulk of the ore has been undoubtedly of a pyritic character, there is one variety of lode-matter associated with these deposits which has fostered the hope that some of the ore at least has been always free from pyrites. This ore is dense, brown or grey in colour, and has the texture, to the naked eye, of a quartzite. The largest masses of it occur on the Boulder lease, where they have been regarded as boulders derived from some other lode or part of the same lode higher up the hill. There have also been found a few small specimens of similar ore on the Renison Bell lease, to the south-east of the present workings. The ore is valuable, bulking, on the Boulder lease, as much as 53 per cent. of metallic tin, and I am informed that some of this tenor has been broken up and sent to the smelters.

The so-called boulders are not of secondary origin ; they have been left standing above the level of the more easily disintegrated lode-stuff by reason of their superior hardness and compact texture.

On microscopical examination the ore proves to be mainly a granular aggregate of quartz tourmaline and tin ore. The tourmaline is not abundant, and the only other constituent is limonite. The latter appears to have been derived from pyrite, which has been present in small amount through the ore. Some limonite-stained cavities remain to mark its former presence.

So the ore cannot be regarded as anything but a local variant of the general type, and it does not appear abundant enough to ever prove important.

The gossans which result from the oxidation of other pyritic-cassiterite bodies in the district may seem to be due to the alteration of another type of vein than that described above. For it has been indicated that the iron content of the " floors " has been not only oxidised, but also completely removed from the surface portions of the formation at least.

The reason for the absence of iron in the form of limonite in the oxidized floors is given by the known interaction between organic acids and the oxidised iron compounds.* The thick growth of vegetation which has covered these deposits has had the effect of rendering the surface-water capable of dissolving out the iron compounds. The roots of the vegetation are to be seen penetrating the upper portion of the lode-system in all directions. In the case of the more vertical bodies of ore and those dipping into the hills the area exposed to such action at the surface is relatively much smaller than in the case of horizontal bodies or those dipping with the hillslopes, and the iron content of the lode-formation is preserved in the form of gossan. For instance, the vertical " feeder " from which so much tin ore has been recovered in the southern portion of the Montana section retains much of its iron content as gossan.

* A. Geikie, "Text-book of Geology," 1903, Vol. I., pp. 598-599.

The relation of the quartzose ore lying above the "floors" and the gossans to the unoxidised pyritic ore is shown diagrammatically elsewhere.*

The gossans which result from the oxidation of the simple or branching lodes are of normal character, and from their general appearance led early prospectors to examine them for lead and silver contents only.

The prospecting of these gossans more recently has not been, in many cases, thoroughly carried out. Too much reliance has been placed upon samples very roughly taken.

The tin contents of the gossans cannot be leached out by atmospheric waters, but the iron contents of all gossans are redistributed in a very irregular manner. Thus, if care is not taken to expose the ore-body proper before sampling, fragments containing the reprecipitated iron oxide only may be selected, and with them tin ore may or may not occur.

It is known that some of the gossanous ores are extremely rich in cassiterite, notably rich specimen-ore being obtainable from the "big blow" and from above the river tunnel on the Renison Bell lease, from the old Cornwall workings, and from the main outcrop on the Dreadnought lease.

Before passing on from the question of the gossans, one more point may be noticed. At the "big blow" workings on the Renison Bell Mine the inclined ore-body called the "big blow" is more or less completely oxidised, while the more vertical ore-body encountered in the underground workings is, on the same level, unoxidized. This may perhaps be due to the geological structure. It seems possible that the inclined lode should catch the surface water, and let it sink downwards, running all the way over the ore and finding an outlet along the direction of the junction of the "branch" lode with the "stem."

It may therefore, in my opinion, be expected that oxidized ore will be found for some distance into the face of the hill above the junction of the "branch" and "stem" in both portions of the branching system. The progress of such oxidation is indicated in the diagram referred to.*

Some other oxidized ores were met with that are due only to the action of surface waters. The most notable occurrence is that of native copper, azurite, malachite, and covellite at one point in the bed of the Argent River where a small stream issues from the gossan on the northern bank. This is certainly due to the deposition of the copper-

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* See Plate V., Fig. IV.

bearing minerals, which are the result of the weathering of chalcopyrite in the pyritic-cassiterite ore. The actual copper pyrites has not been seen at this period, but it is known to be a constant constituent of the ore-bodies of this type.

Chalcanthite and vivianite were observed on some of the joints and weathered surfaces of the ore.

(7)—The Secondary Ore-deposits of North Dundas.

By the term "secondary," as applied to ore-deposits, it is implied that the ore-deposits thus described have resulted from the operation of chemical and mechanical forces upon primary ores.

A.—Tin Ores.

1. *The Residual Tin Ores.*—Consequent upon the chemical alteration of the floors of pyritic-cassiterite ore and the mechanical action of water there have been formed a number of deposits which are commonly referred to as "alluvial" deposits.

But the constituents of these deposits have not moved any appreciable distance, and they retain, on the whole, their original character. Thus, well-formed crystals of quartz are common, and the fragments of vein-matter and country rock are alike angular.

A large proportion of the tin ore in these deposits is excessively fine in grain; and it would indeed be remarkable if quite a considerable proportion of this cassiterite-slime has not been removed and distributed far and wide by the surface waters. It is possible to find this slime tin ore in the surface soil of the district, as, for instance, on the north-eastern slopes of the Dreadnought Hill.

But a great portion of the tin ore has remained, and these deposits have constituted for some time the principal sources whence the output of the field has been maintained.

The vegetable cover has, no doubt, largely assisted in keeping the residual matter from sharing in the general degradation of the district.

The residual deposits are for the most part restricted to the Renison Bell-Montana-Boulder lode-system, but ore of essentially similar character has been worked on the boundary between the two sections of the Boulder Company's lease and at several points round Pine Hill. In almost all cases the residual deposits are from the disintegration of lode-matter enclosed within the slate. However, some of the shallow deposits lying on the quartz-porphyry containing reticulating veins of tin ore have been really residual deposits, since the tin ore has remained practically where it was deposited by the vein-forming solutions.

2. *The Alluvial Tin Deposits.*—The early workings on the tinfield were all on the alluvial ore, which filled the gorges carved out by the Dalcoath and Gormanston Creeks. A portion of Dead Man's Creek has also been worked, and the greater part of Penzance Creek. Little now remains of the true alluvial ore, save near the junction of Dalcoath Creek with the Ring River, where only the central gutter has been worked out.

The tin ore in this area has almost wholly been derived from the Pine Hill lodes, and the rounded pebbles which predominate in the alluvial deposits are formed of the tourmalinized quartz porphyry of that district.

No doubt some contribution of tin ore has been made to the lower portion of this alluvial deposit by that branch of the Dalcoath Creek which traverses the south-eastern portion of the Renison Bell-Montana-Boulder lode-system. Nevertheless, the greater part of the tin ore comes, in my opinion, from Pine Hill.

The most notable feature about these alluvial deposits is the occurrence in the Gormanston Creek of some very large nuggets of tin ore. These are all similar in character, and consist of a crystalline aggregate of quartz tourmaline and cassiterite in variable proportions. Microscopically they show no further details, and are, in my opinion, formed of semi-waterworn fragments of a lode situated in the slate country.

The largest boulders were obtained at a point 2 chains north of the southern boundary of Section 317-M, in the bed of the creek.

Altogether, several tons in weight of these "Gormanston boulders" were obtained at this place, and smaller ones were recovered at various points for several chains down the creek. The largest boulder weighed some 19 cwts., and has been preserved in the Tasmanian Museum, Hobart.

Precisely similar ore occurs right down to the junction of Dalcoath Creek and the Ring River, but the specimens at this end of the creek are all small.

The small creek running into the Argent River in Section 1945-M contains a little tin ore at the north-western corner of Section 4550-93M, but not in sufficient quantities to justify any work being done at that point. This ore is undoubtedly derived from the gossan body in the immediate vicinity.

There is a little alluvial ore in the creeks which run into the Ring River from the eastern slopes of the Dreadnought and Stebbins' Hills. The ore is derived from the lode-system traversing the slopes of those hills.

In the immediate vicinity of the sawmill on Melba Flat there is a small amount of tin ore in the recent alluvial of the flat. Since it does not occur in the upper part of the alluvial deposit the tin ore must be considered to have been shed by the gossanous formation which crosses the hills to the south of the flat.

The Dundas Rivulet near the town site of Dundas has a shallow fringe of alluvial material, in which some tin ore occurs. The deposit is not of any great extent, although on Section 3765-M the grade of the ore is good. The ore here, too, is of local derivation.

In the centre of the deserted town site of Ringville an alluvial deposit of recent date has been worked. The source of this ore is very probably the tin-bearing formation on Section 453-M; and the old workings in Great Northern Creek were probably on ore which had a similar source.

None of these alluvial deposits extend beyond the immediate vicinity of the lodes, which are known to carry the tin ore. Moreover, there is seldom any admixture of other material with the tin ore than fragments of the wall-rocks of the lodes.

But in the case of the broad alluvial deposit of the old Pieman River we find constituents of all the rock-formations in the whole district represented. The more permanent minerals from these rocks occur with a small proportion of tin ore throughout the whole breadth of the formation.

Thus, chromite and colours of osmiridium and gold are all recovered with the tin ore when prospects are being tried with a tin dish.

The reason for the variety of the metallic minerals present is given by the mode of origin of the alluvial formation as a whole. It has been shown that the deposit formed the floor of the matured valley of the Pieman River, and that it contains the fragments of the rock-formations traversed by the tributaries of that river.

The tin ore varies considerably in the matter of grain, the fragments sometimes attaining a diameter of three-quarters of an inch. This tin ore is not often absolutely pure, but contains a small content of quartz and tourmaline. The majority of it appears to me to have been won from the central area of the tinfield and from Pine Hill. There are many rich patches in the pyritic-cassiterite deposits, for example, in the Renison Bell, Dreadnought, and other leases, which would on disintegration produce nuggets like those recovered from the alluvial.

The widespread character of this alluvial has suggested to many the idea of treating the formation as a whole for the tin content.

This does not seem to the writer to be practicable, since the water supply in the district is insufficient for sluicing on a large scale; and the deposit does not appear sufficiently rich to admit of being treated as a whole on any but an enormous scale.

Where there has been a secondary concentration of ore in the beds of the small creeks traversing this formation deposits of better grade have been formed, but these are small in extent, and have only produced a limited amount of ore.

The deposit of alluvial which carries tin ore may be expected to extend for some distance beyond the limits of the area here mapped.

The principal creeks which have been worked for tin ore within this formation are Isaacson's Creek and the small creeks which take their rise in the button-grass plain to the north of that creek.

B.—OSMIRIDIUM AND GOLD ORES.

1. *Gold.*—Brief mention has been made above of the presence of both gold and osmiridium in the alluvial tin deposits of the old Pieman Valley.

With regard to the origin of the gold it is difficult to pronounce an opinion. Very little can have been afforded by the pyritic-cassiterite lodes of the tinfield, and these alone can be the local sources of gold. It seems to the writer more probable that the majority of the gold has been derived from the lodes situated a few miles to the eastward of the centre of the tinfield. An objection to this view has been offered on account of the difference in assay value between the gold of the alluvial and that of the lodes of North-East Dundas. The lode gold is of lower grade than the alluvial gold.

This is not exceptional; it is, in fact, usual to find alluvial gold of a higher degree of fineness than vein gold, even in cases where the presumption is very strong that the latter has been the source of the former. The difference in fineness must have been caused by the intervention of chemical action.

Taken as a whole, the alluvial deposit of the Pieman River cannot be considered likely to prove of value, but a few ounces of gold have been won by prospectors while working for tin ore in Isaacson's Creek.

In the alluvial deposit on the Melba Flat there is gold, and a large number of prospectors have been at work there at different times. The writer did not attempt on this occasion to solve the problem of the origin of the gold.

2. *Osmiridium.*—The presence of osmiridium with tin ore seems at first sight curiously anomalous; for it is usual to think of osmiridium as being associated with basic or ultra-basic igneous rocks, and of tin ore with those of acidic character. The anomaly is dispelled by the explanation which has here been given of the association of these two groups of igneous rocks. The acidic and basic rocks of the district are in very close proximity, and the ores which are genetically associated with each group have intermingled in the alluvial deposits.

Chromite is in all cases the common associate of the osmiridium, and gold is usually present.

Very little osmiridium has been won from the tinfield proper, but a number of ounces have been recovered from the creeks situated a short distance to the northward of the area represented on the geological map.

Mr. J. Riley, who has done a large part of the prospecting of this area, kindly offered to show me over the country, and I was thus enabled to make a flying visit to the district. The following brief notes on the occurrence are the result of that visit.

The creeks which carry the largest proportion of the osmiridium are those which traverse a broad belt of serpentine lying to the north of the area included in the geological map, at a distance of about a mile from the junction of the Pieman and Huskisson Rivers. This serpentine, at its southern boundary, has a bearing about W.N.W.-E.S.E., and appears to be continuous for some considerable distance.

The Pieman alluvial comes right up to the edge of the serpentine, which forms a series of low hills.

In mineralogical character the serpentine does not appear to differ essentially from the other occurrences of the rock in the district. It varies in colour from dark green to a dull greenish-yellow, and from the weathered surfaces crystals of chromite sometimes stand out in relief.

The surface of much of the serpentine is entirely covered by a dense crust of residual limonite; a fact which led to the pegging of the whole outcrop in the boom days by inexperienced prospectors who thought the iron oxide to be the gossan of a large lode-formation.

Those creeks which have been worked have proved payable only within the boundaries of the serpentine itself or in the slate which is but a few chains distant from the serpentine.

The extraordinary feature of these "alluvial" deposits is the almost complete absence of "wash." The creeks have for the most part clean smooth beds, with occasional deposits of sedimentary material an inch or two in depth. The osmiridium is recovered by scraping up the bottoms of the creeks, which consist, as a rule, of soft decomposing serpentine. There are numerous limonite-stained crevices in the bottoms of the creeks, and these act as natural riffles and hold the osmiridium. Especial care is therefore taken to clean out these crevices.

In one place I was shown a couple of bags of tin ore which had been won while sluicing for osmiridium, but not removed on account of the difficulties of transport. This tin ore is doubtless the result of secondary concentration from the Pieman alluvial, which is near at hand, and which may even have extended over this locality before the drainage system acquired its present development.

The origin of the osmiridium is undoubtedly the serpentine rock, although no specimens attached to fragments of the rock have been seen. The mineral is probably disseminated throughout the body of the rock, and not restricted to veins, as most other metals are. The workable deposits, therefore, will only be alluvial deposits.

The other streams taking their rise in this serpentine are all worth examination for osmiridium.

In other parts of the field there are small quantities of the same mineral, but, with the exception of some said to be present in the Melba Flat, all the colours are derived from the old Pieman alluvial formation.

As regards any other contributing source than that body of serpentine mentioned above, the writer regards the broad dyke of serpentine which traverses the western flank of the Colebrook Ridge as the most likely. The streams which flow towards the Ring River are worth prospecting for osmiridium.

C.—IRON ORES.

There are some occurrences of the ores of iron which have been regarded by some as possible economic sources of iron.

The principal occurrences are classified here, since they are formed of residual limonite due to the weathering of ferriferous serpentine. The limonite forms only a superficial crust, and is not likely to prove of any commercial value.

It is best developed on the serpentine area near the junction of the Pieman and Huskisson Rivers which has just been mentioned, and on the southern slopes of Serpentine Hill, near the Argent tunnel.

At this latter place there are a number of fragments of columnar magnetite from the disintegration of veins in the serpentine. The veins are as much as a foot thick in places, if we may judge by these fragments, and in some cases the columns are curiously contorted. The specimens are of interest for the marked polarity which they display, but are not likely to prove of value.

The origin of this magnetite is to be explained by the transformation of a rock rich in ferrous compounds into serpentine.

The chromite in the Pieman alluvial and in all the creeks which flow away from the basic rocks is too small in amount to be of commercial importance.

One occurrence of iron ore on the eastern slope of the ridge running down from Pine Hill to the junction of the Ring River and Dalcoath Creek is probably to be classed as a gossan rather than a residual iron ore. A small gold content having been found in some of this ore, it has been proposed to work it for fluxing purposes.

(8)—SUMMARY OF THE GENESIS OF THE ORE-DEPOSITS.

At the close of the period here provisionally termed Cambro-Ordovician the site of the field was occupied by a great sedimentary series, of which the lower members were intruded by intrusive types, and the upper members interstratified with the effusive types of a rock which is usually a quartz porphyry or a felspar porphyry. The ore-deposits of the whole field were quite unknown.

Following upon the prolonged period of sedimentation, some great earth movement took place, and the sediments acquired a certain schistosity or slaty cleavage, while the igneous rocks were also rendered schistose and suffered an alteration and reconstruction of their constituent minerals

Into this complex, after some considerable interval of time which is not recorded in the formations of the field, there intruded a great igneous magma.

Whether the earth movements of prior date had caused any directions of crustal weakness by which the distribution of the igneous material was governed is not now certain. As far as the geological map can explain the structure, no such general directions of weakness can be detected for the earlier phases of the intrusion. There was an intrusion of molten material into the deeper portions of the earth's crust, and this material began to solidify in amorphous form. From the processes of consolidation resulted the basic rocks of the district in all their variety, and at this period the osmiridium first appeared in the district.

The mechanical stresses of intrusion, possibly aided by other stresses, seem to have caused a more or less regular fissuring of the central portion of the field, and a more irregular fracturing of the surrounding district. This fissuring was not utilized by the early magma itself save in one instance, where a long narrow dyke of gabbro was formed. But the fissures became of prime importance at a later date when they became filled first by the quartz porphyry and later by the ore-bodies of the field.

As solidification proceeded the magma appears to have altered very materially in composition, and finally a highly acidic type was evolved. This penetrated the deeper portions of the crust in the form of dykes of quartz porphyry and granite porphyry. And still the magmatic reservoir continued to differentiate until quartz, tourmaline, and sometimes tin ore were forced upwards. At about this time also the vein-forming solutions were given off, and they rose through the fissures mentioned above into regions of lower pressure and temperature, where their mineral contents were precipitated. The pressure must have been exceedingly great, even where ore-deposition took place, and the solutions probably forced apart the fissure-walls until free crystallization was possible. The internal evidence of the ore-bodies affords proof of this free crystallization, and the pressure conditions may be deduced.

For it is now known that certain lode-forming minerals are characteristic of certain zones of depth or types of veins.* Taking the vein-types of this field, it will be seen

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* *Vide* **W. Lindgren, "The Relation of Ore-deposition to Physical Conditions"—Economic Geology, Vol. II., 1907, pp. 105 *et seq*. Also, W. H. Emmons, "A Genetic Classification of Minerals"—Economic Geology, Vol. III., 1908, pp. 611 *et seq*.**

that the mineral groupings are characteristic of "contact metamorphic deposits," or the "deposits of the deep-vein zone."

With this period of ore-deposition, which eventuated in Devonian time, the genesis of the primary ore-bodies ceased.

No feature of importance to the economic side of the geology of the field was impressed upon the district until the agents of denudation had removed so much of the cover as to expose the deeply seated ore-deposits to surface weathering and degradation. Then the period of disintegration and redistribution of material began, and proceeded steadily until a matured river system—that of the old Pieman—was evolved; and deposition of the load of material gathered from the hills began. This proceeded for some considerable period, and the conditions were altered by an uplift of the western portion of Tasmania, whereby the river systems were revived. This latter period has lasted up to the present time, and during it the secondary ores have been formed and reconcentrations made of the contents of the older alluvial.

VI.—THE HISTORY OF MINING ON THE FIELD.

The mining history of the field dates back to about 1890, when many prospectors were traversing the district. During this earliest period of prospecting little, if any, thought was entertained of the possible presence of tin ore; and attention was given first of all to any gossanous outcrops which might, in the opinion of the prospectors, prove to be the cappings of silver-lead ores.

It is probable that some of the early workings, of which no history can now be obtained, belong to this period. Tunnels were driven for short distances, and then the sections were abandoned, for the silver contents of the gossans proved always low.

The tunnel driven into the Dreadnought Hill is an example of these workings which is notable, in that the rich tin-bearing lode-stuff was actually penetrated without its character being recognized.

The first actual discovery of tin ore on the field was made in June, 1890, when Mr. Ringrose Nicholson found tin ore in the Ring River, in the neighbourhood of its junction with Dalcoath Creek. This discovery was not followed by any active mining operations at the time, and little notice was taken of it until a temporary set-back in the Zeehan field caused a number of men to look for work which would tide over the bad times. Payable alluvial tin ore was then found, and the prospectors followed the course of Dalcoath Creek and Gormanston Creek up to Pine Hill. In the course of this prospecting the lode-formations on the Boulder Company's ground were found, and some work had been done on these at the time of publication of Mr. Montgomery's report in 1893.

The Gormanston boulders were discovered by Mr. T. Strong in November, 1893, but no rush resulted, as tin was at that time at a low price.

Between this period and that of Mr. Montgomery's later visit in 1895, the work of prospecting the lodes was restricted mainly to the ground now held by the Boulder Company and by Mr. A. D. Sligo.

The prospecting of the Renison Bell lease had been begun, but it does not seem to have been fully appreciated at that time that the gossan outcrops were the cappings of tin ore-bodies. In fact, the report of Mr. Montgomery includes a strong recommendation to the company to test the lode for tin and gold.

The next important step in the development of the field was the construction of the Emu Bay Railway, which was carried through in 1900, and a connection was thus made with both Zeehan and the remainder of the island.

The railway-line necessitated a large cutting on the Renison Bell lease, which actually penetrated the main lode-system on that property.

There was still little progress made in any part of the field, and little activity was displayed until, in October, 1905, the detrital tin deposits were first revealed by Mr. H. E. Evenden's discovery of payable ore on the Renison Bell lease.

This was the beginning of the present period of mining the surface of the pyritic floors.

The other end of the Renison Bell-Montana-Boulder lode-system (which at that time was only known in the Renison Bell ground) was found by Mr. A. Duncombe in the north-western portion of the Boulder Company's lease in May, 1906.

In view of these discoveries it seems remarkable that no attention had been paid to the gossan outcrop on the Dreadnought Hill. It remained for Mr. H. E. Evenden to recognize the possibilities of the gossan in February, 1908, and since that discovery the Dreadnought-Federal lode-system has been prospected at several points.

Still later, in 1908, tin ore was found near the Dundas town site by Messrs. P. Quinn and P. Hodge, who are now prospecting their discovery.

VII.—THE MINING PROPERTIES.

(1)—The Renison Bell Prospecting and Mining Company, No Liability.

The company's property consists of a number of smaller sections now united to form the consolidated lease, No. 3187-M, consisting of 181 acres in all; and a water-right, No. 408-W, for eleven heads of water in the Argent River.

This large lease lies mostly on the southern side of the Argent River, and comprises the summit and slopes of the Renison Bell Hill, which are steep, and are traversed by no streams of any importance.

The creek known as Porphyry Creek affords the small amount of water now used in the sluicing operations; but this small supply will prove quite inadequate when operations are being conducted on a larger scale, and the company must look elsewhere for a source of power and water. The Argent River, which runs through the northern portion of the property, will doubtless be drawn upon to supply the necessary water, but it is doubtful whether the remaining available water-rights on this river can supply the necessary power for a milling plant.

The rock-formations represented within the lease are members of the slate series, porphyroid, and sericitized and tourmalinized quartz porphyry.

The members of the slate series are broken up and folded by earth movements subsequent to their formation, and it is not possible to state an average value for their dip and strike. Adjacent blocks are found to dip in entirely different directions, and the railway-cuttings show that, in addition to the fracturing and dislocation of the sediments, there has been a gentle folding. Nevertheless there cannot be said to be any regular general folding into anticlinal and synclinal folds. One railway-cutting immediately to the west of the lease shows this structure, which is, in my opinion, a local, not a general, feature.

A well-defined fault is shown in the railway-cutting which has traversed the main lode-system, and the result of the faulting has been to lower the western portion of the country relatively to that on the eastern side of the fault. The amount of the movement is not to be ascertained, but it has sufficed to bring the conglomerate down on to the same level as the slate.

This fault-plane is itself important, in that the fault-breccia which marks its position has been impregnated by pyrites. It is this fault-breccia which has been called by the company the "cross lode." The capping and weathered portion are stanniferous, but whether tin ore is present in the railway-cutting seems to be unknown.

In my opinion this plane of dislocation is one of the "feeders" referred to above, and further work on the property may prove that the main lode which has been cut in the underground workings is one and the same with this "cross lode."

The property contains within its boundaries a number of lodes which at first sight appear to be separate bodies of ore. They are, however, to be more properly regarded as belonging to a smaller number of lode-systems which present a variety of structural detail.

These are here referred to as—(1) the low-level lode-system; (2) the "big blow" lode system; (3) the western lode; (4) the gossan outcrops north of the Argent River.

(1) The "low-level lode-system" is the title here applied to the lode-matter now being worked on the north-eastern slope of the Renison Bell Hill, the lodes which are exposed in the Emu Bay Railway cutting, and the lode-matter partly worked between the railway-line and the Argent River.

The underground workings at the river level are fully described in Mr. Twelvetrees' report on the property in the year 1906.

Briefly, they are as follow:—A drive has been carried southwards on the footwall of a gossan lode visible at the river bank, and crosscuts have been put out east and west.

The western crosscut met with nothing but country rock (soft slate), although there is a mass of dense gossan vertically above it. This gossan, called the "No. 1 lode," dips at a very flat angle to the east, and the western crosscut has been driven below the level of this flat lode.

The first eastern crosscut passed through two zones of lode-matter, the more westerly being an admixture of gossan and clay, the second a silicified slate carrying pyrrhotite.

The second eastern crosscut passed through both these formations. The gossanous one is contracted, but the hard siliceous lode is associated with a very broad belt of dolomite or ankerite, with which is associated a little pyrrhotite. This carbonate lode, is, as has been indicated above, apparently due to merely a local variation in the character of the mineral-bearing solutions at the time of the formation of the lodes. The normal pyritic body was cut through in the last few feet of this crosscut, and another small vein of dolomite found on the hanging-wall.

Driving was resumed in a south-easterly direction on the hanging-wall side of the lode. After driving for 60 feet in the hanging-wall a short crosscut has been put in to cut the lode, which carries both quartz and carbonates as gangue minerals at this point. The drive was carried another 60 feet and crosscuts driven towards the north-east and south-west. The latter cuts the continuation of the pyritic body already mentioned, and on passing through it a few odd splashes of galena associated with ankerite were met with.

The north-eastern crosscut was abandoned in very hard pyritiferous slate at a point 70 feet from the hanging-wall drive, when it had not been carried far enough to cut the massive pyritic lode exposed in the railway-cutting above this point.

These underground workings have not served to prove anything conclusive with regard to the main lode. It is to be regretted that the drive was not pushed forward in the lode itself, rather than in the country. The cost of working would have been greater, but the information to be obtained from a drive on the course of the lode would have more than compensated for the increase of expenditure. As it is, too little has been done to show the mode of distribution of the tin ore in the pyritic lode.

The railway-cutting, almost vertically above the most southerly portion of these underground workings, affords an excellent section of the lode-system. There exists to the eastward of the zone, partially exposed underground, a very dense pyritic body of the pyritic-cassiterite vein-type. This pyritic lode is 24 feet in width at the level of the rails, and on either side of it is a belt of altered and fissured slate impregnated with pyrites. The eastern zone of pyritic slate is some 11 feet wide, and the western 46 feet in width. It is this impregnated slate which shows the elaborate system of "floors" and "feeders" on a small scale with the same structure as the lode-system when viewed as a whole. The officers of the company have taken a sample over a width of 40 feet at this point (including the dense pyritic lode and the impregnated slate on either side of it), and I am informed that the sampling gave most encouraging results. Nevertheless, it would be unquestionably better to take a number of samples over shorter sections of the ore-body than to take a single bulk sample in the way that has been done.

The massive pyritic lode appears to be continuing downwards at the level of the rails, yet it does not reach the surface only a few feet above. It is capped with indurated pyritic slate similar to that occurring on either side of the pyritic body. No anxiety need be felt by the management at this failure on the part of the pyritic lode to reach the surface, for the lode is a "feeder" in the lode-system; and although the continuity of one member of the lode system may fail abruptly at a given point the continuity of the system as a whole must exist, even if the other portions of the system are not, in the present state of development of the mine, apparent.

The fault-fissure, which is filled with brecciated fragments of slate and impregnated with pyrites (the "cross-lode" referred to above), lies 128 feet to the west of the pyritic lode in the railway-cutting. It is 10 feet in width, and shows a notable development of quartz and pyrites on the footwall (western) side. The fault can be traced northwards from the railway-line for a distance of 100 feet on the surface, where its course is marked by an outcrop of quartz.

Southwards it cannot be followed with certainty, but may possibly be connected with the quartz veins to be seen on the crown of the ridge in the uppermost portion of the area stripped by sluicing operations. The strike of the fault-plane at the cutting is N. 45° W.

Tin ore can be seen in the weathered portion of the sandstone and conglomerate, which form a nearly horizontal series resting conformably on the slate on the western side of the fault-plane.

The ore is largely confined to "heads" or joint-planes, and on the whole is not abundant. Where unweathered, in the railway-cutting, the conglomerate is seen to be impregnated with pyrites and indurated by the introduction of silica; both the pyrites and silica having apparently been simultaneously introduced.

The rock weathers to a white friable sandstone or conglomerate, and this character has given to the formation as a whole the name of the "white lode." Below these layers of conglomerate and sandstone, and apparently conformable with them, the railway-cutting exposes the surface of a dense pyritic floor. Whether this pyrites carries tin or not is not known.

A little higher up the hill, above the railway-line, there have been put down a few shallow shafts, which met with a soft tin-bearing formation. This may be the result of weathering upon yet another member of the lode-system lying to the west of the "cross lode." The shafts were full of water during my visit, and could not be examined.

No pyrites is visible above the railway-line, but the cubical cavities in the weathered conglomerate prove beyond doubt its former presence there.

The pyritic "floor" of the railway-cutting is very probably connected with the "cross-lode" a few feet below the level of the rails, the fault-plane having been the channel by which the mineral-bearing solutions rose and spread out laterally to form the "floor."

These details yet remain to be proved, but there can be little doubt about the suggested relationship of the several members of the system referred to.

From the portion of the lode-system which lies between the railway-line and the river the detrital ore has been removed by sluicing.

There is yet another portion of the lode-system exposed at the surface on the western side of the "cross-lode." This is a dense gossan, which appears to constitute another flat floor, differing from the flat seam of pyrites in the railway-cutting in that it is completely oxidised. Its tin content, if any, is not known. The gossan junctions with the main lode near the mouth of the main river tunnel, and a little above that level.

The only other workings below the railway-line on the lode-system above described are situated near the mouth of the main adit.

A second short tunnel has been driven in a south-westerly direction. In the approach a vein of rich ore is said to have been passed through, and a winze put down here on the lode. This, however, has since been filled in. Although the tunnel is apparently on the line of the lode intersected in the main adit to the westward, no ore-body was encountered after that mentioned as being in the approach. The main lode-fissure may have bent abruptly, or it may have ceased abruptly in the manner described in another part of this report. It is also possible that a fault may have caused a dislocation, and that the northern portion of the lode has been moved a few feet to the westward.

A small open-cut has been started on the outcrop of the pyritic body at the river level, and from the gossan some 5 tons of tin ore have been obtained. This is the recovery from the friable portion of the lode only. Work at this point was not being carried on during my visit. So far only the oxidised portion has been worked, and a little pyrites is beginning to make its appearance in the face. The forkings from these workings show some rich specimen ore, but the heaps are of very uneven grade when examined as a whole.

During sluicing operations upon the ground lying between the railway-line and the Argent River a certain amount of waterworn alluvial material has been treated. This is a portion of the Argent River gravel, formed when that river was flowing at a higher level, and now left as a terrace upon the banks. The tin ore won at this place was darker in colour than that which has not been river-borne, and it was associated with chromite. Some boulders of lode-stuff (black cassiterite and quartz of splendid grade) were recovered, and have been stacked apart for later crushing.

With these boulders there were associated some boulders of tourmalinized quartz porphyry derived from the Penzance district, and both sets of boulders have undoubtedly a common origin. The chromite has been derived from the serpentine traversed by the Argent River in its upper portion, and under such circumstances its association with the tin ore is inevitable. Not being of local derivation, and the alluvial wash in which it occurs not being of any serious importance, the chromite cannot be regarded as an impurity of any material moment. As referred to elsewhere it is a very common associate of the tin ore in some of the secondary deposits in this district.

Above the railway-line, on the northern fall of the long spur of the Renison Bell Hill, the present workings of the company are situated. The lode-matter here cannot yet be connected with certainty with any of the occurrences already described, nor with the "big blow" to be mentioned later on. Yet it undoubtedly forms portion of the one belt of mineralization, in which the workings on the Boulder lease, those of Messrs. Duncombe and Maddox, and of the Montana Company are situated.

The present mining operations are restricted to the sluicing of the detrital material resulting from the superficial oxidation and partial disintegration of a lode which is essentially pyritic in character. The slate associated with the lode and lying above it also conforms to the general type found along the line of the lode-system. It carries veins of tin-bearing quartz, and cubical cavities formed by the oxidation and removal of pyrites crystals are always visible along the bedding-planes.

A tunnel has been driven into the side of the hill in a south-westerly direction for a distance of 67 feet, and passes obliquely through the pyrrhotite body, which dips at an angle of from 40° to 45° in a direction E. 30° N. The adit starts on the hanging-wall side of this lode, and at 31 feet from the mouth of the adit the pyritic ore passes out of the back of the drive. From this point onwards there appears on the walls of the drive only slate dipping E. 30° N. at 45°. In the face a few small seams of pyrites occur, crossing the bedding-planes or sometimes coinciding with them. These veins seem to me likely to belong to the casing of a more vertical body, which may have been the feeding-fissure whereby the stanniferous ore has been introduced to the lode which is being worked.

The material now being sluiced is merely the surface portion of this lode lying between the thin cover of vegetable soil and the non-disintegrated lode-stuff below. The depth of the detritus may be estimated at an average of about 6 feet over the area already worked. It becomes as much as 9 feet in some places, and only 3 feet in others.

The depth of the ground sluiced away varies in a very irregular manner, except at one place where a very hard ridge occurs, running in a north-west—south-easterly direction. This may possibly be the outcrop of a more vertical lode, and possibly identical with the one beginning to show in the face of the tunnel below.

The detrital ore varies considerably in appearance, and must necessarily do so, since the composition of the lode, in its unaltered condition, is variable. The original proportion of the pyrrhotite to the quartz very largely determines the physical character of the oxidised lode-stuff. There is no doubt whatever but that this detrital ore has been pyritic in character. There are a few patches of a dense aggregate of quartz and cassiterite, which cannot have contained much pyrites in the unweathered condition, but the bulk of this class of ore is here, as elsewhere on the field, small in proportion to that of the pyritic ore.

In addition to the sluicing of the surface, a trench has been carried up the face of the hill for 150 feet. It is located above the tunnel, and has been cut down to the pyritic floor.

In all, about half an acre has already been sluiced, and from the results of the prospecting holes which have been put down on the slope of the hill it is estimated that about two acres of payable ground remain to be sluiced. Very little work, indeed, has been done to prove the south-eastern extension of the lode-system. What little prospecting has been done is sufficient to prove conclusively that there is a continuation of the pyritic lode-matter towards the Montana ground. Whether this lode-matter contains tin ore in payable quantities remains to be proved.

Near the south-western corner of Section 1215-M a shaft has been sunk some 20 feet, and a short drive carried for 16 feet in a south-westerly direction. The shaft was full of water at the time of my visit. It is stated that some flat seams of gossan were met with in the slate penetrated by the shaft, and the drive went in under the gossan.

Some trenching has been done, and a shaft has been sunk 16 feet near the north-western corner of the Montana section, and this work serves to prove the continuity of the lode-system to the boundary of the lease. The lode-matter is known to carry a certain amount of tin ore.

Some prospecting holes have been put in on the hillside below this formation, and are stated to have afforded encouraging returns. It is estimated by the management that there exists here half an acre of detrital lode-matter which will pay for sluicing.

2. The "big blow" lode-system.—Next to the lode-system already described, the most important ore-body is that known as the "big blow." This name has been given to a dense gossan consisting mainly of limonite, but with a certain amount of quartz in addition. The lode dips at a flat angle towards the south-east, and the strike of the main portions of the ore-body is north-east and south-west. The outcrop curves with the spur of the Renison Bell Hill. The total distance over which the lode outcrop may be traced is 358 feet, measured in a direction approximately north-east and south-west; but the lode is not continuous over this distance. The most southerly portion extends for 85 feet towards the north-east and then terminates abruptly, having been cut off by a fault. Between this point and the spot where the outcrop again continues in a north-easterly direction there is a break of 130 feet. Within the limits of this break there is an isolated patch of gossan outcropping.

The strike-lines of the fault which have dislocated the main lode are not yet to be determined. The strike of the main lode cannot be exactly stated. The lode seems to be dipping towards the south-east at the southern end of the outcrop, while the dip approaches more nearly to the eastward at the northern end of the outcrop. Yet the isolated patch of gossan, occupying a position at the south end of the gap in the main outcrop, is dipping towards the south. The explanation of this change of dip cannot be given until there is more work done upon the property and the course of the faults becomes known.

Beyond the break mentioned the main outcrop continues without interruption for 143 feet, and then terminates abruptly as if cut off by yet another cross-fault.

No accurate idea of the width of the lode can be obtained from the outcrop, for it apparently dips at a flat angle, and the irregularities of the ground surface consequently have a considerable effect in determining the width of the outcrop.

Some surface work has been done upon this gossan with a view to the determination of its tin contents, and a number of sample holes have been put in along the whole length of the lode. These holes have been bored as "half-uppers" in the footwall side of the lode, and the returns from the assay of these borings indicate that the lode is one of great possibilities.

Some underground work has been done to try and obtain some further information concerning this lode, but so far the workings are too insufficiently advanced to afford any definite figures as to the strike, width, dip, or value of the lode.

The main adit starts in country, and bifurcates at a point a few feet in. From the more westerly drive a rise was put up to the surface, and a crosscut carried eastwards to meet the other arm of the main drive. At the point where this crosscut meets the drive the northern limit of the lode is clearly seen.

The drive is continued for some distance on the lode, which is still completely oxidised, and gradually passes out into the footwall of the lode. A rise has been carried right through to the surface and penetrates this lode, emerging at the surface at a point 86 feet above the level of the drive. It is difficult to determine satisfactorily the real thickness of the lode passed through by this rise. There were no ladders in the rise, and from the examination which was possible from a bucket it appeared that the footwall of the lode was passed at 43 feet from the surface, and that the gossan continued from that point to within 18 feet of the surface. Thus the rise was for 25 feet in gossan, but this is not the true width, inasmuch as the rise and the lode are both inclined in the same direction, and the lode has therefore been intersected at an angle.

Some short crosscuts have been put in from the main drive towards the east, and indicate the presence of a sulphide lode of the normal pyritic-cassiterite type. The slate in the end of the drive is mineralized, and the ore-body appears to be making in the last few feet of the drive.

This pyritic body appears to be distinct from that lode which is called the "big blow." It seems to be much more nearly vertical, and may possibly be connected with an outcrop of gossan which extends southwards up the hill for some distance. If this proves to be the case, the "big blow" lode will probably unite with the pyritic body along a line not yet exposed underground, but not far from the position of the main drive. Mention has been made above of these branching lode-systems, and this system appears to be likely to offer a clue to the structure of others, since in this case the tin content offers every inducement to the company to develop the lode. Moreover, should the "big blow" lode prove to be the offshoot or branch of a more nearly vertical body there will be every reason to look to the vertical pyritic lode as a productive source of tin ore. It is reported that excellent values have been obtained from samples taken from the pyritic lode-stuff.

On what is probably this same lode a short tunnel was started at a point slightly to the east of the main adit, but the workings have collapsed.

Higher up the hill a little work has been done on the gossan outcrop referred to above as being the possible outcrop of the pyritic lode in the tunnel. The outcrop has been bored and samples taken, but nothing beyond this has been done.

The gossan has become more and more siliceous as the summit of the hill is approached, and the lode merges finally into a belt of indurated slate. This lode, if it does prove to carry tin ore in payable quantities, and supposing it to be identical with the pyritic formation in the underground workings at the "big blow," will be an extremely valuable asset to the company, for some 300 feet of the backs could be obtained at the southern end by working it from the level of the tunnel at the "big blow."

No time should be lost by the company in pushing on the development of this portion of the property. Until this is done no definite statement can be made as to the quantities of ore, nor any accurate knowledge be gained of the structure of the lode-system. It must be remembered that the above account is no more than a description of the probable relationship of certain bodies of ore which are not yet positively known to be connected.

There are some other outcrops on the upper portion of the hill which may be connected with the same lode-system.

To the east of the long gossan outcrop mentioned above some trenching has been done for a distance of 5 chains in an east and west direction. Some further gossan has been disclosed by this work, and outcrops here and there all along the trench. A little tin ore is known to exist in the surface-soil immediately below this formation, but not in payable quantities. The strike and dip of the lode cannot yet be determined.

Still further south, and near the top of the hill, there is a small open cut, which has exposed a pyritic lode carrying galena, zinc-blende, and siderite. A little tin ore is said to have been obtained from a soft "dig" running down alongside the formation.

3. The "western lode" is a massive outcrop of gossan outcropping on the western bank of Porphyry Creek, and coursing in a direction bearing north-west and south-east. It is distinct from any ore-body referred to above. Practically nothing, beyond the driving of a short tunnel at the northern extremity of the outcrop, has been done on this lode. It is said to be tin-bearing. As in other cases, there has not been sufficient work done for the structure or true thickness to be ascertained. The lode appears to be dipping in a south-westerly direction at a flat angle. The outcrop is of such a size that it merits more attention than it has received up to the present.

Still further to the west of this point a trench has been excavated many years ago, but no record has been kept of the results obtained. There is some gossan exposed, and this is said to give a little tin on being crushed and vanned.

4. The gossan outcrops on the northern bank of the Argent River form, in all probability, part of the continuation of the lode-system described above as the "low-level system."

Two short drives have been put into the face of the hill, and show a lode-matter consisting of gossan and irregular masses of ankerite and dolomite. From the more westerly of these workings tin ore has been obtained.

Opposite the main river adit the river gravel has been cemented by native copper, and stains of secondary copper ores appear on the face of the slate underlying the wash. The origin of this material has been indicated elsewhere in this report.

Near this place pyrites can be seen in the bed of the river.

Ascending the hill towards the north-western corner of the property there are some further outcrops of gossanous material upon which some trenching has been done; and right on the corner of the section a dense outcrop is visible. This can be traced for some distance to the north-west, and is dealt with elsewhere.

The structure of the lode-system in this corner of the property will be better understood when further work has been done on the southern lodes, and the work of prospecting will thus be rendered less arduous and costly.

The present mining operations are confined to the sluicing of the detrital lode-stuff which forms the capping of the main lode-system, and the area being worked is situated on the north-eastern slope of the Renison Bell Hill.

The methods of sluicing do not differ materially from those followed in other portions of the field.

The detrital material is broken down with a pick and sluiced downhill. About one head of water is being used, being obtained from Porphyry Creek. The heaviest of the non-disintegrated lode-matter is removed in the face. The rest passes over a hopper plate, which removes all stone of a diameter more than three-quarters of an inch. Below this hopper plate is a box-race, some 3 chains in length. The first two chains are 1 foot in width, and the lower chain 2 feet. The material, after passing through the race, runs over a screen, in which the holes measure 4 millimetres in diameter. The oversize passes to waste. The fines go to a wide box, 16 feet by 8 feet, with a fall of 4 inches in the 16 feet, and the fine tin is recovered here. The tails from this box pass to the tailings dam, where they are being stacked for mechanical treatment at some future period.

The work done with this crude plant is excellent, and all the more creditable in view of the extremely fine state of division of a large proportion of the tin ore.

There is nevertheless no doubt but that by mechanical concentration it would be possible to effect a greater saving of tin ore, and an economy of labour.

The company are at the present time making arrangements to instal crushing and concentrating machinery on the mine, and are wise in pushing on with this work at once.

A milling plant, working continuously and dealing finally with the ore as it is mined, will effect a great saving in handling alone, whereas the present practice of stacking forkings and tailings is steadily increasing future costs.

As regards the ore which the mill will treat, there already exists a certain amount of material already wholly or almost wholly exposed.

The tin-bearing gossan won from the open-cut near the mouth of the main river-tunnel, the forkings and screenings can be dealt with at once. Then there is a quantity of thoroughly oxidised lode-stuff remaining *in sitû* at the surface on the slopes which have been sluiced.

Better values are reported to be obtained from the coarser forkings than from the finer screenings. The reason of this appears to the writer to be that the tin ore is very largely restricted to the veins which pass out of the pyritic ore-body into the slates overlying it, rather than scattered through the altered slate itself. For the forkings show a greater proportion of vein-matter to altered country than do the screenings.

Besides the ore mentioned above there is every reason to expect that free milling ore will be derived from the "big blow." In fact, the sampling of a portion of this lode has given such encouraging returns that it may confidently be regarded as a most valuable asset. Moreover, it is so situated that the ore can be easily won and transported to the mill.

In view of the early erection of milling machinery this lode should be fully opened up at once and thoroughly sampled.

In addition to this oxidised lode there will probably be some more gossanous lode-matter to be won from the upper portion of the pyritic lode between the railway-line and the Argent River. This could easily be mined by means of an open cut.

Also, when a mill has been erected it may possibly prove profitable to mill the whole of the oxidised lode-matter which overlies the main lode-system. At the present time, since sluicing alone is possible, there has been no attempt made to estimate the tin contents of the lode-matter as a whole. Prospecting holes have been sunk at more or less regular intervals, and the grade of the ground has been judged solely from the dish assays made for tin recoverable by sluicing. These have not taken into account the tin content of the non-disintegrated lode-stuff. There may be as much tin ore contained in the lode-matter in some holes which have given poor results for mechanically-free cassiterite as in other holes which have yielded high returns. This question should be gone into without delay, as it will have a very practical bearing upon the future working of the mine. That is to say, careful assays should be made of the whole of the lode-material, whether compact or in a state of partial or complete disintegration. The area to be tested in this way is that belt or zone already referred to as the main or low-level lode-system passing through the north-eastern portion of the lease in a direction approximately north-west and south-east. Its full limits cannot be said to have been yet defined. The present working face is within this zone, and the work of testing the whole surface lode-stuff might well proceed outwards from the present workings.

Beyond these more obvious assets the company should look to other possible sources of ore.

Reference has already been made to the necessity for investigating the pyritic lode encountered underground in the "big blow" workings. For it must be remembered that the oxidised ore cannot be expected to last for an indefinite period; the sulphidic ore must be worked in the future and the development of the lodes which are not in the oxidised condition should proceed steadily, while the free milling ore is being mined.

Again, from the structural features presented by the portions of the main lode-system exposed at the surface, and the general conclusions arrived at by the writer after studying the lodes on this mine and those on adjacent properties, it is considered possible that there may perhaps exist other bodies of ore not yet exposed to view. This question of the lateral and vertical extension of the lode-system is treated of in another part of this report.

Whether or not these ore-bodies will turn out to be sufficiently rich in tin ore to be payable cannot, of course, be told. Practically nothing has been done on the exposed pyritic lodes in the way of systematic sampling.

The irregular distribution of the tin ore in the pyritic-cassiterite lode-matter renders it more necessary to carry on more extensive prospecting operations than would otherwise be required; but the large extent of ground covered by the lode-system, and the encouraging results already obtained from the surface workings, should offer sufficient incentive to the company to push on energetically with the work of prospecting. For the present this work should be restricted to the opening-up of the "big blow" and the prospecting of the "low-level" lode-system in the vicinity of the area already sluiced.

Arguments are given elsewhere to indicate the probable future value of the pyritic floor, at present practically untouched. This should be carefully sampled, and full records retained for future use.

The sampling of the gossans should be very carefully carried out in the way indicated above.

In conclusion, the property of the company is one of great potentialities, for there are at least two lode-systems within its boundaries, each of which has great possibilities. Beyond this statement little can be said, on account of the backward state of development of the mine.

However, there appears to be a period of much greater activity now at hand, and much more information should shortly be available, if the work is carried on with the fixed intention of accumulating such data with regard to the lodes as will be of permanent value. In particular, it will be necessary to open up the lodes themselves, since drives in the country rock are at present of very little, if any, value. Information is not yet to be acquired from neighbouring mines, and the pioneer work in lode-mining must be done by this company.

The output of tin ore from the mine up to June 30, 1908, has been 57 tons 9 cwts. 2 qrs. 14 lbs., of which the assay value averaged 72.7 per cent. metallic tin.

The gross value of this ore is about £6725.

I am indebted to the management of the company for the figures regarding the quantity of ore produced and the assay value thereof.

(2)—Montana Tin Prospecting Syndicate, No Liability.

The company holds one section, No. 1342-m, 78 acres, together with the water-rights for 7 heads of water.

The section is situated to the eastward of the Renison Bell Hill, and includes portion of the lower slopes of that hill. The water-supply is brought on to the section by a long race running round the Renison Bell Hill, and extending southwards along the western slopes of the Commonwealth Hill.

The water-race intersects the quartz porphyry, porphyroid, and gabbro dykes, but is for the most part in slate country.

The members of the slate series are the principal rock-types present in the mineral section, but a quartz-porphyry dyke is visible in the south-eastern corner of the section. The long dyke of diabase traverses the section diagonally, but is not visible near the northern boundary. In the place where the outcrop might be expected to be visible the members of the slate series are coloured a deep red. This may be due to the development of haematite by the intrusion, but it is a very local phenomenon, and was not observed elsewhere.

The occurrences of ore which are being worked by the company are situated within the lode-system, which has been here called the Renison Bell-Montana-Boulder lode-system.

This lode-system traverses the section diagonally, and has been worked in the northern and southern portions of the section.

The northern workings are situated on the northern fall of the saddle which connects the Dreadnought Hill with Renison Bell Hill.

The hillside is very steep, and there is very little accumulated detrital matter on the lower slopes, but on the ridge and upper slopes the tin-bearing detritus is 6 feet or more in depth. This surface material has been sluiced off the upper slopes, and laid bare two very distinct "floors" of almost completely oxidised ore, on the spur between the two branches of Renison Bell Creek.

These two floors are about 12 feet apart, and exhibit the structure of the system more fully than any other point throughout its length.

The "floors" conform closely to the dip and strike of the bedding-planes of the slate, which is here considerably disturbed, but of which the prevailing dip appears to be to the north at a very flat angle. They are connected by smaller bands of siliceous gossan, more or less vertical in position, and carrying tin ore.

The slate country also carries veinlets of tin-bearing quartz, and has been impregnated with pyrites, which has since weathered out and left cubical cavities.

The ore in the "floors" is said to have been the richest in cassiterite. It consists largely of a friable aggregate of acicular quartz crystals, but in parts is more compact. These denser patches of stanniferous quartz have been forked out of the races, and are stacked apart for future treatment.

The more compact portions come from exactly the same type of lode-stuff, and have remained massive on account of the higher proportion of quartz in those particular portions of the vein-filling from which they are derived.

There is a little pyrite showing in the deeper portions of the open cut, but the greater part has been removed by surface waters.

The portion of the lode-system which has been worked at this point is bounded on the south-west by a fault-plane which itself has been mineralized. The fault strikes in a direction bearing N. 43° W., and dips to the north-east at a steep angle.

This fault-fissure has very probably been the main feeding fissure of this portion of the lode-system, and in this respect appears to play the same part as the "cross lode" on the Renison Bell lease referred to above.

The two "floors" referred to above may be found to extend no further to the south-west at this particular point, but the lode-system, when viewed as a whole, does not cease with the fault-plane.

The section in the railway-cutting on the Renison Bell lease shows similar features in many respects, and both occurrences show the similarity between the structure of the complex lode-system and that of the branching lodes.

Work has been carried on in two benches, and at the time of my visit work was proceeding in the lower bench. This lower floor has a thickness of about 4 feet, and is 12 feet below the upper one. The bottom of the cut, therefore, has reached a point nearly 20 feet below the surface, and the sulphidic ore is beginning to make its appearance. As work is carried into the hill more pyrites will probably be encountered, since the unoxidised lode-matter will be found to belong to the pyritic-cassiterite type.

From these workings some 29 tons of tin ore have been recovered.

The eastward continuation of the portion of the lode-system, which has been worked at this point, lies just across the northern boundary-line of the Montana Company's lease, and has been worked in Section 1215-M.

There has been a little work done to the south-west of the principal northern workings at a point across the western branch of the Renison Bell Creek. This place is known as "Campbell's face," and has produced nearly 3 tons of tin ore. The ore at this point has the appearance of being very much more siliceous than usual, but it is difficult to pronounce a definite judgment until further work has been carried out.

Higher up the hill, and to the southward of this place, a pyritic lode has been exposed in a north-and-south trench. The slate above it is silicified. It carries some very good ore, which is high in silica. Some pyrite has been present even in that ore which is now free from it, but the proportion cannot ever have been high in some of the ore. The locality is worthy of much more attention being paid to it, especially as the ore promises to be more easily treated than the average pyritic vein-stuff. A few bags of tin ore were recovered during the excavation of the trench at this spot.

On the southern slope of the saddle between the Dreadnought and Renison Bell Hills a start was being made by the company to open up that portion of the lode-system at the time of my visit. Prospecting holes had been sunk, and had proved the depth of the detrital matter to be between 16 feet at the top of the hill and 3 feet as the lower slopes are reached. The grade of this deposit had not been determined, except by these prospecting holes, when my examination was made, but it was estimated by the management that at least an acre would pay for sluicing.

Still further south in this section the most important and productive workings are situated. A long spur from the Renison Bell Hill runs down to the creek, and the workings are situated on the eastern slopes of this spur. The ground was first opened up by a party of tributors, who, after sluicing away the surface detrital ore, came upon a gossan body. This was followed down, since the lode-matter was of a friable character, and a cutting was made in the hill slope to carry the tail-race. The open cut on the lode was 100 feet long, 5 feet wide, and 16 feet in depth when I last visited the property, and the lode seemed to be strong in the bottom. It is of a very thoroughly oxidised character, and was originally rather poorer in quartz than the average lodes of the pyritic-cassiterite type. Very little trace of pyrites remains, except on the western wall of the lode. The walls are of slate, which has been silicified, and carries numerous veinlets of tin-bearing quartz.

This gossan belongs, in my opinion, to the lode-system, and constitutes one of the "feeders" or more vertical components. It is remarkable both for its size and for the tin content, for the tin ore throughout the lode-system appears to be most abundant in the "floors," and the "feeders" are seldom of such size as this one. There appeared to me to be a flat pyritic vein running into the hillside on the top or south-western side of the open cut. Above this pyrites the slate and grit are impregnated with pyrites right up to the dam near the southern boundary-line of the section. At this latter spot a massive gossan formation exists. It is reported to carry good tin values, but has not yet been opened up.

The lode-matter continues to the northward and eastward of the main open cut on the gossan "feeder," and during my visit a commencement was being made to open up this area on the surface. Some gossan was encountered at two places, but insufficient work had been done to enable its structure to be determined.

A tail-race which was cut in the vicinity of the Government track revealed some highly payable ground, which can easily be opened up and worked. There is an outcrop of gossan which must belong to the general system, but so far it is only partially exposed. Some coarse-grained galena was found at this point, but did not appear to me to be of local derivation. It has very probably come from some portion of the stanniferous lode-system, for there are numerous occurrences of galena and blende within the limits of the lode-system which are regarded by me as local variations from the normal stanniferous type rather than as separate lodes.

The surface of the hill slope is known to be tin-bearing right up to the southern boundary of the section.

Thus far work has been almost wholly restricted to the higher ground; yet in the creek, not far from the south-eastern corner of the section, a pyritic mass has been exposed. The lode-system certainly extends across the creek in this part of the section, and has been worked on a small scale in the adjoining Section 1273-M.

The property has not yet been shown to contain any deposits of ore other than those which belong to the Renison Bell-Montana-Boulder system; yet this latter complex formation extends over about half of the section.

The future of the area will depend on the results of the deeper development work. Two points appear to be most favourable for the testing of the lode-system in depth—one where the gossan feeder is being worked, and one near the northern boundary of the section. Of these, the former appears to me the preferable site, for there seems to be a greater proportion of tin ore present in the lode-matter which is still *in sitû*. It is difficult to pick the exact spot from which the deeper development should proceed for reasons which have been given in the general portion of this report. If the large gossanous "feeder" be followed downwards by a shaft on the lode valuable information should be obtained.

During the deep-level prospecting it must be borne in mind that the lode-system comprises both vertical and horizontal members, so that workings in two directions at least are necessary for the location of bodies of ore. The "floors" can be located by means of shafts or rises, but the "feeders" can only be found by crosscutting.

In the event of the deeper workings proving the presence of payable lode-matter, the prospects of the section will be excellent. At present only surface detrital material and the oxidised portions of the lode-system are visible, yet, as has been indicated above, it is improbable that there has been any material concentration of tin ore in this oxidised lode-matter. It is therefore well worthy of attention by the company. Unless this prospecting of the lodes is pushed forward rapidly the life of the section cannot be a long one.

There have been stacked some heaps of the forkings from the sluiced faces which will provide a certain amount of ore for future crushing, but these forkings by themselves are far from sufficient to justify the erection of crushing machinery.

The general methods of mining and concentration on this section are very similar to those already described with regard to the Renison Bell workings. Greater care has, however, been taken over the concentration of the slimes which are allowed to settle in pits. The settled product is run through the boxes with a small supply of clean water. By these means there have been effected both a saving in the amount of tin ore treated and an improvement in the grade of the ore.

The ore sent out has been dressed by these simple appliances till the percentage of metallic tin is 74·7. As a rule, the coarser-grained tin ore is of slightly better grade than the slimes.

The first ore produced from the section was sent to market in April, 1907. Between that date and February 9, 1909, a total weight of 88 tons 8 cwts. of tin ore have been sent out.

The gross value of this ore is about £9500.

(3)—A. B. Duncombe and A. Maddox's Section.

The section held by Messrs. Duncombe and Maddox is that numbered 1963-M, and comprises 80 acres.

With the section is held a water-right, number 674-W, for 2 heads of water.

The section is situated at the base of the Renison Bell Hill, and comprises the south-eastern spur of that hill. The water-race follows the eastern flanks of the Renison Bell and adjoining hills, and picks up the water from the head of the Dalcoath Creek, which takes its rise on the Commonwealth Hill.

The greater part of the section is occupied by slate, which is traversed by two dykes of quartz porphyry. These latter are to be seen in the north-east and south-western corners of the section, and in the very north-eastern angle the dyke of diabase crosses the creek.

There are three occurrences of lode-matter within the limits of the section, and of these the most important is that which belongs to the great lode-system which has been dealt with above in the reports on the Renison Bell and Montana properties.

The workings are restricted to the disintegrated portions of this latter lode-matter which occupies the north-eastern corner of the section, 2 to 3 chains distant from the south-eastern corner of the Montana section.

In the lower ground which has been worked the tin ore is said to have been in part rounded, but in my opinion it has not travelled any considerable distance. Some of the nuggets of tin ore from this place are clearly derived from the formation higher up the hill. They are aggregates of exceedingly fine-grained tin ore, and are very pale in colour. A few specimens from this place exhibit a yellowish tinge, but most are pale grey. With them were found fragments of lode-stuff containing black tin ore in a crystalline quartz matrix, derived from the veins which are mentioned below.

On following this detrital ore up the spur towards the westward the surface of a much-altered dyke of quartz porphyry was found. This dyke is from 2 to 3 feet in width, and traverses the whole width of the working face in a direction bearing 152°, and it dips to the east. In one place the dyke has split, and the two branches have rejoined, enclosing a "horse" of slate. It is hard to recognize this porphyry at first, since the most completely weathered portion appears to have a cleavage. This apparent cleavage is, I think, due to the influence of weathering upon the contraction-joints formed during the cooling of the rock.

In the dyke itself there is not known to be tin ore, but it is charged with pyrites, and, since the pyrite was introduced by the stanniferous solutions, it is worth while to try the dyke itself. This is more especially necessary at this point because the dyke is actually within the limits of the lode-system, and the mineral-bearing solutions have the power of altering rocks of this character very considerably and of replacing non-metallic minerals by metallic ones.

It has been said that this dyke formed the limit of the ore-body on the east, but the statement does not hold true for the whole length of the portion of the lode-system exposed by the sluicing operations, for the lode-matter extends across the Government track in the direction of the Boulder workings. The lode-system may extend a little further to the south on the western side of the dyke, but the latter does not appear to me likely to have exercised any great control over the distribution of the lode-forming solutions.

The sluicing away of the detrital matter lying upon part of the lode-system is all that had been done at the time of my visit. About half an acre had then been stripped to an average depth of 2 feet 6 inches.

The lode-stuff still left *in sitû* when the disintegrated portion has been removed by sluicing presents a rather different appearance from that shown by most of the other outcrops situated within the limits of the lode-system.

At the time of my visit no main "floor" nor any "feeder" was visible. The area is traversed by a very large number of smaller veins, which possess no constant direction of strike or dip.

These veins are thoroughly oxidised, and consist of the aggregate of crystalline quartz and granular grey tin ore which is commonly seen in the completely weathered veins of the pyritic-cassiterite type in this district. These veinlets are on this section much richer in tin ore than any others which I saw elsewhere on the field.

Between the several veinlets the slate blocks are displaced relatively to each other. There appeared to me to be a tendency for these slate masses to dip in a direction bearing a few degrees east of north; but the whole area has been much disturbed by earth-fracturing.

The slate has suffered impregnation along the bedding-planes between the veins, and this impregnation has taken place along the coarser, and therefore more porous, bands. Along these bands the outward and visible sign of the impregnation is the presence of cubical cavities after pyrite. When examined microscopically needles of tourmaline can be seen to have been introduced into the pyritiferous zones. From some portions of this impregnated slate, after crushing and vanning a sample, fine tin ore can be obtained.

Very few signs of the presence of other lode-matter than that mentioned were visible at the time of my examination At one point in the upper portion of the workings a little dense limonite was visible. This represents undoubtedly the result of oxidation upon pyritic lode-stuff; and at this place there has obviously been some material removed in solution, for the ground is cavernous, and the water used in sluicing was found to escape by some underground channel.

The chief difficulty with regard to the lode system at this place is to determine satisfactorily the structural details. It seems to me that the zone of slate traversed by the tin-bearing veinlets may be either—(1) A shattered zone wherein the fracturing has been much more complicated than usual, so that the numerous small fractures represent collectively the same displacement as one or two "floors" and "feeders"; or (2) the fringe of a system of "floors" and "feeders" of the usual type, the impregnated zone being simply that portion of the system which lies upon a "floor" of ore not yet exposed.

Since leaving the field I have been informed that a flat formation has been partly opened up, but no speculation as to the structure can be framed in the absence of personal examination.

The general direction of elongation of the lode-formation is towards the southern workings on the Montana section, but the limits of the lode-system have not yet been fully marked out.

On the spur above the main working-face some vein-matter consisting of crystalline quartz and black tin ore is exposed in a head-race. This is similar in character to that which has been exposed in a trench on the Montana Company's ground and referred to above.

It is also similar in character to some of the quartzose ore of the Pine Hill area; but until further work has been done it is impossible to say definitely whether this vein-matter belongs to a later period of vein-filling than that of the formation of the main lode-system, or to the same, or even an earlier, period.

As regards the prospecting of this portion of the section the owners must be guided by the structure of the lode-system indicated by the most recent developments. If there are present the "floors" which are so characteristic of the whole length of the formation it is clear that a low-level tunnel may prove insufficient to reveal the presence of any appreciable amount of ore, for the tunnel may start below a floor and continue for a considerable distance in country. Such a tunnel, of course, should be reasonably expected to intersect any more vertical "feeders" that may be present, but it only occasionally happens that these "feeders" assume any considerable dimensions. On the other hand, a shaft sunk would be the best way of prospecting for concealed "floors," but would be useless for the detection of the "feeders."

When prospecting at a depth is undertaken at this place another matter must be borne in mind. The ore occurs here in the shattered slate, and may not be restricted to the main "floors" or "feeders" at a depth any more than it is on the surface. Hence the zones of impregnated slate, which will certainly be pyritic in depth, must be prospected as well as the more compact bodies of ore.

The detrital ore is worked in the usual way. The timber is first cleared and the surface vegetable soil burnt and stripped. The friable portion of the lode-matter is sluiced to boxes. The larger fragments of the lode-matter are forked out and stacked on the worked ground. There are 30 feet of boxes, 16 inches wide. Thence the ore passes over a screen with slots measuring $\frac{1}{32} \times \frac{1}{2}$ inch. The oversize passes to waste. The fines go to the second set of boxes, 24 feet long and 18 inches wide. The overflow passes to a dam, where the fine tin ore has time to settle.

Near the north-western boundary, and close beside the water-race, there are two outcrops of gossan, 80 feet apart. One has had a few shots put in it. No tin ore is visible, and no assay has been made of the gossan.

It is possible that there may be some connection between this outcrop and that which lies to the northward of it, on the northern spur of the Renison Bell Hill.

The only other lode-matter known on this lease is situated on the southern boundary-line where the Dalcoath Creek crosses that line. The lode-matter is a mixture of quartz, siderite, pyrite, and blende. It does not appear to me likely that this lode will prove of commercial value, for it is entirely similar to a number of small veins of galena—blende sporadically distributed through the field, and seldom showing any continuity.

The prospects of the section will therefore depend upon the manner in which the lode-system in the north-eastern corner opens up. At present there is still some detrital material in sight which can be sluiced. Much, also, of the lode-matter which remained *in sitû* will make excellent battery stone. Still, it cannot be claimed that enough ore of an oxidized character (and therefore free-milling) has been proved to justify the erection of a milling-plant for this property alone.

The oxidized ore still *in sitû* and the forkings already stacked would not last long. The depth of the zone of oxidation has not yet been determined. When once it is passed all the ore will be of a pyritic character.

The proportion of tin ore in the veinlets which traverse the slate is such that every inducement is given to prospect the lode-system at a depth.

The output from the section up to December, 1908, has been 21 tons 16 cwts. of tin ore.

This ore has been all won from the north-eastern corner, and represents a gross value of about £2300.

The average assay value of the dressed tin ore is stated to be 70 per cent.

(4)—The Boulder Tin Mining Company, No Liability.

There are two mineral sections held by the company—No. 271-m (77 acres) and No. 5101-93m (80 acres).

The northern section (271-m) is situated at the meeting-place of the principal streams of the district, and contains only the lower slopes of Stebbins, Renison Bell, and Commonwealth Hills, and of the high spur which runs down from Pine Hill between the Ring River and Gormanston Creek.

The topography of a large portion of the section is shown in the photograph reproduced in this report, and it will be seen that the section occupies the principal depression between the hills mentioned.

The southern section (5101-93m) occupies the northern slopes of the Commonwealth Hill.

The geological structure of the northern section is simple. It consists of slate, which is traversed by a single dyke of diabase in a direction about north-west and south-east. The dyke does not cause any notable modification, either of structure or composition, in the slate, and is of the same character throughout. It follows a somewhat curved path across the section, and splits at one place near the battery site.

Above the confluence of the Dalcoath and Gormanston Creeks there is a small area covered with alluvial material, below which a slate bottom is visible along the creek bed.

The southern section is for the most part slate, which is traversed by a broad dyke of gabbro-amphibolite. The long narrow dyke of quartz porphyry which crosses the Renison Bell Hill traverses the south-western corner of the section, and another dyke of similar material intersects the gabbro in Dead Man's Creek. The south-eastern corner is on a belt of clastoporphyroid.

The principal occurrences of lode-matter on the sections are situated in the north-western portion of the northern section, on the boundary between the two sections and on the course of the Dalcoath Creek.

From the accompanying geological map it will be seen that the lode-system which extends from the Renison Bell lease through the Montana section is continuous as far as the north-western portion of Section 271-M, and at this place the present workings of the company are situated.

The detrital ore occurring at this place was found and worked on tribute by Messrs. Duncombe and Maddox before the present company started operations for themselves. Thirty-three tons of tin ore were thus recovered before the company took over the ground.

The deposit is similar in almost every respect to that which has been opened up on the Renison Bell ground and described above. There is exposed at the surface a quantity of pyritic ore, in which the pyrrhotite has for the most part given place to marcasite. The upper portion of this deposit consisted of the friable quartz and tin ore aggregate and impregnated slate. Both of these varieties of ore have been described above.

The chief point of difference which I noticed was that the impregnated slate, even where free from quartz-cassiterite veinlets, was in places fairly rich in tin ore. This ore is very fine in grain, and to the unaided eye invisible, although it can easily be recovered by crushing and vanning the slate. Pyrite has been present in the slate, and the tin ore was probably introduced at the same time.

Taken as a whole, the lode-matter forms a very flat "floor," dipping at a small angle towards the south-west. The pyritic portion was left by the tributors, and only the detrital ore above the pyritic floor removed. Mention has been made in another part of this report of the dense granular quartz-cassiterite aggregate lying upon the pyritic body, and its characteristics. Very little of this massive ore remained at the time of my visit.

A small creek finds its way down to the main creek immediately to the north-west of the pyritic floor, and has deposited along its course some bog iron ore. In this limonite are cemented angular fragments of the lode detritus, hence it is not surprising that the ironstone blocks afford good prospects for tin ore.

Another small creek situated to the south of the lode-matter, and running southwards, has been worked on tribute for a few chains for a width of from 16 to 20 feet. The bottom of the sluiced ground is in slate carrying veinlets of quartz and cubical cavities after pyrite. The slate is much contorted and crumpled here, and adjacent blocks dip in different directions. The diabase dyke crosses this stripped ground, and can be seen to be unaffected by the crumpling and to be free from the veinlets of quartz and to be non-pyritic.

The area lying between this creek and the sluiced "floor" referred to above is part of the one great lode-system.

Such was the nature of the ground when the company undertook to work it.

It was decided to erect a battery and concentrating plant, and the site chosen was the hillside immediately below the sluiced "floor."

A tunnel was put in to test the lode at a depth, and has establiished the fact that here at least the ore forms a "floor." The adit started in detrital matter, which is about 4 feet thick at that point, and traverses soft slate for the first hundred feet. The drive was carried in a north-easterly direction for 129 feet on a bearing of 55°, and thereafter for another 49 feet on a bearing of 60°. At 120 feet from the entrance a rise was put through to the surface, which is 36 feet from the back of the drive.

The slate shows slight variations in the dip of the bedding-planes, but all approach very closely to the horizontal.

After the first 100 feet the slate gradually hardens until from 122 feet to 130 feet a hard vein-stuff was encountered, carrying pyrite, sphalerite, galena, and fluorspar. The pyrite is much the most abundant of these. The slate alongside this vein, which is approximately vertical, is silicified, and carries pyrite in thin veinlets which both intersect and are conformable with the bedding-planes. Beyond the pyritic lode, which is, in my opinion, one of the "feeders" of the system, the slate is again soft nearly as far as the face of the drive. The last few feet are more siliceous, and carry veins of quartz ankerite and pyrite as if another feeder was not far distant.

The rise was put up in slate until within 10 feet of the surface, where it entered friable pyritic ore, and continued in this as far as the surface.

Good pyritic ore is to be seen at the surface near the mouth of the rise, and the section of the ore-body exposed in the rise should be carefully sampled and assayed for the tin ore in both the pyrites and the pyritic slate.

The tin-bearing oxidized lode-matter extends at the surface for some distance beyond the actual pyrites floor; and in erecting the crushing machinery the company estimated that there were available some 10,000 cubic yards of tin-bearing material which would produce over 100 tons of tin ore. The battery material includes the non-disintegrated lode-matter, the detrital ore not yet worked, and the forkings left stacked by the tributors. Up to the time of my departure from the district no crushing had been done by the battery.

The milling-plant consists of a five-head stamper battery of 1000-pound stamps, spitzlutten, spitzcasten, one Card table, and one rotary table. The two tables were, I understand, to be duplicated when crushing started. The driving power is a 12 h.p. simplex oil engine.

During the progress of the stripping and crushing of the oxidized ore every effort should be made to discover the value of the pyritic ore. Arguments have been given elsewhere to show that the tin contents of the pyritic ore may well be as high as those of the oxidized ore, and the matter should be enquired into forthwith.

Moreover, if promising results are afforded by the sampling of the pyritic ore, an effort should be made to discover whether another floor exists below that which is exposed at the surface. None is now visible, but this may be only because the configuration of the country has not laid bare other bodies. The prospecting for such other possible bodies should not be undertaken until an accurate idea is obtained of the value of that pyritic lode now visible, and if undertaken the prospecting must be done by sinking or boring.

The long lode-system apparently terminates near the top of the ridge of the spur of Stebbins Hill, which runs down to the junction of Gormanston and Dalcoath Creeks; but beyond this point other lode-matter is apparent along the boundary-line between this section and Section 1273-M. Whether the three outcrops of gossan which are shown on the map are mutually related cannot yet be told. The two lower ones follow the contours of the spur, and may therefore be regarded as successive "floors" or "branch lodes," more or less parallel to each other and dipping at a very low angle to the south-west. The reason why they appear as gossans rather than as pyritic floors with superincumbent zones of non-pyritic detritus is that they dip into the hill instead of with the hill. This matter has been fully discussed elsewhere in this report.

Some effort has been made in the past to prospect the lode-matter at this point. A tunnel has been driven westwards into the hill on a bearing of 272° for a distance (including an approach of 15 feet) of 227 feet.

The first 39 feet after the approach are in gossan, which then gives place to slate, dipping E.N.E. at a low angle. At 135 feet from the mouth of the tunnel a second gossan body was met dipping on its eastern border to the west at 30°. The drive continues in gossan for 75 feet, and the western border dips to the eastward. The last couple of feet are in horizontal slate. The noteworthy feature is the difference in dip between the two borders of gossan. It may possibly be that the main or feeding lode dips to the east, while the branch lode dips to the west, but this cannot be decided until more work has been done. The gossan should certainly be examined for the presence of tin ore.

At a time when Section 1273-M, to the northward, was a portion of one property with this section, a low-level tunnel was driven from the Dalcoath Creek to cut these gossans in depth. The dip of the lode-matter was probably very seriously underestimated.

The tunnel has a total length of 756 feet, and practically follows the boundary-line between the two sections mentioned.

For the first 525 feet the bearing is 272°; the next 64 feet have a bearing of 261°; the next 100 feet bear 248°; then, after 37 feet on a bearing of 268°, the tunnel bends abruptly, and was carried 30 feet on a bearing of 304°, and there abandoned.

Several inconsiderable bodies of ore were passed through in this drive. The more important of these were met at the following points:—At 85 feet a pyritic formation, said to carry tin ore, was cut. At 210 feet some soft iron pyrites was found, but is not known to carry tin values. Another pyritic body similar to the latter was cut at 267 feet, and yet another at 464 feet. There was a fair stream of water issuing from this latter place.

The last seam met was a 4-feet pyrrhotite lode, cut through at a distance of 695 feet from the approach.

Whether these veins have any essential connection with the massive bodies on the surface is not certain. We do know that some of the feeding-veins are small in comparison with the flatter bodies at the surface, but the main channel whereby the solutions rose to the upper fissures may not have been exposed in this tunnel. Moreover, it appears to me unwise to assume a connection between the veins cut in this tunnel and those of the Dalcoath Creek, which are mentioned below. Only a short exposure is given of a vein in a tunnel, and the strike cannot be accurately calculated on so short a length.

The veins intersected by the tunnel should, of course, be sampled and assayed, and any which may offer inducement should be followed. It would be wise to investigate the gossanous bodies, and the expense of so doing would be less than that of working from the lower level.

On the southern boundary of the Section 271-M there are several fractures filled with lode-matter. Of these, the most important is a pyritic body of ore which belongs to the pyritic-cassiterite type.

The main portion of the lode crosses the boundary-line from the southern section, in which the underground workings are situated. Near the Government track it is faulted. As far as could be determined the strike of this fault is N. 25° W., and it dips to the north-east at 60°. The faulted portion of the main lode has been located further to the westward, on the other side of the track, and has been trenched upon to a depth of 12 feet. The course of the lode here is N. 5° E., and it dips to the east at an angle of 18°. Further reference is made to this lode-matter below.

On following the course of the lode northwards the outcrop becomes lost under some partly worked alluvial ground, and reappears near the junction of the two main branches of Dalcoath Creek. From this point the lode, which is apparently the same ore-body as that mentioned above, follows the course of the creek for some chains on a bearing of N. 70° E. Here it is a vertical lode. Just above the junction of the Dalcoath and Gormanston Creeks it terminates abruptly, having been cut off by a fault. No work has been done on this lode for many years; in fact, the workings are practically in the same condition as at the time of Mr. A. Montgomery's visit in 1895. The report of that gentleman should therefore be consulted with regard to these workings.

A large quantity of ore has been shot out of the creek bed and stacked on the banks. It varies a good deal in composition; quartz, arsenopyrite, and pyrite or pyrrhotite are predominant at different points.

Throughout the length the lode seems to be about 8 feet in width. The tin ore is not often visible, but it is always hard to detect it in the pyritic ore. According to Mr. Montgomery's report the lode carries both silver and gold. The sample taken by him in the way described cannot be of any more than qualitative value, but it serves to point out the necessity of testing these pyritic-cassiterite lodes for the precious metals.

At the junction of the Dalcoath and Gormanston Creeks, and from the western bank of the former, a tunnel has been driven to test the lode at a depth, but the results of the driving were unsatisfactory. The tunnel was driven for 76 feet from the entrance on a bearing of 274°. Here a lode from 1 to 3 feet in thickness was met with and followed for 42 feet on a bearing of 241°. The lode-matter resembles that of the ordinary semi-oxidized lodes, consisting of a crumbling aggregate of quartz, marcasite, and pyrite. Whether it carries tin ore is not known. It dips to the south-east at 55°.

This lode was cut off by a cross-fault, which was followed northwards, on a bearing of 321°, for 32 feet. The fault-plane is filled with silica, pyrite, galena, and blende for a width of 2 to 3 inches, and does not seem important.

The main drive was continued for 44 feet on a bearing of 227°, and then for 17 feet on a bearing of 261°. The next 37 feet of driving were on a bearing of 305°, and after 20 feet more on a bearing of 284° work was abandoned. A small veinlet a few inches in width and similar to the other one was met with. It was dipping E.N.E. at 15°, and appears unimportant.

The relation of these two small veins to the main lode in the creek is not quite apparent from the work which has been done up to the present. It is quite possible that they may be branches of the main lode, which probably lies further to the south-east.

On following the Dalcoath Creek down towards the mouth of the very long tunnel referred to above there are two small veins to be seen crossing the creek. A 30-feet tunnel has been driven on one of these in a direction S. 10° W., but the formation was passed through near the mouth of the adit. The ore consists of quartz and pyrites, but no information as to the tin ore contents is available.

In the south-eastern corner of the section, where Dead Man's Creek runs into Gormanston Creek, a quartzose vein is visible. It carries zinc blende, and tin ore is reported to have been obtained from it. The strike follows the course of the Gormanston Creek.

Reverting now to the ore-bodies on the south boundary of Section 271:—The main lode is one of great importance on account of the proportion of tin ore present. The dip of the lode is eastward at an angle of about 40°, and the lode-matter is strongly banded. Unfortunately only extremely weathered surfaces were available for examination at the time of my visit. However, the lode has been partly exposed by an open cut, and the structure of the lode is clear. The slate has been replaced in zones parallel to the bedding-planes, and the lode-matter, therefore, contains a certain amount of undigested slate. The lode minerals are those usually present in the pyritic-cassiterite type; but the distribution of the tin ore can be studied on account of its relative abundance. It is certainly irregularly distributed on the whole, and where more abundant can be seen to occur in seams parallel to the bedding-planes of the slate and in veinlets which traverse these bedding-planes at all angles. These latter cross-fractures are, in my opinion, not of later date than the others. Both appear to have been simultaneous, and the tin ore was introduced at the same time as the less valuable minerals.

At one place in the open cut axinite is visible along the central portion of the lode and conformable with the bedding-planes. It has been introduced at a later date, in my opinion, and has been derived from the axinite vein which fills a fault-plane in the formation.

The disintegrated portion of this formation at the surface has been sluiced for detrital ore, and some of the semi-oxidized ore which caught fire spontaneously on the dump has also been profitably sluiced.

The open-cut exposure is about a chain in length, and at its northern end a shaft has been sunk. The greater part of this shaft has been filled in, but some excellent ore is lying on the surface, nearly—probably derived from thence. This ore is crustified, and consists of quartz and an intermixture of arsenopyrite and fibrous-radial cassiterite. The depth of the shaft is said to be 40 feet.

There is some further work done underground upon the more southerly portion of this lode. A tunnel was driven for 78 feet on a bearing S. 34° E. This crosscut intersects the axinite vein at a small angle. At 78 feet from the entrance a short crosscut of 12 feet was carried eastwards. It encountered a dense pyrrhotite body dipping to the eastward, and was abandoned.

Driving was resumed in the country, and at 22 feet past the turn-off from opening drive the axinite was again met.

A crosscut was here carried along on the axinite vein. Pyrrhotite came in first on the eastern wall of the drive, dipping at about 30° to the eastward, and strongly banded in structure.

On the western side of the crosscut the structure appeared more massive. The bounding-wall of the lode on this side of the crosscut appeared to me to be dipping to the west, but the ore had weathered to such an extent that accurate observations were impossible. At a distance of 28 feet from the main drive a winze was put down 6 feet. This is said to be on good ore, but it was full of water. Good ore is also said to occur above the winze on the eastern side of the axinite vein. Crosscutting was continued past the winze till a total distance of 76 feet from the main drive was reached.

A narrow veinlet of ½-inch to 1 inch in width was found rising in the back of the crosscut as the latter advanced (dipping westwards). This is said to assay well for gold. A few feet ahead of this place, in the face of the crosscut, there are quartz seams carrying tin ore and dipping in all directions.

The main drive was carried forward on the footwall side of the lode. The country is strongly banded, and carries pyritic veins said to carry tin ore. At 88 feet from the crosscut mentioned above another was started and carried eastwards for 21 feet. It was abandoned in hard slate carrying pyrrhotite.

Some 40 feet further on a rise was put through to the surface, and emerged at a point 90 feet above the back of the drive. Good ore is said to have been passed through for 30 feet on the eastern side of this rise, and the ore is said to have passed out on that side. This seems remarkable, as it would indicate a dip to the westward. The rise was inaccessible, and I could make no investigation of it myself.

The main drive was continued beyond the rise, and after driving 30 feet no more ore was seen. At 68 feet past the rise a small crosscut was driven some 12 feet eastwards on a small vein said to be tin-bearing. Beyond this, at a distance of 16 feet, the underground work ceases. A little axinite is visible in the face.

All of these exposures are very much discoloured by the weathering which has proceeded during a long period of inactivity, and it is hard to decipher the details of occurrence; but from the appearance of the ore upon the tip there can be little doubt but that the lode is an extremely valuable one.

The more friable portion of it is partially decomposed, and would be amenable to cheap treatment, but the undecomposed ore is dense and hard, and carries pyrrhotite rather than marcasite and pyrite as the principal gangue mineral.

In Section 271-M there is yet another lode of the pyritic-cassiterite type, which appears to have a close genetic connection with the lode just described. It is striking towards the tunnel mentioned above, on a bearing S. 24° E. It is a narrow lode, 1 to 2 feet in width, and has been trenched upon for a length of 3 chains to a depth of 2 feet. I am informed that the work done here was highly profitable.

This lode, when considered in conjunction with the larger mass worked underground and on the surface, as described above, shows a marked resemblance to the structure of the quartz-porphyry dykes. Mention has been made of this in another part of this report.

It is therefore proper to investigate the question of the southward continuation of this small lode. Up to the present very little has been done in the southern section, but enough, in my opinion, to show that part of this lode-system does continue up the hill to the southward.

On the southern bank of Dead Man's Creek some trenches have been put in to try and locate the origin of some tin ore which was found on the slope towards the creek. These trenches have proved the presence of a broad band of slate traversed by numerous stringers of stanniferous pyrites and quartz. The veinlets have no constant direction where visible.

A short tunnel driven for 21 feet in a direction S. 18° E. had intersected several of these bands in a semi-oxidised condition when abandoned.

Nearer to the main workings, and in the creek bed, a pyritic lode carrying tin ore was found alongside an 18-inch dyke of quartz porphyry which intersects the gabbro at this place. The workings were covered up at the time of my visit.

The quartz porphyry is very probably connected with the dyke which is showing in the face worked by Messrs. Duncombe and Maddox. The lode has some connection with that on the boundary between the sections, for the water met with in the rise mentioned above suddenly ceased when a dam on the site of this lode was removed.

The axinite vein which intersects the underground workings has been trenched on for a distance of 2 chains. The lode is of the "limuritic" type, and has been described above. It is itself distinct from the tin-bearing lode-stuff, and occupies a fissure which has intersected the pyritic-cassiterite lode after its formation.

The property owned by the Boulder Company shows much promise, and the development of the other lode-matter should be pushed forward while the battery is treating the detrital ore and oxidized lode-matter in the north-western corner of the lease.

In particular, the old Cornwall workings should be reopened, since without a considerable amount of further work actual mining cannot be carried out. It will be decidedly unwise if the opening up of the lodes is left until the battery has no ore of an oxidized character left to treat. In the event of the Cornwall workings opening up well it will probably be found necessary to move the site of the battery.

The total output of tin ore from the section cannot now be arrived at.

Alluvial ore has been won from both Dead Man's Creek and Gormanston Creek, and a certain amount also from Dalcoath Creek.

The amount of detrital ore obtained from the outcrops near the boundary of the two sections is not known.

Some 33 tons of cassiterite were won from the sluicing of the pyritic "floor" near the present battery site.

Since crushing started I am informed that the mill has recovered altogether 10 tons of tin ore from 700 tons of stone crushed. The average assay value of this ore is 70 per cent. metallic tin.

These figures afford the details of the output up to the beginning of February, 1909, and have been courteously furnished by the mine manager.

(5)—The Dreadnought Sections.

The two sections constituting the Dreadnought lease are No. 2650-M (78 acres), standing in the name of Chas. Brumby, and No. 2763-M (77 acres), registered in the name of A. G. S. Morton.

These two sections comprise the northern and eastern slopes of the Dreadnought Hill, and beyond these the southern fringe of the old flood-plain of the Pieman River. The greater part of the section is occupied by the slate of the Dundas series. A dyke of diabase crosses the south-western corner of the lease, but is not of economic importance in any way, since it is of later age than the ore-deposits, and does not intersect them within the boundaries of the lease.

The economically important portions of the lease are—(1) The lode-system which has been styled above the Dreadnought-Federal lode-system; and (2) the secondary concentration of alluvial material in Isaacson's Creek, which runs along the northern boundary of Section 2763-M.

(1) The Dreadnought-Federal Lode-system.—This term has been here applied to the complex system of veins which extends through the greater part of Section 2650 in a north-west—south-easterly direction. The northern limit of the system, as far as has yet been proved, is near the crest of the Dreadnought Hill, and it extends beyond the southern boundary into Section 1273-M.

The width of the formation cannot yet be definitely stated, but it is considerable.

The principal work done on the formation has been carried out at a point near the summit of the Dreadnought Hill, where the most prominent outcrop is located.

The north-eastern slope of the hill is extremely steep at this place, and the outcrop, which came right up to the surface, was masked by a dense cover of scrub. On this account, no doubt, the lode remained so long unprospected. However, in the early days of the mining field, it must have been found, as a tunnel was started at a point about 180 feet below the crest of the hill, and driven into the hillside for 99 feet before being abandoned.

Mr. H. E. Evenden's discovery of tin-bearing stone in the outcrop, and afterwards in the gossanous body intersected by the tunnel, led to the present resumption of work, both on the surface and underground.

The scrub has been cleared, and a few trenches cut in the hillside to the north-west of the tunnel entrance for a length of 2 chains, and at heights varying from 30 to 90 feet above the level of the tunnel. This trenching has been done on the line of the lode-system, and without so far exposing the north-western limit of the formation.

The main trench is some 2 chains in length, and has been carried up the hill face in steps. The direction of the trench is W. 25° S.

From the exposure that has been made of the ore it can be seen that there are a series of more or less parallel zones of tin-bearing gossan in the slate, and that these zones at this point usually conform to the bedding-planes of the silicified slate. The prevalent dip at this place is to the E.S.E., at an angle of about 50°.

Samples taken from a width of 40 feet in the lower portion of this trench have given exceedingly promising results.

A shaft was started at the head of the first bench, but abandoned when 4 feet 6 inches of sinking had been done. The object of this sinking does not seem clear, since the successive zones of tin ore are much more nearly vertical than horizontal, and with a steep hill face to assist prospecting short tunnels would afford much more information regarding the structure and contents of the lode than isolated shafts can give.

The other trenches which have been cut are more shallow and give less information. They show in places bands of extremely rich stanniferous gossan of a character which is common to the richer portions of the pyritic-cassiterite lodes of the district. How much of this ore is present cannot be determined from the amount of work done on the surface up to the present.

The directions and angles of dip of the bedding-planes of the slate are at first a little confusing when the surface evidence is examined.

As a whole, the lode-system appears to me to be dipping at a fairly steep angle towards the north-east; and in most cases the slate which lies within the limits of the formation has a similar dip. These remarks apply, of course, only to the present exposed portions of the formation, which constitute only a fraction of the total length of the system.

The tunnel was driven on a bearing S. 22° W. for the first 99 feet. At 54 feet from the entrance a small excavation has been made in the western wall of the drive on gossan carrying tin ore. At 86 feet from the entrance short drives have been carried on lode-matter in both north-westerly and south-easterly directions; for it was at this point that the stanniferous gossan was first recognized underground.

The north-western drive was only carried 10 feet. It shows that the lode-matter partly follows the bedding-planes of the slate and partly cuts across them.

The bedding-planes at this point dip E.N.E. at an angle of 10°. In the face of the drive semi-oxidized pyritic ore is visible.

The south-eastern drive runs for 37 feet on a bearing of 140°. It runs along a zone of slate impregnated with a number of veins of pyritic-cassiterite ore. No pyrites was showing in the old tunnel, but the new drive came into the pyritic ore at once. The principal veins of ore dip E.N.E. at 58° in this drive, and conform to the bedding-planes of the slate.

The main adit, at 99 feet from the mouth, has been turned, and continues for 69 feet on a bearing of W. 27° S. This drive has intersected a number of zones of iron-stained slate with bands of clean slate between. The gossanous slate zones dip N.N.E. at an angle of 40° to 50°. Numerous small cross-fractures occur, which are filled with ironstained clay, and carry tin ore.

In the face of the drive there is less limonite, and a few veins carrying quartz, pyrite, pyrrhotite, and cassiterite are visible.

The underground workings, as far as they have gone, show that the lode-system is still continuous at that level, and that there is rich ore present in the lode-stuff. The quantity of ore cannot, of course, be even guessed at until much more extensive workings are available for examination.

The level of the tunnel appears to have intersected the lode-system near the base of the zone of weathering, for oxidized, semi-oxidized, and unoxidized ore are to be found on the same level. The base of the weathered zone is not a plane surface.

Some 7 chains to the south-east of the tunnel a trench has been cut in a formation very similar to that which has been described above. The slate is indurated by impregnation with silica, and is stained with iron oxide resulting from the weathering of pyrite. Cubical cavities whence the latter has been removed are to be seen. The impregnation of the slate has as usual followed well-defined bands, and the tin ore is distributed in the same way. Some of the bands of tin ore at this place have been sampled, and have afforded high values on assay. Between this occurrence and those which are situated to the north-west (described above) and the south-east, there has not yet been proved a definite connection. There is, however, no doubt in the mind of the writer but that the several outcrops belong to a single-fracture system, and that they will be proved to be more or less continuous throughout. This opinion is considerably strengthened by the ascertained facts of the distribution of the outcrops, for they are situated on a line which runs about north-west and south-east; that is, in the main direction of fracturing in the district.

Very little more work has been done, except in the south-eastern portion of the section on the line of this lode-system.

A small cut has been made in the bed of the creek and the lode-matter has been exposed. It is very much more siliceous at this end of the section, but both pyrrhotite and pyrite are present.

Some of the quartz is crystalline, but for the most part it is massive. Tin ore is present, especially in the more gossanous portions of the lode.

A similar outcrop has been cut into at a point still further to the south-east, and has proved tin-bearing.

Taken as a whole, the lode-system which has been tapped at the several points described above may be regarded as one of considerable possibilities. Until more work has been done in exposing the length and breadth of the formation little more can be said. The formation extends in a south-easterly direction to the boundary of the section. So far its north-easterly limit can hardly be said to have been proved. The most northerly trenches have not penetrated the surface cover of decomposed slate, which may well conceal the continuation of the outcrop. In this connection it may prove of interest to state that the outcrop of a diabase dyke on the opposite fall of the hill has been concealed in exactly the same way; yet we can have no doubt about the connection between the outcrop of the diabase on the Dreadnought Hill and that which is visible in the creek bed to the north-west of Section 3621-M.

The question of the northern extension of the ore-body can, in the opinion of the writer, be left unsettled until more is known of those portions already partly exposed. The configuration of the country is favourable to the prospecting of the lode-system by adit levels; and in locating the site of a future tunnel, it would seem wise to secure as many feet of backs as possible. By such a procedure a double purpose would be served, for, apart from the question of the height of possible stopes, there is thus to be gained some information regarding the width of the lode-system.

This lode-system is to be regarded as a shattered zone of rock impregnated with pyritic-cassiterite ore of normal type. While the dip and strike of the several veins which constitute the whole system are variable from point to point, there is not that marked divergence from normal lode-structure which is shown by the other great lode-system running through the Renison Bell, Montana, and Boulder leases; that is to say, the vertical components of the Dreadnought-Federal system are the more important, and the structure is not essentially different from that of complex lode-formations in other localities, where mineralization has followed the course of a zone of fracture rather than a plane of fracture.

(2) The deposits of Isaacson's Creek have been worked at various times by small parties for the tin ore collected by the creek from the older Pieman alluvial deposit through which it runs.

This appears to be one of the few localities in which there has been found workable ore within the limits of the older alluvial, and, as has been indicated above, another concentration by a present-day stream has been necessary to render working for the tin ore payable.

It was impossible to ascertain how much tin ore has been won from this creek. A few ounces of gold are said to have been obtained while work was in progress.

The chief value of the northern section, as far as is yet known, lies in its position on the line of strike of the lode-system.

(6)—The Federal Tin Mines, No Liability.

The section numbered 1273-M, 79 acres, and standing in the name of A. S. Stebbins, contains the crest and slopes of Stebbins' Hill.

The area is almost wholly covered by members of the Dundas slate series. Near the north-west corner there is a small outcrop of porphyroid, and in the south-west corner the diabase dyke is visible.

The lode-matter of most importance in the section is that which belongs to the "Dreadnought-Federal" system, to which reference has been made. Besides this, the south-western portion of the section lies within the limits of the Renison Bell-Montana-Boulder lode-system, and on the southern boundary dense gossans are outcropping.

The principal work done on the section up to the present has been the renewal of operations upon the lode-system extending into this section from the Dreadnought Company's ground. The outcrop was found many years ago, and a tunnel was started at a point 150 feet below the top of the hill, but after being carried 27 feet the tunnel was abandoned.

The lode-matter was just touched by these workings.

On the resumption of mining the driving of the tunnel was continued, and an open cut started upon the outcrop higher up the steep hill slope.

These open-cast workings have disclosed the presence of some pockets of rich ore enclosed in ore of much lower grade. The rich ore is of a gossanous character, and similar to that from the Dreadnought lease. The main cut at this place shows a wall to the lode-matter, composed of slate, and striking N. 4° E. At first sight this may seem strange, since the lode-formation as a whole has been charted as running on a N.W.-S.E. course. But it must be remembered that the fracture-system is a complex one, and that the several minor fractures may not correspond in strike with that of the system as a whole.

A trench has been carried up the hill in a direction nearly due west, and has not disclosed the presence of any ore.

The tunnel has been driven for 52 feet on a bearing of 243°, and thence onwards on a bearing of 227° for a total distance of 107 feet from the entrance.

For the first 25 feet the tunnel penetrates weathered slate. This is succeeded by a broad zone of quartz and gossan for 29 feet. The lode-formation is very irregular in structure and composition. Parts are dense quartz and other parts contain fragments of altered slate, while here and there are cellular patches of interlacing quartz crystals stained brown with limonite.

At a distance of 50 feet from the approach good ore was met, and at 54 feet some very rich iron-stained tin ore was found. This zone is followed by 19 feet of mixed lode and country. At 62 feet from the approach there are some rich pockets of soft pug and tin ore.

Beyond this, at 73 feet from the approach, a belt of slate 11 feet wide has been cut. The boundary between the lode-matter and the clean slate dips to the north-east at 35°. Beyond the slate another body of ore, consisting of quartz and gossan, 5 feet in thickness, was passed through. This ore-body dips north-east at 70°. Beyond it only slate was met with.

It is not possible to detect the dip of the bedding-planes of the slate underground.

The several ore-filled fractures vary considerably in dip, but in the latter part of the tunnel the ore seems to be crossing the direction of the tunnel at right angles, so that the direction of strike would conform to the general strike of the whole formation.

A little driving has been done on the course of the rich ore in a south-easterly direction for 33 feet and in a north-westerly direction for 9 feet. The longer drive is in gossanous ore carrying some very rich patches.

The outcrop on this lode-system continues to the north-east for some distance. At the surface it appears to turn a little more to the eastward as it is followed south, but this cannot be regarded as certain until the ground is opened up, for the more easterly outcrop may belong to another portion of the system.

A low-level tunnel could easily be put in to test this lode-formation, as the configuration of the country is favourable. The same advantages would be gained by a low-level tunnel as those mentioned in the case of the Dreadnought lode.

On the south boundary of the section, where it adjoins the Boulder lease, some work has been done on the lodes mentioned above in the account of the Boulder lease.

The gossan outcrops which curve with the contours of the hill have been sampled in this section. A number of bore holes are visible, but no records have been preserved of the results. I am informed that a rough sample chipped from the surface showed the presence of tin and silver as well as a trace of copper.

At the top of the ridge and near the southern boundary of the section a shaft has been sunk at some period now unknown on gossan.

The shaft was full of water, and to judge by the size of the dump, must have been 40 or 50 feet in depth. The material composing the dump is a quartzose gossan, and should be examined for tin ore.

The scrub is very dense at this place and should be cleared, and the surface trenched to determine the nature of the gossan and its structure.

In the south-western portion of the section there has been a little sluicing done upon the lode-system which continues southwards into the Boulder lease. This has been sufficient to show that the flat "floor" structure is well developed. The richest detrital ore was found at a spot too high for sluicing, and it was found necessary to pass it down a timber slide to the necessary level. The excavation of a dam for this work at the foot of the slide revealed the presence of a massive pyritic formation.

This is probably continuous with the pyritic "floor" exposed by a trench 2 chains long that has been carried up the hill at a point some little distance to the northward; and there is also very probably some connection between the pyritic mass and that exposed on the Boulder section.

The slate overlying the pyrites is banded and irregularly impregnated with opal and quartz.

The methods for prospecting this lode matter and the need for samping the pyrites have already been discussed above.

The only other place where tin-bearing lode-matter has been found is situated near the foot of the eastern slope of the hill. A trench has been cut in a quartz and limonite formation for a few feet. This work was done some years ago and abandoned. More recently it has been found that the lode carries tin ore. It may possibly be connected with the Dreadnought-Federal line of lode, but this cannot be regarded as established until some work has been done between the known outcrops.

Hitherto the output of tin ore from the section has been small, and has been derived from the sluicing of the detrital ore in the south-western corner near the Boulder lease.

The future of the property depends largely upon the way in which this latter lode-system and the formation in the north-western portion of the section open up. The gossan outcrops on the southern boundary, if they prove to carry a payable percentage of tin ore, will be valuable assets, for the ore-bodies are large and easily accessible.

(7)—C. Brumby's Section.

The Section 1215-M, of 36 acres, charted in the name of C. Brumby, lies between the Dreadnought and the Renison Bell sections, and occupies the western slopes of the Dreadnought Hill, with a small part of the northern spur of the Renison Bell Hill.

The greater part of the section is slate, and the diabase dyke is visible on the eastern boundary and for a few chains into the section.

There are two isolated outcrops of gossan on the section, and the south-western portion of the lease lies within the limits of the Renison Bell-Montana-Boulder lode-system.

It is this latter portion which has been profitably worked along the bed of the eastern branch of the Renison Bell Creek.

The workings at that point are not extensive, but, for the area treated, highly productive. They are undoubtedly part of the lode-system, and connected with the closely adjacent workings on the Montana section. There is a pyritic "floor" visible in the bed of the creek, and the detrital ore has been sluiced down to this.

At the time of my visit very little work was being done, for the formation within this section has now been stripped of practically all the disintegrated ore; and to treat the residue of even the oxidized lode-stuff crushing will be necessary. The pyritic "floor" visible in the creek bed may be a portion of the lower of the two floors visible on the Montana section, or possibly it may be yet a third floor not elsewhere exposed.

A few chains down the creek, and on the eastern bank, there is an outcrop of black gossan, which stands up precipitously. No attention has been given to this huge outcrop, probably because it does not continue on the surface for any distance.

There is another outcrop of gossan near the north-western corner of the section on the boundary-line between this section and the Renison Bell lease. It was probably thought at one time that the two isolated outcrops of gossan were portions of one lode, for a very long tunnel has been driven, apparently in the hope of cutting the supposed lode. This tunnel was started in the Renison Bell ground and driven eastwards on a bearing of 75°. It is wholly in slate, dipping to the north at an angle of 15°.

A small plant has been erected in the bed of Renison Bell Creek to deal with the accumulated slimes and sands which have come down from the workings at the head of the creek. The sands and slimes have settled in the creek bed, which has been dammed for the purpose.

The treatment scheme is as follows:—

There are two main dams, the upper of which serves to control the flood-water by diverting it into a bywash. This water is used lower down for scouring the waste material into the creek.

From this upper dam only enough water is allowed through to carry feed to the trommel, which is situated immediately below the second dam. The trommel-screen is perforated by circular holes of $1\frac{1}{2}$ m.m. diameter.

The oversize from the trommel is carried away by the bywash, as mentioned above. The undersize passes over the waterwheel which drives the trommel, and thence is carried to two settling pits. These are filled alternately, and the overflow from them drives an overshot waterwheel which drives the rotary table.

The table is geared to rotate three times in four minutes.

The slimes from the settling-pits are hand-fed into a launder and pass through a trommel with a woven wire screen of 30 mesh. The oversize passes to waste, and the undersize is fed on to the table.

Two settling-boxes are placed in series to catch any slime tin ore which may not be caught in the concentrate compartment.

The tin ore is streamed by passing it over the table.

The first product assays between 25 and 30 per cent. of metallic tin, and the reconcentrate assays 70 per cent. or thereabouts.

The value of this section will depend upon the future of the lode-system in its south-western portion. The prospecting of the lode-system is dealt with elsewhere in this report. It will be particularly interesting to the owner of this section to find what is the dip of the lode-system as a whole. At present it is undetermined, but some of the principal feeding-fissures dip towards the north-east, and it is possible that the lode-system as a whole may have a similar dip. If so, it will underlie into this section.

The gossans which have been mentioned should certainly have a cut put into them, and should then be sampled and assayed for tin ore.

The output from the section from all sources has been nearly 25 tons of tin ore, the assay value of which is about 70 per cent. metallic tin.

The gross value of this ore is about £2350.

(8)—H. E. Evenden's Section (3370-M), and H. E. Evenden and S. Reardon's Section (3660-M).

These two sections lie between the Dreadnought and Stebbins Hills and the Ring River.

The greater part of both is covered by slate, but there is an outcrop of gabbro in one portion of Section 3370-M.

In this section, which comprises 70 acres, very little work has been done, save in the creeks which run towards the north-east. From these creeks some tin ore, as well as a little gold and osmiridium, have been recovered. These occur with chromite in the creeks round the foot of the hill, and are clearly derived from the older river alluvial, of which traces still remain.

On following the creeks up towards their sources the chromite, gold, and osmiridium cease, and the tin ore is more angular in character. This tin ore is doubtless from the Dreadnought-Federal lode or from some other similar ore-body.

At a point only a few chains distant from the south-eastern corner of the Dreadnought lease some gossanous ore rich in tin oxide has recently been found, but not enough work had been done, when my examination of the spot was made, to determine whether the gossan was *in sitû* or not. Possibly it is fragmental, and derived from the lode-formation higher up. Other masses have been located in the scrub at this place, which may have had a similar origin. The question can be quickly settled by cutting a trench down to the bed-rock.

It is stated that about 3 tons of tin ore, 5 ounces of gold, and 3 ounces of osmiridium have been taken from the creeks in this section.

The section 3660-M, lying to the northward of the latter, comprises 62 acres. It has been, up to the present, hardly prospected at all. On the southern boundary-line, near the south-western corner, a quartzose lode has been partly uncovered in the creek bed. This lode-stuff has not been tried for tin ore, but a prospect of tin ore can be obtained by washing in the bed of the creek just below the lode.

Near the south-eastern corner of the section a creek running towards the Ring River carries in its bed some water-worn quartzose pebbles, which clearly formed part of the older river alluvial. In this creek-wash there is a little tin ore.

The attention of prospectors on these sections should be devoted to any traces of lode-matter which may be found. It is quite possible that another line of fracturing may occur to the eastward of the Dreadnought-Federal system, and if such does exist the probability is that the strike will be within a few degrees of a north-west—south-east line.

Such being the case trenching should be carried out in a direction south-west and north-east.

(9)—A. Kemp's Sections, and M. Keys' Section.

There are four sections standing in the name of A. Kemp—2101-M, of 13 acres; 496-M, of 5 acres; 103-M, of 40 acres; and 1059-M, of 5 acres.

These are all situated near the junction of the Ring River with Dalcoath Créek; and the three former have been located in such a way as to comprise the bed of Dalcoath Creek for the whole distance from the north-eastern corner of the Boulder lease to within a few chains of where it enters the Ring River. The other section is on the Ring River.

The 13-acre section is wholly in slate, through which the creek has cut a steep-sided gorge. In the adjacent 5-acre section this gorge terminates with a fall, and the creek flows onwards through a small alluvial plain of recent date. The deposit of alluvial material only extends to the Ring River, and is at all points shallow.

That portion of the alluvial wash which is nearest to the gorge of the Dalcoath Creek is composed almost wholly of pebbles from the Pine Hill area, while near the junction of the creek with the Ring River there is a preponderance of pebbles of quartz and quartzite-schist. These latter doubtless come from the upper part of the area drained by the Ring River, and also from the older river alluvial which has been cut through by the Ring River and its tributaries.

The principal workings are situated on the site of the channel of the Dalcoath Creek, which has been turned aside so that it flows along the western border of the alluvial flat.

About 10 chains in all of the old creek channel have been worked, and at the time of my visit the face was very close to the falls. The central gutter only has been worked, although tin ore is known to exist in other portions of the alluvial flat.

The depth of the gutter below the surface of the flat is usually about 10 feet, and in some places as much as 15 feet.

This has been worked by hydraulic power. The water is taken from the Dalcoath Creek just above the falls, and carried down to the face. A hydraulic jet elevator is used to convey the gravel from the face into the race.

The tin ore is, on the whole, coarse in grain, and some of the nuggets recovered are several pounds in weight. These larger nuggets are exactly similar to those recovered in the upper part of the Gormanston Creek, and are certainly derived from the same source.

Towards the centre of the 40-acre section the alluvial material becomes intermingled with that derived from the Ring River, and the tin content is poorer. Some rich pockets have been found on the bottom, but these have not proved to be of any extent.

Mr. Kemp informs me that from these low-level workings £3000 has been taken for the tin ore recovered.

Above the creek channel, on the slopes of the hill, there has been a shallow terrace of alluvial wash similar to that in the bed of the creek. It has been sluiced for several chains, and 12 tons of tin ore are said to have been won from it.

Near the northern boundary of the section some 3 tons of tin ore have been recovered from a similar deposit.

When the main channel through the alluvial flat has been worked it will be necessary to examine the flat carefully for any other former channels which may exist. It is improbable that the Dalcoath Creek has always found its way to the Ring River by the same course, and any other channels which it may have occupied should contain payable wash.

There has been a large amount of non-productive work carried out on these sections which was necessary for the successful working of the main gutter. Such work has now been done, and should any other gutter be located there will not be the necessity for preliminary expenditure and delay.

The flat should be systematically prospected by a series of holes across the unworked area, spaced at short intervals.

The 5-acre section 1901-M, charted in the name of M. Keys, adjoins the north-western corner of A. Kemp's northern section, and lies on the eastern bank of the Ring River.

On it a galena lode has been located, and a tunnel has been started on the lode which strikes N. 11° W., and dips at a steep angle towards the east. In front of the mouth of the tunnel a hole has been sunk, and has exposed some fair ore.

The lode-matter consists of quartz, siderite, and galena, together with iron pyrites.

A few yards to the eastward there is a gossanous outcrop, which probably marks the site of a parallel or branch fissure.

The lode has been lined out with stakes up the hillside, but the underlie has not been taken into account. Before trenching is carried out, this line should be turned a little to the westward, for the dip of the lode would carry it in that direction, as the outcrop rises from the low ground.

The galena has proved to be of good grade, and the lode is well worth further attention.

From this section a small amount of tin ore has been won. It was recovered from a small creek running into the Ring River.

(10)—The Button-grass Plain North of the Dreadnought Hill, and T. C. Goodall's Section.

The nature of the alluvial deposit which covers the flat country to the northward of the Dreadnought lease has been described, and the conditions under which it formed have been indicated. Some dredging areas were formerly pegged out on the site of the creeks which drain the button-grass plain, and flow northwards to the Pieman River; but the deposit is too shallow, and the only section now taken up in this area is that charted in the name of T. C. Goodall, 3621-M, 80 acres.

Some fair prospects can be obtained in most of the creeks running through this area, but there is only a foot or two of wash, and there is some difficulty in bringing in sufficient water to treat the alluvial.

In no case did there appear to be any tin ore present which was of local derivation.

The chromite, gold, and osmiridium found with the tin ore point to different sources in the case of the various constituents.

A few bags of tin ore have been won from the creeks in this area, but the total amount cannot be great.

(11)—E. Hawson's Section.

The Section 1945-M, 79 acres, is situated to the north of the Renison Bell lease, and is traversed by the Argent River. The eastern portion of the section is almost wholly covered by the older river alluvial deposit. Where this shallow formation has been removel by denudation, as in the western part of the section, the slate outcrops.

That portion of the section which is economically the most important is the south-western corner. The great lode-system which stretches southwards through the Renison Bell, Montana, and Boulder leases extends into this section at the place named. A cut has been made in the western bank of the Argent River, which runs north and south at this place, and a pyritic body has been exposed. The exposure is a small one, and is terminated by a cross-head striking W. 15° N., and dipping northwards at 50°. I am informed that this pyritic ore when roasted and vanned will show a prospect of tin ore. This being so, the lode should be opened up.

The western bank of the river rises abruptly from this point in the direction of the north-western corner of the Renison Bell lease, and gossan outcrops here and there on the slopes.

A short tunnel has been started into the hill just above the outcrop in the river, and is driven 20 feet on a bearing of 243°.

It passes through 10 feet of slate, and the next 10 feet are in semi-oxidized pyrites, with branches of ankerite and dolomite. Far too little has been done yet for any idea of the structure of the ore-body to be obtained. The gossan carries a certain amount of quartz, and does not appear to me to vary in any particulars from the normal gossans of the pyritic-cassiterite ore.

A little galena is visible in the carbonates mentioned above, and a solid body of galena, blende, and pyrite is said to occur in the bed of the river. The specimens taken from this vein and now lying on the bank show a little cerussite. The river has been turned during the dry weather in order to work this vein, but during my visit it was concealed. In all, half a ton of lead ore was removed.

The lead ore is not, in my opinion, likely to prove of much value. There are numerous other instances throughout the district of such veins; but they have failed to fulfil the promises shown by the outcrops.

More attention should therefore be given, in my opinion, to the tin-bearing lode-system which extends up the hill.

(12)—R. D. Lewers' Section (now Renison Bell Prospecting and Mining Company, No Liability).

The Section 4550-93M, of 37 acres, charted in the name of R. D. Lewers, adjoins the Renison Bell lease on the north-west. It occupies the crest and slopes of a hill which faces the low-level workings of the Renison Bell Mine.

The boundaries of the section enclose only members of the Dundas slate series, with the exception of a narrow strip of the older alluvial deposit of the Pieman River, which is left as a terrace along part of the northern boundary.

The conglomerate which forms the capping of the pyrites in the railway-cutting on the Renison Bell lease continues across the south-western slopes of the hill. It is impossible to say whether the fault-plane (the "cross lode" of the Renison Bell Mine) forms a boundary of the conglomerate here. There were, at the time of my examination, very few outcrops of the rock visible through the scrub. It is more than probable that the fault-plane referred to does continue through the section, and that the main gossanous ore-body which is charted on the section marks its outcrop. The strike and position correspond, but the dip could not be compared for want of the necessary exposures.

The main body of ore occurring on the section is this gossan, which runs from the north-western corner of the Renison Bell ground right across the section to a point 3 chains eastward of the north-western corner of the lease.

The largest development of the gossan at the surface is in the centre of the section, where the outcrop seems to be one of a nearly vertical ore-body.

There are at this place two other smaller gossan outcrops lying to the northward of the main lode, which belong, in my opinion, to two branches of the main lode. They are in each case bounded by a sharp bluff about 12 feet in height on the north-eastern side.

Shallow trenches have been cut between the main outcrop and these, and only slate country met with. Hence we may regard the three as belonging to a branching system of the variety described elsewhere in this report.

Whether the gossan carries tin ore did not appear to be known when I examined it. It is certainly well worth sampling.

On the northern boundary of the section the gossan becomes very much more siliceous, and is strongly banded. The silica is mostly of the chalcedonic variety.

This lode-matter is said to be tin-bearing, but the tin ore is not visible in the gossan to the unassisted eye. The pyritic ore is not far from the surface here, as pyrite is visible on the freshly broken surfaces of the gossan.

There is a western gossan outcropping on the western boundary-line at a point 2½ chains south of the north-western corner. The surface of this has been stripped off for a few feet, but nothing more has been done. The strike appears to be parallel to that of the other larger lode.

As will be seen later, tin ore has been obtained in the creek bed just outside of this section, and it is logical to conclude that some of it at least has been derived from these lodes.

The creek in the south-western corner of the section probably carries a little alluvial tin ore, but no work has been done there.

Since my return from the district the section has been, I am informed, taken over by the Renison Bell Company, and prospecting work has been carried out along the lode, with the result that tin ore has been proved at several points.

If there is a payable proportion of tin ore present along this lode, the occurrence will be one of considerable commercial value, and the Renison Bell Company will be able to work it from a tunnel driven from the south side of the hill.

(13)—W. A. J. Briggs' Sections.

The mineral sections standing in the name of W. A. J. Briggs are four in number—2764-M, 38 acres; 2766-M, 20 acres; 3240-M, 20 acres; and 2765-M, 20 acres.

These are so located as to wrap round R. D. Lewers' section, and lie for the most part between the Argent River and the McKimmie tramway.

The 38-acre section lies on the strike of the lode which crosses R. D. Lewers' section, and the outcrop is continuous into it for some chains.

So far nothing at all has been done in the way of testing the lode-matter.

The main outcrops mentioned above cross the creek near the southern boundary of this section, and from the disintegrated lode-matter in the bed of the creek I saw some tin ore washed.

The best prospects are to be obtained by washing the material caught in the crevices and spaces between the boulders of gossan in the creek.

Abutting against the massive lode which crosses the creek, and extending for 3 chains in a direction N. 70° W., is another gossan lode, which forms a junction between this lode and the second gossan lode to the westward of the former.

The concentration of lode-matter at this place should offer every inducement for active prospecting to be carried out. Until the lode-matter has been properly sampled and assayed, no idea of the value can be obtained, but the size of the ore-bodies is such that this work should certainly be done.

The lode-matter continues for some distance to the northward, where a little trenching has been done. The old alluvial terrace deposit is found at this place, but in addition to the rounded pebbles of quartz-schist, quartzite, and porphyroid, there is subangular lode-matter of local derivation. This is principally dense gossan, chalcedonic silica, and silicified slate similar to that found on the lode outcrops in the vicinity. A small outcrop of gossan has been located, and near it the prospects of tin ore are better. The gossan seems to me to belong to the lode already mentioned.

To the north-west of this outcrop there is a surface cover of the older alluvial deposit.

The only other outcrop of gossan on the section is situated near the eastern boundary-line in the gorge cut by the small creek which runs into the Argent River. The gossan shows only on the northern bank of the creek, and the structural details were not discernible. The country rock alongside the lode has been converted into a red quartzite carrying veins of silica.

On the northern 20-acre section, 2766-M, some tributors were starting to work the bed of the creek which traverses the south-western corner of Lewers' section and takes its rise here. The alluvial deposit is from 1 foot to 2 feet 6 inches in depth. There is some coarse tin present, which has the appearance of not having travelled far. The country rock at this point is slate merging into the same white sandstone and conglomerate which caps the "white lode" of the Renison Bell Mine. Exposures are rare, but I noted at one point that the dip of the slate was N. 30° E., at an angle of 70°.

The wash is full of fragments of the sandstone and conglomerate, and it has been inferred that the tin ore was shed from those rocks. If it has been thence derived, it is certainly not an original constituent of the formations, and therefore search should be made on the hill above this place for any veins traversing the conglomerate.

To the south-west of this point, in Section 3240-M, and at the head of another small creek, there is a dyke of quartz porphyry 10 feet in width exposed for a short distance.

The strike of the dyke is N. 38° W., and the small exposure here visible is difficult to connect with the other long dyke, to which it is entirely similar. There must have been a very abrupt turn to the westward or a fault to account for its position at this place. Reference to the geological map will show that some turn or dislocation has occurred. There are very few outcrops, and the vegetation is very dense in the neighbourhood.

On the south-western border of the porphyry dyke there is a vein of quartz and pyrites, which is probably the source of the tin ore that can be obtained by washing at this place.

Fair prospects of tin can be obtained at a point further down the creek, near the south-western corner of R. D. Lewers' section.

There is a certain amount of detrital quartz associated with it, which appears to have come from a vein not far distant.

In the north-eastern corner of the southern section, in the creek bed, the most northerly outcrop of the long dyke of quartz porphyry is visible. It is said to carry traces of tin ore at this place.

(14) The North-western Extremity of the Tinfield. (A. D. Sligo's Section and G. Dunkley's Section.)

There appears to be a break in the continuity of the lodes as we pass north-west from W. A. J. Briggs' Section 2764-M. The adjoining 80-acre section, 3356-M, standing in the name of A. D. Sligo, is covered, in its northern portion, with the older alluvial terrace deposit. A number of holes have been sunk on this, along the track which crosses the section. The deposit is a shallow one, and carries only small quantities of tin ore. It appears to me that the best prospects should be obtainable in the beds of the creeks traversing the section.

In the centre of this lease a tunnel has been driven in a south-westerly direction into the bank of the principal creek. The tunnel intersects only slate and some irregular masses of quartz and limonite. It has been carried 85 feet on a bearing of 237°.

No record has been kept of this work, and it is not now easy to discover the object of driving the tunnel, as the ground above it does not suggest the presence of an ore-body.

Near the north-western corner of the section there is a gossan outcrop, which can be traced, with interruptions, into G. Dunkley's 65-acre section, 3296-M. In this latter lease it becomes massive and continuous, and can be followed almost the whole way across the section. Tin ore is said to have been obtained by crushing some of this gossan, but no details are available. In the creek near the termination of this outcrop there has been a little work done, and some galena and siderite are exposed.

This area should be carefully tested for tin ore, in spite of the fact that it is approaching an area which is predominantly a silver-lead district.

It has been shown that there is very commonly a little galena and blende present with the pyritic tin ores of the district, and it should not be assumed that a gossan is the capping of a silver-lead lode because some galena is visible.

(15)—The Penzance Tin Mines, No Liability.

The Penzance Company holds two mineral sections—5093-93M, 72 acres; and 5094-93M, 59 acres—together with two water-rights—810-W and 811-W.

The western mineral section includes the crest and slopes of Pine Hill, and the eastern one is situated on the slope from Pine Hill towards the Ring River.

The water-rights bring in the water from the eastern fall of the Commonwealth Hill.

The geological structure of this area is a little more complex than that of most of the other leases in the neighbourhood.

The surface of the western Penzance section is, for the most part, covered by the talus of quartz porphyry through which the massive quartz porphyry, still *in sitû*, protrudes. Where the talus has been removed by sluicing it is clear that the quartz porphyry is not continuous below, but forms dykes cutting through the slate. By reference to the generalized section on Plate III., the geological structure will be better understood.

The eastern section is for the most part occupied by the basic igneous rocks, but a narrow dyke of quartz porphyry crosses the south-western corner.

The principal occurrences of lode-matter are situated in the western section, and all appear to belong to the stanniferous quartz-tourmaline vein-type. The ore is found in lodes, which are so far not definitely connected with each other, and in a network of small veins intersecting the quartz porphyry and passing outwards into the slate.

In addition, there is a fair quantity of detrital ore in the talus, especially where this deposit rests upon a quartz porphyry bottom.

Up to the present the attention of the company has been directed chiefly to the larger lodes, and the detrital ore has been worked by tributors on both the northern and southern slopes of Pine Hill.

The fact that the removal of the stanniferous detritus has resulted in the uncovering of lode-matter should be sufficient incentive to the company to work the detritus on a much larger scale than hitherto.

The principal outcrop of lode-matter is situated close to the crest of Pine Hill and on its northern slope. The actual exposure of ore is small, but the grade is extremely high. Measured over the 15 feet of outcrop, which have been laid bare by the removal of the overburden of porphyry talus, the strike of the principal vein is very nearly north-east and south-west—S. 42° W. The dip is to the south-east at a considerable angle, which is not yet discernible. It will probably be about 50°. The formation itself is a complex one, consisting at the surface of a belt of brown or black indurated slate, which carries numerous irregular veinlets of quartz and tourmaline, with which tin ore is associated. This quartz is partly massive and partly crystalline, and some of it occurs in seams the surfaces of which are marked by a number of small indentations resembling cuts. This peculiar variety is due to the deposition of the quartz as a layer upon some other mineral since removed. It is regarded as a good sign when this variety of quartz is found in the detrital deposits, but where it occurs here *in sitû* the tin ore is not very closely associated.

A tunnel has been started on the hanging-wall side of the rich vein, and driven southwards for 60 feet from the opening set of timber. The approach and the tunnel passed through indurated slate carrying veins of quartz-tourmaline rock and stanniferous quartz-tourmaline veins for a width of 40 feet. The drive cuts across the formation at an angle, since the bearing of the drive is S. 8° E.

At 60 feet from the mouth solid quartz porphyry was met with, and the drive was abandoned.

Recently it was decided to drive a low-level tunnel to cut the rich vein mentioned above at a depth. The site chosen for the starting-point of the new tunnel is 156 feet north of the mouth of the old one, and 95 feet below it.

The overburden was sluiced from a narrow strip of ground between the two tunnels. From this work no tin ore has been sent to the market. What was recovered lies in the race. This work has been of great value in that it has given some idea of the country to be traversed by the tunnel. Another bar of indurated slate is exposed, carrying some smaller stanniferous quartz-tourmaline veins, and parallel to that mentioned above. The slate has been shattered, and the fragments impregnated and recemented together by quartz. A little pyrites is present, but most of it has been removed by oxidation. There are, however, a few irregular masses of limonite, which suggest the former presence of larger pyritic bodies, since weathered.

On the eastern border of the sluiced ground there are signs of another zone of indurated slate crossing the other (which runs north-east and south-west) at right angles.

The low-level tunnel is driven on a bearing S. 13° W., and had been carried 88 feet at the time of my examination. A gossanous lode-stuff carrying tin ore and tourmaline was cut in the first few feet of the tunnel. Then followed soft decomposed slate up to 64 feet from the opening set. At this point indurated slate carrying narrow veins of quartz and tourmaline was met. Finely divided pyrites is disseminated through the slate, and a little tin ore has been found in the veins. The drive was still in this rock when I last saw it.

After leaving the field I was shown some slate carrying veins of actinolite from this tunnel. The actinolite must have been introduced at a time other than that of the quartz-tourmaline impregnation, for it belongs to another class of deposit altogether. Large masses of it occur to the north-east in the huge vein which runs down the Gormanston Creek bed.

It is difficult to say what distance will have to be driven in this tunnel before the vein, which is so rich in tin ore at the surface, will be met with. Assuming that its dip is 50° there must be at least 230 feet of driving done.

A few trenches have been cut at a point 4 chains to the north-east of these workings, and the same hard slate carrying quartz veins is visible, but it is impossible to say whether this occurrence is the continuation of the rich vein of ore or the poorer zone in which driving was being done at the time of my examination. It seems to me advisable to push on with the present drive, and at the same time to continue the stripping of the surface deposit.

of talus so that the rich shoot of ore may be further exposed.

In the north-eastern portion of this western section there has been some work done to try and locate the vein from which the large Gormanston boulders were shed. Some trenches have been cut, and a shaft was started, but abandoned when down a few feet.

From the site of the shaft some good ore was obtained. It is rather different from the majority of the lode-stuff in this area, consisting of clean white crystalline quartz and black tin ore. The vein is distinctly crustified. There are loose blocks of similar vein-stuff found on the south fall of Pine Hill.

At the shaft there are some small veins of quartz-tourmaline rock, which are probably connected with the dyke outcropping to the southward.

Nearer to the north-eastern corner of the section the trenches have exposed a small portion of the actinolite vein, which extends for many chains towards the north. There are visible at one place haematite, garnet, pyrrhotite, and actinolite, all of which minerals belong to this vein, and not to the normal country rock.

The work done at this place is too limited to give an idea of the probable site of the vein from which the large alluvial boulders have been shed. Still, the vein-stuff exposed, and referred to above, differs in character from that of the rich stanniferous boulders*, and hence cannot have been the source of the boulders.

The parent vein whence these boulders were derived, to judge by the evidence of the boulders themselves, must be one of the stanniferous quartz-tourmaline variety, and it is most probably situated in the slate country.

Hence I regard it as most probable that the large rounded masses of the Gormanston Creek come from either the vein which is now being sought underground near the crest of Pine Hill, or from another vein similar in character and not far distant from the known one in position. It will be seen from the geological map that the strike of the known vein is such that its north-eastern extension would bring it very close to the spot where the big boulders were found.

The only workings upon the eastern section, 5094-93M, are very close to the boundary between the two sections.

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* *Vide supra*, p. cxi.

A tunnel has been driven westwards for a distance of 245 feet on a bearing of 275°, and at a height 35 feet below the tunnel now being driven.

In cutting the approach for this tunnel a zone of black slate carrying quartz-tourmaline, and tin ore was passed through. It appears to have a north and south strike, and to dip at a flat angle towards the east.

Two trenches have been put in on either side of the tunnel, and show that the tin ore is almost totally confined to the hard zone, although a little is to be seen in the soft yellow slate cut in the northern trench.

The tunnel cuts through a number of bands of indurated slate, some of which carry a high proportion of pyrites, but no tin ore was seen in these in spite of the occasional presence of tourmaline. In one place there is a development of gossan from the oxidation of this pyritic material.

The last few feet of driving are in dense quartz porphyry of average type.

The tin-bearing lode left behind at the approach of the tunnel should be further opened up at the surface to determine the length of the shoot and its value.

The workings on the western portion of the lease have been responsible for the greater part of the output of tin ore, but they are all shallow surface workings. In all cases they are in immediate proximity to, or situated directly upon, the massive porphyry.

The talus varies very much in depth from point to point, being only a few inches deep in some places, and as much as 20 feet in others. On the northern fall of the hill, the area which has been worked by the company and by parties of tributors is very close to the boundary, and on the eastern bank of the Penzance Creek. The tin ore is found for the most part on the bottom, but can also be seen in the non-disintegrated boulders of quartz porphyry.

The quartz porphyry which is exposed on the sluiced faces can be seen to carry a reticulating system of veins, which cut, tend to divide the rock up into more or less rectangular blocks. The rock on each side of the veins has been altered by the vein-forming solutions in the manner described above.* The principal veins of the reticulating system have a N.W.-S.E. strike, or thereabouts, and the porphyry has been therefore subdivided into altered zones, which have a strike corresponding to that of the veins.

* *Vide supra*, p. xcviii.

Adjacent blocks are differently affected. In some tourmalinization is the prevailing type of alteration; in others silicification; while in others again the change is one of sericitization.

The tin ore is very largely restricted to the principal veins, some of which are very rich. But it is most important to remember that the ore-body includes also the rock adjacent to the veins into which tin ore has been introduced. This question is fully discussed below.

From this reticulating system the greater part of the alluvial and detrital tin recovered from this lease has been shed.

The tin ore can be seen in the massive porphyry which is *in sitû*, in almost every outcrop, but the percentage which is present has not yet been ascertained.

No time should be lost in sampling the various zones of impregnated rock. If the ore should prove payable, the quantity of it available for treatment is very large, and the facilities for working are great.

This sampling can be rapidly effected on the sluiced faces, and on the exposed face of rock which is crossed by the high-level water-race, and on the cliffs which run from the top workings up to the top of Pine Hill.

At the south-western corner of the lease, and on the southern slope of Pine Hill, a party of tributors are working the deposit of talus in the western fork of the creek.

The upper portion of these workings has revealed a slate bottom, which is brown in colour, and contains veinlets and contorted bands of quartz, with which tin ore is present in several places. Tourmaline is not abundant. The strike of this formation appears to be north-east and south-west, but the exposure is short. The dip could not be ascertained.

Below this impregnated zone the slate is soft, and gives way to a greenish, hydrous silicate of alumina, which appears to be pyrophyllite, the mode of formation of which does not seem clear.

The notable feature of the porphyry wash at this place is the occasional presence of large blocks of a vein-stuff which has not yet been found *in sitû* on the southern fall of Pine Hill. It consists of quartz crystals and black cassiterite, showing marked comb-structure. It is similar to the ore obtained in the shaft at the north-eastern corner of this section, but has doubtless been derived from some vein or veins on the southern side of the hill not now visible. Some of this ore carries a very high tin content, and a search for the vein should be made by sluicing away the surface deposit systematically.

As a prospecting proposition these two sections, taken by themselves, should offer every inducement to investors. Several occurrences of ore have been located, and mention has here been made of other possible sources of battery stone.

There has been hitherto too much hesitation in exposing the veins of good ore which have been found, and in two instances tunnels have been driven while ore was left behind in the approach. Even granting the fact that grave difficulties have been experienced through the dense cover of vegetation and porphyry talus, the methods of prospecting which have been adopted need modification in this respect.

Should the developments of the property create the need for a battery, the site will probably need to be fixed on the Ring River, and the question of amalgamation with the leases to the northward must be considered. The milling and concentration of the ore from this area will present no difficulties, as far as can yet be seen, and the configuration of the country is very favourable to mining.

Some of the questions discussed with regard to the alluvial ground on the area to the northward are of application to the similar material which is found on this section.

The output of tin ore from the company's lease is estimated to be in all about 36 tons, of which 30 tons were won on the northern fall of the hill.

(16)—A. D. Sligo's Sections.

The sections here grouped together are six in number, viz.:—3495-M, 20 acres; 822-M, 25 acres; 317-M, 53 acres; 774-M, 75 acres; 3657-M, 73 acres; and 3658-M, 60 acres.

A water-right, 893-W, for 40 sluiceheads in the Ring River, is held by A. D. Sligo in connection with these sections.

One of these sections, 3495-M, occupies a part of the saddle between Commonwealth Hill and Pine Hill. The others occupy the northern slopes of Pine Hill and the long spur between Dalcoath Creek and the Ring River. The upper portions of the area embraced are traversed by the Gormanston and Penzance Creeks.

No one of the sections named is occupied by a single rock-formation. The greater portion is covered by slate, which is penetrated by, or associated with, igneous rocks.

The quartz porphyry forms a dyke which crosses the north-eastern corner of Section 3495-M. Another broad dyke extends across Section 822-M, and as far as Gormanston Creek on the boundary-line between Sections 317-M and 774-M.

The basic rocks occur as an isolated patch in Section 3495-M, and a broad belt to the east of Gormanston Creek in Section 317-M.

A zone of clastoporphyroid crosses Section 822-M, and is well exposed on the Penzance track.

The quartz porphyry talus extends northwards from the Penzance Company's sections, and almost wholly covers the spur between the Penzance and Gormanston Creeks.

The diabase dyke can be traced into Section 774-M, where it disappears.

Besides these there is a deposit of the older alluvial material in Section 3658-M.

These sections embrace the area which was first worked for tin ore in the district, and until quite recently they provided the greater part of the tin ore which left the field. Apart from the creek workings very little has been done in the way of prospecting the northern ground, but the more southerly sections have received some attention at different times.

On Section 3495-M, at the head of the Penzance Creek, and in the saddle between Pine Hill and Commonwealth Hill, a gossan "blow," attracted the attention of prospectors in the very early days of the field, and was first worked with the idea of testing it for silver and lead.

This ground was then held by the Renison Bell South Company, and Mr. Montgomery, in his report of 1895, makes a brief mention of it. At a later period the ground was held by the Mt. Lyell Copper Estates Company, and was being worked by this company at the time of Mr. Waller's visit in 1902. The workings, when I saw them, were much the same as at the time of Mr. Waller's visit, but the lode-matter exposed has been seriously altered by weathering in the interval.

It is now difficult to ascertain the structural features of the lode which has been responsible for the gossan outcrop. An open-cut has been excavated at the outcrop, and from what I could see the structure at that point is complex, and resembles in some respects that of the lode-systems in the northern part of the field; for the gossan cuts across the bedding-planes of the slate, and also lies between the bedding-planes.

Whether the vein-type is the same as that in the northern area cannot be determined until some unoxidized ore is exposed.

A tunnel was started at a depth of about 80 feet below the top of the hill to drive under this lode.

The approach of the tunnel is cut through a dyke of quartz porphyry, which strikes in a direction bearing 119° at this place. Immediately to the southward of this dyke a broad belt of gossan was encountered, which carries tin ore through it. The tunnel has been driven in a direction nearly due south. The bearing observed was S. 1° E., but this reading, with others obtained here, must be treated with caution, since the adjacent gabbro is heavily charged with magnetite, and pyrrhotite may be present in the lode-matter.

The tunnel was carried 138 feet on this bearing, and then 23 feet more on a bearing of 226°.

At 53 feet from the entrance a crosscut was driven eastwards for 28 feet, bearing 102°, and at 138 feet from the entrance another parallel crosscut was driven eastwards for 26 feet.

For the first 60 feet the tunnel passes through decomposed slate and gossan. Beyond this, both the tunnel and crosscut traverse indurated slate, carrying tourmaline. The first crosscut, also, is in gossanous material.

Until further work has been done at this place it is practically impossible to form any conception of the value of the lode. The size of the gossan outcrop and the visible tin ore in parts of the lode should suffice to justify the recommencement of work here at once. It will first be necessary to carefully sample the ore-body to gain an idea of the value of the lode-stuff. Then the two eastern crosscuts should be extended. It seems probable that the most southerly eastern crosscut will cut the lode if extended a short distance, and should it encounter good ore a drive on ore could be carried between the two crosscuts.

In the meanwhile much could probably be found out concerning the structure of this body by extending the surface workings.

Veins of quartz and tourmaline carrying tin ore run out into the gabbro near these workings, and with them is some magnetite, which appears to me to have been derived from the gabbro.

To the southward on the crest of the hill some trenching has been done on a very rich tourmaline-bearing vein. The ore exposed shows coarse crystals of tin ore in a band of tourmalinized and silicified slate. It is similar to that near the top of Pine Hill, and now being tested at a depth by the Penzance Company.

Whether it is part of the lode which has been followed in the underground workings above described cannot yet be said, for until further work has been done it is impossible to say whether pyrites is one of the important constituents of this type of vein, or whether the pyrites of the Penzance workings (and the gossan on this section) belong to another period of impregnation.

The rich vein on the top of the hill should be opened up in such a way that its strike, dip, and width can be ascertained. It can then be sought in depth from the underground workings mentioned.

The lode-matter on Section 822-M demands attention. At this point the workings on the steep eastern bank of Penzance Creek have afforded an excellent exposure of the reticulating system of veins in the quartz porphyry. The latter has been exposed at its junction with the slate by the sluicing away of a dense cover of porphyry talus.

The porphyry dips here in a direction E.S.E., and at an angle of about 40° or 50°. It was hoped that an ore-body would be exposed at the contact with the slate, but the results show that the contact between the two rocks is crossed by numerous veinlets of quartz, tourmaline, and cassiterite. The slate is not itself visibly affected by the igneous intrusion. At the time of my visit the soft slate carrying these stanniferous veins was being sluiced away below a cliff of quartz porphyry.

Some 10 tons of tin ore have been recovered from these workings, and it is estimated that 20 tons have been won from the Penzance Creek between this point and its junction with Gormanston Creek.

The careful examination of the cliff of quartz porphyry shows that it may yet be proved to be a deposit of very considerable value. It is, at least, necessary to test the whole exposed surface very carefully.

The features presented are similar to those shown by the smaller exposures already referred to in treating of the Penzance sections. The veins which traverse the igneous rock subdivide it into blocks.

The blocks probably owe their origin in the first place to an elaborate system of jointing consequent upon cooling. The veinlets occupy the joint-planes, and the impregnation of the rock has taken place on either side of the fissures.

At this spot many of the veinlets are obviously rich in tin ore. What is required in addition is the knowledge of what is the tin ore content in the impregnated zones of porphyry.* If it can be found that there are even a few zones of porphyry (consisting of the impregnated rock and the central veinlet) containing sufficient tin ore over a workable width to make them payable, the prospects will be bright indeed.

The writer is convinced that the investigation of this matter is one of the most vital questions concerned with the future of the field, for the exposure of available material is very large, and the facilities for open-cut mining are great. The porphyry is traversed by these veins for a great distance, and the ore, so far as exposed, is an excellent milling proposition.

It is not supposed that the whole of the porphyry can be treated, nor is it definitely known yet that zones of workable width carry sufficient tin ore to render the working of them profitable; but as a problem to be dealt with in future prospecting the importance of the question cannot be exaggerated.

The writer has, with microscopical assistance, seen an appreciable content of tin ore in rock which does not appear, to the unaided eye, to carry any at all.

This impregnation of the rock has not taken place to a similar extent in the slate country, and the veins themselves are less readily noticed in the porphyry. Hence it is that this occurrence has hitherto received no attention.

On the western bank of the Penzance Creek there is a little tin ore in the surface soil. It has probably been derived from the porphyry higher up the hill. The only other occurrence of lode-matter here is that of a little zinc blende in the porhyroid, but it does not appear to me to be very promising.

The deposit of most value in this area, apart from the lode-matter above described, is the alluvial or talus deposit which extends across into Gormanston Creek, in Section 317-M.

At a place 2 chains north of the south boundary of this latter section the large Gormanston boulders were found, and similar material in smaller sizes has been recovered all the way down the creek. The big ones probably came, as has been pointed out, from some such lode as that for which the Penzance Company is now driving a tunnel. Other similar bodies may exist beneath the cover of talus, and are, in fact, now being found where the alluvial

* See Plate V., Fig. III.

material is sluiced away. In support of this view, that other such lodes occur but are not yet revealed, may be cited the occurrence of angular blocks of tin ore in the Gormanston Creek at a place 3 chains to the northward of the southern boundary of Section 774-M. Some of these were so big as to weigh 50 lbs.

The creek-bed deposits are only that portion of the talus that has reached the creek and has not yet been carried down to lower levels.

Here and there a little work has been done above the level of the creek-bed, and the talus has been worked; but the work has been spasmodic, and the difficulty of handling the larger boulders has proved an obstacle to successful treatment by small parties of tributors. The small areas which have been worked successfully are sufficient evidence that much of the ground would be payable if worked on a large scale; and if this were being contemplated it would be most important to ascertain whether the boulders of porphyry which constitute the talus deposit are not themselves worth treating. They are composed of precisely the same materials as the massive porphyry described above, and, if the massive rock contains a payable percentage of tin ore, the boulders in the talus should do so also. The difficulty which arises here is that the vein can be seen in the solid rock, and attention can be paid only to the most likely portion or to that which is actually known to carry tin ore, whereas the talus contains boulders from all portions of the porphyry intrusion jumbled together.

However, it appears to me possible that discrimination between the various types of altered porphyry can, with a little practice, be made by eye. Sampling of the several types will, of course, be necessary, and the eye must be trained, but the quantity of available rock is large, and it is worth while attempting to turn the disintegrated rock to account.

The sluicing that has been carried out near the bed of Gormanston Creek has revealed a lode of "contact" type, composed chiefly of actinolite and garnet. There is very little axinite associated with this lode in the southern part of its outcrop, but in Section 774-M, above the bed of the creek, axinite is fairly abundant. The lode attains a maximum thickness of 2 chains on the boundary between Sections 774-M and 317-M, where the banded character is very clearly shown. Zinc blende is the most common metallic constituent at this place. The lode is fully described elsewhere in this report.

The lode continues southwards under the spot where the big boulders were obtained, and a quantity of surface gossan which is visible at the head of the creek has very probably resulted from the oxidation of the pyrrhotite, which has been introduced during this period of vein-formation. Part of the gossan may, of course, have been derived from the weathering of the basic rocks which occur here. At the head of the creek the normal gabbro appears, but in Section 317-M the gabbro-amphibolite variety predominates.

In the bed of the Gormanston Creek, a few chains above its junction with the Penzance Creek, there is a lode which has been proved to carry tin ore. It is about 18 inches wide, and dips to the south-west at an angle of 30°. Judging by the composition of the exposed portion, I believe that this lode will prove to be of the pyritic-cassiterite type, and to be more closely related to the lodes to the north-west rather than those to the southward.

In the northern portion of this Section 774-M there are two small creeks which join and flow into the Dalcoath Creek opposite the long low-level tunnel on the northern boundary of the Boulder lease.

There is a shallow deposit of wash similar to that occurring in the bed of the creek on the eastern bank in this place, and it has been worked by tributors. The wash seldom exceeds 3 feet in depth, and is not often over a foot deep.

The exact amount of tin ore recovered from this place is not known, but must be fairly large.

A little gold and osmiridium was obtained here. It has doubtless been derived from the older alluvial deposit, which forms the crown of the hill to the north-east.

In the opinion of the writer, this older alluvial terrace does not constitute in itself a body which is likely to prove payable. Yet the deposit at this place is likely to prove richer in tin ore than at other spots more distant from the tributaries of the older Pieman River, which brought in the tin ore. The present site of the Dalcoath Creek does not appear to be very far from that which it occupied at the time of the formation of the alluvial deposit now forming a terrace. It will be worth while examining this older alluvial formation carefully for the presence of quartz porphyry pebbles, since these would certainly be present in the terrace deposits in greater proportions than usual at the former junction of the Dalcoath Creek and the old Pieman Valley.

Some work has been done on the course of a small creek in Section 3658-M, and the usual characteristics are shown. The tin ore was associated with chromite and a little gold and osmiridium, and, as usual, proved payable where secondary concentration has taken place.

On the eastern fall of the spur, above the Ring River, some sluicing has been done many years ago. The boulders and pebbles in this wash are similar to those of the Ring River of to-day, and to those in the terraces, except that in the lower portion some pebbles of quartz porphyry are to be seen. This wash is in places 3 feet or more in depth, and the bottom is slate. Mr. A. Montgomery, in his report on this area in 1895, suggested the presence of a former gutter running through this hill. It may be present, but I could find no positive evidence of it. The Dalcoath Creek must have existed at a very much higher elevation than it does at present, for the porphyry wash is visible high on the sides of the spur to the westward of the ridge. In fact, it may have joined the old Pieman River in some part of Section 774-M, and if so the porphyry boulders now visible on the Ring River side of the spur are due merely to a redistribution of the material brought down into the older Pieman basin.

A shaft has been sunk near the top of the spur in Section 3658-M, to which Mr. Montgomery refers in his report. It is down some 35 feet, and has been untouched since Mr. Montgomery's visit.

The evidence of the material on the tip, which consists of soft kaolin and fragments of slate, does not, to my mind, show any proofs of a gutter which might be the site of the former course of Dalcoath Creek. There are at least no pebbles of quartz porphyry in the materials heaped round the collar of the shaft.

On the eastern bank of the Ring River there is another terrace of the alluvial deposit of the old Pieman River, and Star Creek, which joins the Ring River in Mr. A. Kemp's section, 1059-M, has been worked in the earlier days of the field for the tin ore which has, doubtless, been derived from the older alluvial.

It is a very similar occurrence to several others mentioned in this report, and the payable ore occurs where the secondary natural concentration has happened.

The only other work done within these sections is that which has been directed towards the proving of a lode situated at the water's edge, on the western bank of the Ring River, and in Section 3658-M.

The lode strikes with the Ring River a few degrees west of north, and appears to dip to the eastward. The lode belongs undoubtedly to the pyritic-cassiterite type, and should be tested for tin ore wherever it is exposed. The lode-stuff is impregnated slate and clean ore as well, and is remarkable for the proportion of zinc blende and galena present. Reference has been made above to the presence of small amounts of zinc blende and galena in the pyritic-cassiterite lodes. At this place the lode shows so much of the two minerals mentioned, together with fluorspar, that it resembles more closely a pyritic lead vein than one of the type to which it has been here referred. It is in reality one of the occurrences of vein-matter which is intermediate in character between two related types.

At one spot there are a few veins of clean galena running in a south-easterly direction into the Ring River. These appear to be only small branches of the main lode.

There is a small outcrop of quartz stained with limonite at the northern end of the spur between the Ring River and Dalcoath Creek, but it is not known to carry tin ore.

The several mineral sections here considered constitute a property the chief value of which is situated in the northern portion. However, if it be found possible to work the porphyry as a whole, or a large portion of it, the ore can be carried to the Ring River on a good grade without leaving the boundaries of these sections; and it will probably be found possible to utilize the power stored in the Ring River for milling purposes. The supply of water is reliable; and from the topographical map published herewith it will be seen that there is a fall of over 200 feet (aneroid reading) between Ringville and the junction of the Ring River with Star Creek. The available water-rights are secured.

Should it be found possible to work the reticulating vein-system in the porphyry, these sections here treated of, together with the small section, 5063-93M, in the name of E. Swenson, should be amalgamated with the Penzance sections, and the whole group worked together, for the occurrence of tin ore is the same in these sections, and the problems of treatment are the same for all. Moreover, a large amalgamated lease should offer more inducement to capitalists. The possibilities, especially of the veins in the porphyry, are, to my mind, at least as great as those of any in the district; but it is certain that operations must be conducted on a large scale, and for that reason an amalgamation of interests is desirable.

Until capital is found to undertake the systematic sampling and prospecting of the area, nothing very definite can result. Yet, as a prospecting proposition, there can be no doubt about the merits of this area.

The output of ore from the leases standing in the name of A. D. Sligo cannot be given. The amount of ore removed from Gormanston Creek is not known, but it must have been considerable. Star Creek, also, is said to have produced a fair quantity.

(17)—The Remaining Sections near Pine Hill.

E. Swenson's Section 5063-93M, 5 *acres*.—This section is situated at the south-western corner of A. D. Sligo's section, 317-M, and occupies the central part of the spur between Gormanston and Penzance Creeks.

A fairly large area of the porphyry talus has here been worked with profit by a small party. Prospects which I saw washed on this section were certainly very good. Below the talus bands of indurated slate can be seen. They run in a N.W.-S.E. direction, and are probably due to the action of the vein-forming solutions which affected the quartz-porphyry.

I am informed that 18 tons, in all, of tin ore have been recovered from this section, of which 8 tons have been recovered by the present owners.

M. Curtin's Sections—3650-M, 76 *acres; and* 3651-M, 40 *acres*.—These sections are situated on the south of Pine Hill, and include the area between the Penzance lease and the Confidence Saddle. The northern of the two sections is situated on the broad belt of gabbro which runs through to the Melba Flat. The southern section is for the most part on slate. A quartz porphyry dyke traverses the two sections.

In the northern section there is a very promising vein in the gabbro, but at no distance from the quartz-porphyry dyke. Crystalline tin ore is visible in a gangue which is composed of quartz and fibrous radial aggregates of tourmaline needles.

The vein strikes S. 31° W., and dips towards the south-east at an angle of 75°. A little work has been done by the former owners of the section, but the intention has not apparently been to prove this lode, since the tunnel was driven away from it.

The bearing of the tunnel is S. 19° E., and it has been driven 40 feet. In the approach the lode is cut, and is of good value. The rest of the tunnel has been driven at an angle with the strike, and is gradually getting further and further from the lode. A short crosscut driven westwards from the end would intersect the lode in a few feet of driving. This should certainly be done.

A little trenching has been done near the mouth of the tunnel, and this work should be continued on the strike of the lode.

On the southern section, 3651-M, a tunnel has been driven for 96 feet on a bearing of 27° through a zone of brecciated slate. In this slate are some veins of quartz and pyrite, but no definite lode-structure could be discerned. A trench which has been cut on the slope above the tunnel is said to have afforded good prospects of tin ore.

From the creek which runs towards the Ring River from the north-eastern portion of the section a little tin ore has been obtained. But there is a great deal of chromite with it, as might be expected from the proximity of the basic rocks.

W. A. Hawkes' Section 1085-M, 27 *acres.*—Some work has been done in the north-western portion of this section, which adjoins the western section of the Penzance lease, and lies to the south of it.

The more recent work has been carried on in the bed of the creek which runs out of the Penzance ground through the quartz-porphyry talus. On the northern boundary this deposit is 20 feet thick. With the boulders of porphyry are a few composed of altered gabbro, the latter occurring *in situ* at this place.

A few small veins of quartz and tourmaline are visible in the bottom where the wash has been sluiced away.

From these workings 8 tons of tin ore are said to have been won, and the assay value of this ore is between 68 per cent. and 72 per cent. metallic tin.

Altogether, about 6 chains of this creek, southwards from the Penzance boundary, have been worked.

To the west of these workings some attempts have been made to pick up the course of a lode which was partly exposed by a trench in the north-western corner of the section. The country rock is slate, and it carries quartzose veins, in which tin ore is said to occur. The lode appears to me to be the continuation of that which is partly exposed in the south-western corner of the Penzance section.

A shaft was sunk to a depth, it is said, of 38 feet, and tin ore is reported to have been found in it. At the time of my visit the shaft was full of water.

At a point further east, a tunnel has been driven for 120 feet towards this lode-formation in a direction bearing 306°. The first 18 feet of the drive are in gabbro, and the remainder in shattered slate. At 90 feet from the entrance a drive of 18 feet was carried northwards on a small make of quartz.

The workings which show tin ore at the surface are still further to the north-west, and the tunnel must be continued in order to prospect the lode in depth.

G. K. Moore's Section 3114-M, 40 *acres*.—On this section there are some quartzose bands in the slate which occupies the northern part of the section. These were very probably introduced during the period of impregnation during which the siliceous lodes above described were formed.

No actual mining has been done on the section, but it is said that tin ore occurs in the surface soil. How much of this tin ore is of local derivation remains to be proved. The chief value of the section lies in its position on the strike of the lode running through the north-western corner of W. A. Hawkes' section.

G. E. Brown's Section 453-M, 80 *acres*.—This section is situated a mile and a half to the south-east of Pine Hill, on the Great Northern Creek, and is traversed by the North-East Dundas Tramway. The topography is extremely rough, and the greater part of the section is covered with dense scrub. Two lodes have been located in the lease, one of which is predominantly copper-bearing and the other is known to carry tin ore.

Both lodes should, in my opinion, be classed in pyritic-cassiterite type.

The copper-bearing lode is situated in the northern part of the section, on the western bank of the Main Creek, and just below the falls in the creek. The lode is 2 feet wide, and strikes N. 38° W., and dips to the north-east at 80°. On the foot-wall side the slate is impregnated for a width of a foot. The predominating mineral in the lode is arsenopyrite, with which occur pyrrhotite, copper pyrites, and quartz. The lode should certainly be tested for tin ore and gold, in addition to the copper known to be present.

A small open-cut has been made, the workings being carried into the steep hillside; and on the opposite bank a strip has been cleared for the purpose of erecting a haulage-system to raise the ore to the North-East Dundas Tramway-line, but at the time of my visit work was not in progress.

The tin-bearing lode has been exposed in the tramway-cutting near the southern boundary of the section. It is there in a semi-oxidized condition. The strike appears to be N. 60° W., and the dip is to the north-east, at about 80°. The lode-stuff is for the most part quartz and pyrites, but some specimens were shown to me which are said to have come from this place, and these are certainly rich in tin oxide.

An attempt has been made to cut the lode underground, and a short tunnel has been driven westwards on a bearing of 260°. This tunnel intersects a shattered belt of slate carrying flat quartz veins and seams of siliceous gossan. Some of these have been followed for a few feet in the underground workings, and some of the ore removed from thence shows a little crystalline tin ore.

(18)—Other Occurrences of Ore in the Central Portion of the Tinfield.

The section, 2816-M, 79 acres, held by Messrs. C. E. Brown and A. E. Hodge, contains a galena lode upon which some work has been done. It lies in position between the Emu Bay Railway line and the Argent River.

There has been a shaft sunk on the lode to a depth of 23 feet, and from this shaft some 3¼ tons of galena were recovered. The shaft was full of water at the time of my visit, and no work was proceeding.

If the lode exposed in the railway-cutting is the same as that upon which the shaft was sunk the ore-channel has pinched very considerably. The strike appears to be N. 30° W.

An assay made of clean galena from the shaft is said to have given a return of 86 per cent. lead and 66 ounces of silver per ton. The grade of the metal is therefore good, but the continuity of the lode remains to be proved.

On vacant ground near the top of the Commonwealth Hill a little work has been done some years ago by the West Coast P.A. upon a lode which is composed of galena, zinc blende, iron pyrites, with a gangue of quartz and siderite. The slate alongside the lode is indurated.

Another lode on vacant ground which has been partly worked is situated on the north-western slopes of the Commonwealth Hill, and is distant a chain and a half from the end of Messrs. Duncombe and Maddox's water-race. The lode-matter consists of zinc-blende, with pyrite, pyrrhotite, and a little galena in a gangue of quartz and chlorite, with minor amounts of calcite, ankerite, and fluorite.

It is a lode which resembles that described above as occurring in the bed of the Ring River, in Section 3658-M, and should be examined for tin ore, since it is clearly only a variant from the normal type of pyritic-cassiterite veins.

The lode runs almost exactly north-west and south-east, and a tunnel has been driven in a south-easterly direction for 129 feet on its course. The thickness of the lode varies from a few inches to a foot, and the dip is to the north-east at an angle of from 70° to 80°.

Both in this case and in that of the old West Coast P.A. workings, mentioned above, the distribution of the metallic minerals is irregular; and the occurrences do not offer very much encouragement.

On the eastern slope of the long spur which lies between Gormanston Creek and the Ring River there are two outcrops of gossan which are situated at points 5 chains east and 5 chains south of the north-eastern corner of Section 317-M. The area enclosing these two outcrops has, I understand, been recently taken up with a view to the proving of these gossan outcrops. Whether the two are connected it is yet impossible to say.

Samples taken from the more easterly outcrop are said to have shown a small content of gold; and, such being the case, the lode has possibilities for smelting purposes.

As in the case of other gossans in the district it should not be forgotten that there may be tin ore present.

(19)—The Occurrence of Tin Ore on the Melba Flat and in H. E. Evenden and W. T. Moyle's Section.

There has been a fair quantity of tin ore won from alluvial workings on the Melba Flat. Very little is being obtained at the present time, but some tons have been sent away in the past from the neighbourhood of the sawmill. The tin ore is not found more than a few chains eastward of the sawmill, and has been traced into Section 3558-M, 80 acres.

Up to the present time very little more than its actual presence on the section is known.

A strong gossanous ore-body crosses the section, and the tin ore has been traced up to this lode.

I saw some of the lode-matter crushed and vanned, with the result that fine tin ore could be seen; but it seems probable that there are veins of better grade than any which I saw *in sitû*, for the tin ore on the Melba Flat is sometimes fairly coarse and clean. More careful prospecting is therefore required on the section here referred to. The gossan is a dense one, and carries a high proportion of haematite, in addition to limonite. This may not be a feature of the lode in depth, and till some work has been done it cannot be decided. There has been a tunnel driven on the lode in a southerly direction, but it had completely collapsed, and was inaccessible at the time of my visit.

The upper portion of the hill is composed of the brecciated conglomerate referred to elsewhere, and there are two well-defined branches of the main lode exposed. Careful search should be made for any other branch veins in the conglomerate, some of which may have shed the cleaner ore found in the alluvial deposit of the Melba Flat.

The main lode follows a course which bears S. 12° E., and can be traced southwards for many chains beyond the boundary of Section 3558-M. It crosses Section 2339-M, and has been broken into on the surface at a number of places south from this section.

Whether a tin-ore content has been proved outside of Section 3558-M, I could not ascertain. Some of the work done was carried out a long time ago, and it is probable that no thought was paid to the possibility of tin being present in the lode.

(20)—The Occurrence of Tin at Dundas.

During my examination of the North Dundas tinfield there was a discovery of tin ore made near the centre of the town site of Dundas. The alluvial tin ore was discovered by Messrs. Quinn and Hodge, and was by them traced to a lode outcropping along a south-easterly spur of the Razorback.

The occurrence is one of extreme interest, in that no acidic igneous rocks have yet been seen in the neighbourhood, and the lode mentioned is very close to the junction of the slate with a broad belt of serpentine. However, the common origin of this serpentine, and the acidic rocks, has here been strongly advocated, and if this view be accepted there is less cause for comment on the association of tin ore with serpentine.

The lode lies in slate which shows a remarkable induration near the contact with the serpentine. The upper part of the Razorback consists of the brecciated conglomerate referred to elsewhere.

Two sections have been pegged out by the discoverers, viz., 3756-M, 20 acres; and 3765-M, 10 acres. Of these, the former is located high up upon the spur of the Razorback, and the latter lies in the flat country traversed by the Dundas Rivulet near the town.

At the time of my visit the upper section was being worked, water having been brought on to the section by means of short races from the small streams. A dam has been built at the top of the spur, but the water-supply is precarious, and rapidly ceases when rain stops falling. The area being sluiced lies on the north-eastern slope of the hill, and when my examination was made, very little had been done beyond the preliminary work of race-cutting, &c. The deposit being sluiced presents many surface features in common with the detrital deposits of North Dundas, but the structure remains to be proved. At only one place was the bottom exposed. It consists of slate in which are numerous cubical cavities after pyrite and veinlets of a siliceous or gossanous character.

In some of these veinlets the tin ore is fairly clean.

Those which I saw are small, but the presence of large slugs of lode-stuff in the detrital ore is proof of the presence of some fair-sized veins, some of which must carry a high percentage of tin ore. The forkings from the race present many features of similarity with those of the central area of the tinfield.

The depth of the detrital ore varies considerably—from a few inches up to over 5 feet in one place.

Only half a chain distant from the face which was being worked when I was on the section is an outcrop of quartz and limonite from which tin ore can be obtained by crushing and vanning. This outcrop appears to be part of the lode-system which is being worked, although its relationship to the detrital ore cannot yet be deciphered.

On the lower slopes of the hill there is a good deal of limonite in the surface detritus, and on account of this cover the junction of the slate with the serpentine is difficult to determine.

In the northern part of the section there is a tunnel which has been driven for 180 feet on a bearing of 248°. It is in serpentine all the way. The apparent reason of this work was probably the testing of the iron outcrop in depth, but the work was abandoned before reaching the slate country.

On the southern section taken up by Messrs. Quinn and Hodge some excellent alluvial ore exists. No work has yet been done on the section beyond the sinking of prospecting holes. The prospects washed here are certainly good, some of them giving as much as 4 ounces of tin ore to the dish.

Along the junction between the serpentine and slate at this point there is a considerable silicification of the slate. It seems to me probable that the tin ore has been derived from some veins in this silicified zone.

The amount of available alluvial ore is not large, and the deposit is restricted to the immediate neighbourhood of the creek and the zone of silicification. The tin ore is hardly rounded at all.

Just outside the section, and close by the western boundary, an attempt has been made to work the alluvial ground. A few square yards of surface wash have been sluiced away, and a few bags of tin ore won, but on the whole the ground was too poor to pay. The wash here is from 6 inches to 2 feet deep, and the bottom is a gritty sandstone belonging to the slate series. The tin ore obtained was partly coarse and partly fine. The latter contained an admixture of crystalline chromite, which could not be sieved out, but the coarse tin ore was effectively cleaned by sieving.

The section, 1897-M, which lies between the two sections taken up by Messrs. Quinn and Hodge, lies on the junction between the slate and serpentine; and along the contact runs an irregular outcrop of limonite, which has been partly prospected for the purpose of testing its value as a flux.

No work was proceeding on this section when I visited the district.

Only after the discovery of tin ore by Messrs. Quinn and Hodge was the section tested for tin ore. This is reported to be present in the lode-matter at one point in the northern portion of the section, but nothing more seemed to be known concerning it.

The lode-matter should be tested right through the length of the section, and the surface soil examined for detrital ore.

The lode which traverses the area here referred to appears to be continuous for some distance to the southward, and in view of the discovery of tin ore here should be tested right along its outcrop.

The type of vein represented at Dundas is the pyritic-cassiterite type, but the unoxidized ore has not yet been exposed.

VIII.—CONCLUSION.

It is as yet a very difficult matter to make any confident prediction with regard to the future of the field, for the era of lode-mining is only just beginning, and in very many cases still no attention is being paid to ores other than those of an alluvial or detrital nature. The future of the district cannot depend upon these classes of ore, which have hitherto provided almost the whole of the output.

A number of the more important occurrences of ore in the central portion of the tinfield have been here grouped together under the title of the Renison Bell-Montana-Boulder "lode-system," and the collective system presents certain difficulties when the future mining and metallurgy of the ore are considered. For the structure of the lode-system is exceptionally complex, and the ore for future treatment is a pyritic one.

It is perfectly certain that the oxidized ore cannot last long; therefore, for the sake of the future of the properties, a proportion of the profits made from the comparatively simple treatment of the oxidized ore must be spent in perfecting a system of treatment for the pyritic ore.

This question—the treatment of the unoxidized lode-stuff—must be always foremost in the minds of those to whom the management and control of the mining properties have been entrusted. It is a question which must not be left over wholly unsolved until all the oxidized ore is exhausted. Such a procedure would be economically unsound.

Since the problem must now be faced by a number of separate companies or interest-holders, its solution would undoubtedly be aided by the amalgamation of interests in the case of those mining properties in which the mode of occurrence of the ore is the same or similar.

It may be that the problems concerning the treatment of this pyritic-cassiterite ore will prove to be less serious than the holders of the several properties anticipate, but they can only be solved by careful and systematic experimental work. Statements have been made regarding the impossibility of having the ore treated locally by Australian metallurgists. Such statements are wholly unjustifiable.

There are several matters which are at present almost wholly undetermined with regard to this pyritic ore, and which demand solution forthwith.

First and foremost, the average value of the ore in the several mines must be ascertained. This cannot be done without development, and it cannot be done without careful and systematic sampling.

Then several other questions must be considered, and the details regarding the crushing, roasting, and concentration of the ore, together with the plant necessary for these operations, must be taken into account. The metallurgical and dressing problems cannot be settled in an offhand way without experiment, and the best available advice should be sought at an early date.

There is no doubt but that the ore can be successfully treated, and marketable tin ore produced, if the grade of the ore is sufficiently good to enable the several operations of mining, milling, and roasting to be carried on at a profit. It is therefore essential to determine as soon as possible the value of the ore-bodies.

And in this valuation of the lodes there is one matter in particular which requires careful investigation.

The pyritic-cassiterite ore may prove to be itself of sufficiently high grade to allow of treatment, but it may be interlaminated with slate in some places in such a way that the bands of slate and ore must be considered together as the ore-body. In these cases it remains to be determined whether the ore-body as a whole can be profitably mined and treated, or, if not, whether hand-sorting or rough concentration can be effected so that the grade of the ore can be raised to the necessary standard.

The mineralized area in the centre of the field is certainly large, but it has been shown that this is mainly due to the horizontal position of many of the component members of the principal complex lode-system.

It remains for future prospecting to reveal the nature of the downward continuation of that lode-system. It is certain that the system continues downwards, but the details of the structure of the lower portions remain to be laid open by mining operations.

The work which has been done up to the present upon the Dreadnought-Federal lode-system would seem to indicate a greater simplicity of structure. Hence the mining and prospecting of the system will prove less difficult. But the same problems as those indicated above must be solved with regard to the dressing of the ore, which is of the pyritic-cassiterite type. Outside of the two lode-systems mentioned, and the lodes immediately adjoining these, the outcrop of greatest promise is that which is situated in the boundary between the two sections of the Boulder Company's lease. Some of the ore here is undoubtedly of very high grade, but very little work has yet been done on the actual lode.

The ore of the sections situated in the neighbourhood of Pine Hill presents a far greater simplicity of character, and as far as can yet be seen does not show any appreciable percentage of pyrite as an essential constituent of the lode-matter. The dressing costs should therefore be considerably lower than those of mines which have to deal with the pyritic ore.

The future of the properties in this area depends more upon the results of development work now actually in progress or suggested in this report than on the perfection of an effective and inexpensive method of treatment. Some excellent veins of ore have already been located; but there has been far too little done yet (in the way of following up these veins along their outcrop on the surface and of prospecting them in depth) to determine whether the future of the area is assured.

It has here been pointed out that the great mass of quartz porphyry, penetrated by stanniferous quartz-tourmaline veins and impregnated by mineralizing solutions on either side of these veins, is a possible site of future mining operations. The large area of impregnated rock, and the readiness with which it could be mined and treated, are surely sufficient inducements for active sampling and prospecting.

In the absence of any ascertained data bearing on the questions herein briefly indicated, an expression of opinion as to the future of the field cannot be given.

The field has produced a large amount of tin ore, and this fact alone should stimulate prospecting and encourage section-holders to proceed steadily with the work of testing the unoxidized ore.

With regard to the future of sections situated outside of the central portion of the field still less can be said, for very little work of any kind had been done on these at the time when this examination was made. There are numerous occurrences of lode-matter, some of which have shed a fair quantity of alluvial ore. In all such cases the parent lodes should be very carefully prospected.

The boundaries of the tinfield have probably been almost fully delineated by the limits of the area included in the geological map herewith.

It does not appear to the writer very probable that tin ore will be found *in sitû* far beyond these limits; but, as has been shown, alluvial tin ore may be expected to be seen for miles down the Pieman River, both in the older river terraces and in the more recent gravels.

Those portions of the area mapped within which prospecting should be carried on in greater detail, and within which lode-matter not yet located seems most likely to be found, are:—

(1) The long spur lying between the Gormanston-Dalcoath Creek and the Ring River.

(2) The area lying to the east and south-east of Pine Hill, between Ringville and the Confidence Saddle.

Before finally closing this report, it should be stated that there are certain points herein emphasized which should prove of value in the prospecting of areas beyond the limits of the tinfield of North Dundas.

Of these, much the most important is the association of the basic and acidic igneous rocks, and the association of the tin ore with both.

It is known that the igneous rocks of the North Dundas tinfield are not separate units, without connection with any other similar rocks, for the igneous invasion has extended for many miles to the north and north-west (without taking the granite of Granite Tor into account).

The area in the neighbourhood of the Meredith Range therefore calls for careful examination, and the mode of occurrence of the ore at North Dundas should be borne in mind in the prospecting of this still unknown country.

This report embodies the results of field-work which was carried on continuously, save for the interval of one week, from June 22 to October 14, 1908.

In expressing my thanks to the mine managers, prospectors, and others on the field who have at all times afforded me all possible assistance and information, I wish to assure them that their help has been fully appreciated

To Mr. A. D. Sligo, of Zeehan, I am especially indebted for much information regarding the field, and for field assistance on very many occasions.

The Dreadnought and Penzance Companies kindly placed their respective camps at my disposal during my stay on the field, and for this hospitality also I wish to express my thanks.

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

Launceston, 12th February, 1909.

APPENDIX.

Notes with regard to the Plates.

PLATE I.—The heights given are in feet above sea-level. The altitudes of points on the Emu Bay Railway and the North-East Dundas Tramway lines have been courteously furnished by Mr. J. Stirling and Mr. G. C. Bernard respectively. The figures given apply to the heights of the rails at the points indicated.

The altitudes of other points are from the aneroid readings made by the writer of this report.

PLATE II.—The numbers of only the outlying mineral sections are recorded on this map.

PLATE IV.—The numbers of the mineral sections other than those mentioned above are shown on this map. The sections which are shown are those which were held at the time of the writer's visit to the field.

PLATE V.—The diagrams to explain lode-structure are not drawn to scale. They are diagrams only, and are not intended to be applied to particular localities.

Figure I. represents the branching type of lode referred to on page 61.

Figure II. represents the complex type of lode-system referred to on page 63.

Figure III. shows the method of distribution of the veins and zones of impregnated rock in the reticulating vein-system in the quartz porphyry of Pine Hill.

Figure IV. is intended to show diagrammatically the passage of pyritic-cassiterite ore into (1) gossan, and (2) siliceous ore free from iron. The controlling causes producing the two varieties of oxidized ore are discussed on page 70 of this report.

Figure V. is an ideal section across the main lode-system in the centre of the field—here called the Renison Bell-Montana-Boulder lode-system.

The diagram shows the relation of the "floors," "feeders," and zones of impregnated slate.

The different varieties of feeding channels are shown.

KEY TO THE NUMBERS OF THE MINERAL SECTIONS SHOWN ON PLATES II. AND IV.

Number of Section.	Acres	Lessee.
3187-M	181	Renison Bell Prospecting and Mining Co., N.L.
4550-93M	37	R. D. Lewers, now Renison Bell P. & M. Co., N.L.
1342-M	78	Montana Tin Prospecting Syndicate, N.L.
1963-M	80	A. B. Duncombe and A. Maddox
271-M	77	E. Flight (The Boulder Tin Mining Co., N.L.)
5101-93M	80	M. P. O'Dea (The Boulder Tin Mining Co., N.L.)
2650-M	78	Chas. Brumby (The Dreadnought Sections)
2763-M	77	A. G. S. Morton (The Dreadnought Sections)
1273-M	79	(A. S. Stebbins) The Federal Tin Mines, N.L.
1215-M	36	C. Brumby
3370-M	70	H. E. Evenden
3660-M	62	H. E. Evenden and S. Rearden
103-M	40	A. Kemp
496-M	5	A. Kemp
2101-M	13	A. Kemp
1059-M	5	A. Kemp
1901-M	5	M. Keys
3621-M	80	T. C. Goodall
1945-M	79	E. Hawson
2764-M	38	W. A. J. Briggs
2765-M	20	W. A. J. Briggs
2766-M	20	W. A. J. Briggs
3240-M	20	W. A. J. Briggs
3356-M	80	A. D. Sligo
3296-M	65	G. Dunkley
2212-M	32	E. H. Butler
3166-M	56	H. E. Evenden
3762-M	75	A. Nicholas
5093-93M	72	The Penzance Tin Mines, N.L.
5094-93M	59	The Penzance Tin Mines, N.L.
3495-M	20	A. D. Sligo
822-M	25	A. D. Sligo
317-M	53	A. D. Sligo
774-M	75	A. D. Sligo
3657-M	73	A. D. Sligo
3658-M	60	A. D. Sligo
5063-93M	5	E. Swenson
3650-M	76	M. Curtin
3651-M	40	M. Curtin
1085-M	27	W. A. Hawkes
3114-M	40	G. K. Moore
453-M	80	C. E. Brown

Number of Section.	Acres.	Lessee.
2816-M	79	C. E. Brown and A. E. Hodge
3771-M*	78	J. Hamilton
2196-M*	40	G. D. Cooper
2197-M*	40	
3558-M	80	H. E. Evenden and W. T. Moyle
2339-M	20	W. J. Hodge
3573-M*	20	
1788-M*	40	V. Braggiotti
3756-M	20	P. P. Quinn
3765-M	10	
1897-M	80	J. S. Robertson

NOTE.—Ore-bodies on the sections marked * were not examined.

GEOLOGICAL EXAMINATION OF THE ZEEHAN FIELD.

I.—INTRODUCTION.

(a) Reasons for the Institution of the Present Survey.

During the last year or two the operations in depth of the English companies represented in the Zeehan field failed to meet with the same measure of success as rewarded their efforts in former years. The shoots of ore which have been worked in the past have been followed down to points where they either terminated or became too small to admit of profitable extraction. This has been the experience of the deepest mine on the field, viz., the Western, and in some measure, but with important qualifications, that of the Zeehan-Montana Mine. With regard to the other mines, in no case has sufficient depth been attained to justify any adverse statement with regard to the downward continuation of the ore-shoots.

A despondent view has, however, been taken by the board of directors of the Zeehan-Montana Mine. This found expression in a speech delivered by the chairman at the last annual meeting of shareholders in London, when he stated "sinking to greater depths in Zeehan has now been conclusively proved to be practically waste of money. The show exists from the surface down to the 500-feet or 600-feet level, and below that the shoots of ore begin to disappear. The lodes continue, but the shoots of ore do not." In this speech there are apparent indications that the group of English companies operating in Zeehan are inclined to withdraw the capital invested in their enterprises here. This impression is confirmed by the recent suspension of operations by the Mt. Zeehan (Tas.) Silver-lead Mining Company.

Under the circumstances the Government of Tasmania decided to initiate a special examination of the Zeehan field, in order to ascertain all facts bearing upon the behaviour of the lodes in depth and the permanence of the field in general.

(b) Period Occupied by the Examination.

The investigation of the problems involved has occupied a period of three months, and a detailed report will be prepared and issued as a Geological Survey Bulletin as expeditiously as possible.

In the meanwhile this preliminary report is submitted as a brief outline of the results of our examination, and of the conclusions at which we have arrived.

II.—NATURE OF THE EXAMINATION, ITS SCOPE AND METHOD.

The principal object of the present examination has been to acquire all possible information bearing upon the genesis of the lodes, the source of their metallic contents, their structural features, the distribution of the ore-shoots, the probable extension of these, and the variation of metallic contents from point to point, together with all such questions as cluster round ore-deposition.

The consideration of these problems is the special function of the Geological Survey, and lies outside the province of the mining engineer, whose investigations naturally centre on "ore in sight" or "ore available" and commercial questions dealing with costs and quantities and methods of exploitation.

Nevertheless the more purely geological factors have a vital bearing on the supplies of ore and methods of prospecting, and sound information in respect of them must assuredly be of the greatest practical value both to the investor and to his technical adviser.

The forthcoming report will deal with all these questions in a systematic manner, and will, we venture to think, comprehend all that geology has to say upon the field as at present accessible and disclosed.

Several of the more important and numerous lesser mine workings are now inaccessible, and our examinations have consequently not been so complete as we could have wished. Our conclusions have had to be drawn from fewer instances, and are necessarily to that extent deprived of some of the force they would otherwise have possessed. We shall, however, take care to indicate those which we regard as irrefragable, and such as have only the force of probability.

Although the principal aim has not been to furnish descriptive reports of the mine workings of individual properties, nor to map the position of every ore outcrop, every endeavour has been made to examine all accessible occurrences of ore, and especially those now being exploited. These have been examined principally with a view to the light which they may shed upon the larger and more general questions which concern the field as a whole.

The general geology of the field has received attention as well as its mining geology, and some advance has been made in our knowledge of this. This has been the first opportunity of reviewing the general geology in the light of the results of recent investigations, and the subject will be treated at length in the full report.

The comprehensive report and geological map of the Zeehan field prepared by Mr. G. A. Waller, and issued by the Department of Mines in 1903-1904, have materially assisted our investigation and effected a great saving of time.

III.—FORECAST OF THE FORTHCOMING REPORT.

A sketch outline of the subjects to be embraced in the coming report may be provisionally stated as follows:—

(1) The physiography of the field, including its topography and an account of the processes by which the present surface of the land has come to occupy its actual position. The effect of topography on mining. The relation of occurrences of primary ore to present land surfaces.

(2) The general geology of the field; comprising the sequences of the geological record (sedimentary and igneous rocks).

(3) The economic geology of the field; including the description of the ore-deposits, their type, their contents, their gangue, their structure, the changes to which they have been subject, &c. Discussion of the genesis of the ores, of their connection with the Heemskirk *massif*, of the contact metamorphic zone surrounding the granite of Heemskirk, of the *magnetite-blende-galena-chalcopyrite* lodes in this zone (Comstock), of the connection of the tin-bearing veins in the Zeehan field with the underlying granite. Other signs of the proximity of granite in the field (dykes). The sequence of mineral deposition at increasing distances from the magmatic hearth.

(4) The observed variations in the contents of the lodes. Primary variations. The question of the modification of primary contents by secondary processes. The distinction between primary and secondary variations. Differences in the metallic contents at different horizons in the lodes.

The depth to which the ore-bodies may be expected to extend. Deductions which may be drawn from the deep mining of similar ores in other parts of the world.

(5) The geological considerations to be taken into account in testing the existence of lodes below or beyond present workings.

IV.—PRELIMINARY STATEMENT OF RESULTS OF THE GEOLOGICAL EXAMINATION.

For the purpose of this preliminary statement the scheme outlined above need not be closely followed. Our remarks for the present may be confined to such portions of the investigation as have an immediate practical bearing, and to a statement of the conclusions at which we have arrived.

Brief Historical Statement.

Zeehan dates from the discovery of a silver-lead lode on the present Mt. Zeehan ground in December, 1882, by Frank Long, who, with his mate John Healy, had made his way from Long Plains through Heemskirk to the unknown and inhospitable country around Mt. Zeehan. Owing to the then low price of lead, no great attention was paid to the field at the time. The Broken Hill discoveries and improved metal prices led to a revival of interest in the Zeehan area. In 1892 the Government Railway from the port of Strahan to Zeehan was completed, and serious mining then started. After two abortive attempts to establish smelting (at Argenton and Zeehan), a third smelter was erected by the Tasmanian Smelting Company, Limited, on the railway-line, 2 miles from Zeehan, in 1898; and this company's furnaces at present serve the field.

The output of ore from the mines has been continuous, although the quantities have mainly depended first on one mine and then on another. The most prosperous period was that of a few years ago, when undiminished production coincided with high market prices of metals. But for the last year or so the output began to fall off as the shoots of ore being worked in the mines operated by the large companies became less productive, and no adequate discoveries of fresh metal were made to take their place. For the present year it is probable that the output of the Zeehan mines proper will not greatly exceed a value of £100,000. It is expected that the output will increase materially as soon as stoping is resumed in the Florence

Mine, which is now being pumped out after the inrush of water which took place over a year ago.

Still, with mines and smelters the industry is supporting about a thousand men and their families, irrespective of the population of the wider mining area surrounding Zeehan.

Genesis of the Lodes of the Zeehan Field.

The following brief summary of the salient conclusions which have been drawn with regard to the genesis of the metallic ores must here be presented without a full statement of the data upon which they are based:—

(1) *The Granitic Invasion.*—At a geological period following closely upon that of the accumulation of the Silurian sediments the western portion of Tasmania was invaded by a magma of granitic composition. The granitic consolidation-products of this invasion are now exposed at the surface at many points. The granite which approaches most closely to the Zeehan field is the *massif* of Mt. Heemskirk, the eastern borders of which appear at a distance of about 5 miles from Zeehan. To the eastward the nearest lodes of similar origin are found on the tinfield of North Dundas, and it must be granted that the granitic magma underlies the field at some unknown depth. Dykes of granitic origin penetrate the Zeehan mining field at a number of points, and the rocks immediately surrounding the granite exhibit strong evidences of contact metamorphism.

(2) *The Period of the Formation of the Primary Ores.*—During the cooling of the granitic magma the metallic contents were gathered together within the magmatic hearth, and finally expelled into the surrounding country-rocks in solution. From these solutions the ores were deposited in the several channels of circulation.

With the close of this migration of the metallic contents from the granitic magma into the surrounding country the period of primary ore-deposition entirely ceased.

(3) *The General Degradation of the Region.*—At the time of their deposition the ores now worked at or near the surface in Zeehan were deeply buried beneath superincumbent rockmasses. However, since the close of the Mesozoic era the erosion of the region has been continuous, and has finally resulted in the exposure at the surface of the granite and its metalliferous mantle. The ore-bodies themselves have, beyond doubt, shared in the general

erosion, and their bulk has therefore been materially reduced.

(4) *Variations in the Lode Contents.*—The physiographic development of the region has proceeded at such a rate that *the primary ore lies exposed at the very surface.* The weathered crust has been removed immediately after its formation, and there is in general no leached and oxidised zone where the lodes outcrop. Hence there is no zone of secondary enrichment lying above the primary lode-filling. The ore presents exactly the same appearance at the surface as it does several hundred feet below.

Yet primary changes in the metallic contents of the lodes are marked in many parts of the field, and are shown in different ways.

In some cases it is found that the proportions of the constituents of one vein-type will vary, while the type is not changed. Thus the galena of the siderite-galena veins is restricted to shoots.

In other cases it appears that the vein-type varies, *i.e.*, that there is a gradual passage of one association of minerals into another association. For instance, the pyrite-blende-galena veins appear to merge on the one hand into magnetite veins, as in the Comstock district; or, on the other hand, into pyrite-stannite-chalcopyrite veins, as in Clark's lode on the Zeehan-Queen Mine and in the Oonah Mine.

Conditions Controlling the Deposition of the Metallic Ores.

(1) *Restriction to Certain Definite Channels.*—While it must be granted that the ores have had their origin in the magma of which the Heemskirk granite *massif* forms the most prominent consolidation product, the exact loci of the ore-bodies are determined by factors outside of the parent magma. On emerging from the igneous hearth the metalliferous solutions have been forced upwards, and in their ascent have been restricted to certain definite channels in the country surrounding the granite. These channels are fractures in the earth's crust which have originated at a period nearly coincident with the granitic invasion; for it is found that the Silurian rocks have been fractured and disturbed, as also the apophyses from the granite magma itself. Preference as loci of ore-deposition has been given to certain fractures rather than to others. Those fractures which obtained the preference either afforded a more ready passage to the metalliferous solu-

tions, or they attained, at their lower limits, more closely to the actual points of supply.

In some cases the ore-channels are simple fractures. In other cases the metalliferous solutions have ascended along—

(*a*) The intersections of fracture-planes.
(*b*) The intersections of fracture-planes with crushed fault-zones.

The crustal movements on the Zeehan field have been accompanied by dislocations showing enormous vertical displacement, and the fault-planes, many of which are associated with the deposition of ore, must on any theory be considered as descending to undefined depths.

(2) *Immediate Causes of Precipitation.*—The actual deposition of the ores in the channels of circulation appears to be due entirely to the physical conditions of temperature and pressure, and to the differences in the solubilities of different metallic compounds. As far as can be ascertained, the nature of the country-rock has in no way influenced the deposition of ore.

Vein-types in the Zeehan Field.

Enumeration of Types.—The metallic compounds mined in Zeehan occur in the lodes in certain definite associations, which are called vein-types. The appreciation of these vein-types and of the relationship between the various types is necessary for the correct interpretation of some of the most important primary variations observable in the lode-filling. Certain of the several types are known to merge gradually into certain others in such a way that passage-types exist at many points. Yet the most clearly defined of the separate groupings are these:—

1. The *pyrite-cassiterite* vein-type.—This type occurs within the boundary of the Zeehan field proper at one point only—on the Oonah property, where it has not yet been worked. The same type of ore is being worked at North Dundas. Very similar ore, but distinguished by the presence of a large amount of tourmaline, is worked at Mayne's Tin Mine, south of Mt. Agnew.
2. The *magnetite* vein-type.—This simple type constitutes very large bodies of ore on the western borders of the Zeehan field, notably in the mineral section formerly known as the Tenth Legion. The magnetite bodies are found in the contact

metamorphic zone which surrounds the granite of Heemskirk. Cassiterite has been recorded from this variety of lode-matter.

3. The *magnetite-blende-galena-chalcopyrite-pyrite* vein-type, which is closely associated with the last-named, is represented in the Comstock district on the old Silverstream section, now held by Mr. W. Thomas.
4. The *pyrite-blende-galena* vein-type is strongly represented in the western portion of the Zeehan field. In the Comstock district it is the prevalent type, and shows close affinities with the lastnamed type.
5. The *pyrite-galena* vein-type is closely related to the latter, and has been worked at a number of places; for instance, at the Colonel North Mine, Barnett's lode, and the Montana No. 2. Ore of this type is chiefly found in the western portion of the field, and merges into that which carries blende, in addition to the pyrite and galena.
6. The *siderite-galena* vein-type is that which has proved of greatest economic importance as a source of silver-lead ore in the central portion of the field. The Montana No. 1 and the Spray mines may be taken as examples of mines in which this type has been worked.
7. The *nickel-silver-cobalt* vein-type is represented at one point only, viz., on the old Central Balstrup Mine, now held by Mr. J. J. Walsh.
8. The *pyrite-stannite-chalcopyrite* vein-type is rather more variable in character than the others mentioned above, but the several mineral associations to be grouped here seem to be very closely related. The differences appear to be rather in the proportions of the several metals present than in the actual grouping itself. The Oonah stannite lode and Clarke's lode on the Zeehan-Queen Mine are the two occurrences of higher grade ore of this type. The lode worked by Mr. Bruce on the Oonah Mine is an example of the lower grade ore of this type.
9. The *pyrite-stannite-galena* vein-type is a slightly different type from the lastmentioned, and probably merges into it in depth. It has been worked in the Clark's lode on the Zeehan-Queen Mine, and the deeper portions of the galena lode

of the Oonah Mine are formed of ore closely related to this type.

The Economic Importance of the Several Vein-types.

The same metals have been sought from different vein-types, and especially from those portions of the different veins in which the metallic contents have been segregated apart into shoots. Thus argentiferous galena, although principally obtained from the *siderite-galena* type, has been won also from the *pyrite-blende-galena*, the *pyrite-stannite-galena*, and the *pyrite-galena* types.

Zinc blende has hitherto been almost entirely neglected, but parcels of ore may be derived from the *magnetite-blende-galena-chalcopyrite* and the *pyrite-blende-galena* types.

Stannite has been won from both the *pyrite-stannite-chalcopyrite* and the *pyrite-stannite-galena* veins.

The *magnetite* ore-bodies, although of very considerable bulk, have hitherto remained almost untouched.

Pyrites for the manufacture of sulphuric acid has for some time past been regularly exported from Mr. Bruce's tribute on the low-grade *pyrite-stannite-chalcopyrite* ore of the Oonah lease.

The *nickel-silver-cobalt* vein on Mr. J. J. Walsh's section has been only recently discovered, and the capping only has been broken.

In addition to these varieties of lode-matter, there have been worked at various times a few oxidized ores or gossans for sale as fluxes. These have not been fully exposed in such a manner that the primary contents of the vein-types whence they have been derived can be determined.

The *siderite-galena* veins have hitherto produced the bulk of the silver-lead ore of the Zeehan field, and the *pyritic-galena* veins rank next in importance as regards silver-lead production.

Within the past few months the successful smelting of the *pyrite-stannite-chalcopyrite* ore by the Oonah Company has rendered this type of vein-matter of immeasurably greater importance than hitherto.

The Distribution of the Vein-types in the Zeehan Field.

It has been found that there is a well-defined succession of vein-types observable on passing outwards from the granite *massif* of Heemskirk.

There are no workings on the Zeehan field proper which have penetrated to such a depth as to reach those portions of the granite which are considered, on geological evidence, to lie beneath the sediments exposed at the surface. Hence no safe deduction can be made with regard to the complete relationships of the vertical vein succession to the granite below the field. Any such attempt must therefore be restricted to the observations to be made at or near the surface on the veins which are situated at increasingly greater distances (horizontal) from the exposed Heemskirk *massif*. The questions of vertical and horizontal succession as the granite is left must necessarily be very closely related. for the reasons indicated above, viz., because the precipitation of the ores depends on the physical conditions of temperature and pressure, and on the relative solubilities of the metallic contents. The necessary conditions for precipitation exist at varying distances from the granite for different types of ores. Irregularities in the theoretical zonal arrangement of types may be due, in part at least, to the unseen irregularities in the boundaries of the parent magma.

Granite Zone.—The ore-deposits of the types here catalogued which occur actually within the boundaries of the granite are those classified as *pyrite-cassiterite* veins. The type is represented at a short distance outside of the granite boundaries by the tin ore-deposits of Mayne's Mine.

One small vein, which is barely exposed at the surface, is to be seen at the Oonah Mine. The ore at this place resembles that of North Dundas, but its relationship to the *pyrite-stannite-chalcopyrite* type is not clear.

Contact Metamorphic Zone.—In the highly metamorphosed rocks of the immediate contact with the granite the *magnetite* and *magnetite-blende-galena-chalcopyrite* types are represented. The recorded occurrence of cassiterite in association with the magnetite serves to connect these varieties of vein-matter with those of the granite zone, while the type of mixed magnetite and metallic sulphides indicates the passage into the *pyrite-blende-galena* type.

Trans-metamorphic Zone.—Outside the limits of the zone of contact metamorphism the lodes are predominantly pyritic ones for some distance, and these are then replaced by lodes in which the vein-type is marked by a sideritic gangue, when a still greater distance from the igneous hearth is reached. Thus the trans-metamorphic zone may be divided into a pyritic belt and a sideritic belt, within each of which subdivisions there are more vein-types than one represented.

1. The Pyritic Belt:

(*a*) On the one hand the *pyrite-blende-galena* and the *pyrite-galena* types of the Comstock district, and the western portion of the Zeehan field (such as Barnett's lode, and the lode recently worked on the Britannia section), are to be grouped here. The lodes of this type in the Comstock district display a very intimate relationship to the ores of the contact metamorphic zone.

(*b*) On the other hand, there appears to be a distinct succession represented by the *pyrite-stannite-chalcopyrite*, *pyrite-stannite-galena*, *pyrite-blende-galena*, and *pyrite-galena* types of the Oonah and Zeehan-Queen Mines. These, and passage-types related to them, have not been recognised in the contact metamorphic zone, and yet they are related to the *pyrite-cassiterite* vein-type which is known to extend right down into the granite zone.

2. The Sideritic Belt:

Most distant from the igneous source are found the *siderite-galena* and the *nickel-silver-cobalt* types. The former is apparently related to the *pyrite-galena* lodes of each of the groups in the pyritic belt.

The *siderite-galena* lodes occur in the central and eastern portion of the Zeehan field, as, for instance, in the Montana No. 1, Argent, and Spray Mines.

The affinities of the *nickel-silver cobalt* ore are not to be determined on account of the lack of exposure. The gangue, however, is predominantly sideritic, and hence the type belongs to this belt.

Deep Working in the Zeehan-Montana No. 1 Mine.

It is impossible to present in this preliminary report an account of the many properties visited. These will be dealt with in the later report. At the same time it may be well to present a statement with regard to the occurrence of ore in the Zeehan-Montana No. 1 Mine, since it was with respect to this mine that the statements were made which led to the present visit.

The Zeehan-Montana No. 1 Mine ranks among the deep mines of Zeehan, being surpassed in depth only by the adjoining Western Mine. The respective depths are: Western Mine, 1000 feet; Montana, 800 feet. The collar of the former shaft, however, is 75 feet above that of the Montana.

The mine has been worked since 1893, and has put out continuously large quantities of fair-grade galena. In depth, however, the ore-shoots shorten, and the output from the deeper levels has been comparatively insignificant. Recent discoveries down to 500 feet are tending to restore confidence, and are improving the declining output.

The geological features of the mine have exerted great influence on the occurrence of mineral, and must be taken into account if it is desired to understand the distribution of the ore.

The lodes are in country consisting of slate and subordinate micaceous sandstone and quartzite, with contemporaneous beds of tuff and vesicular lava, the latter sometimes apparently intrusive.

Three main faults traverse the country, dipping north-east, and one other dips south-west. Beside these, minor fractures fault the lodes without producing any results of importance.

The lodes may be described as a series of north-and-south fracture-fillings, which become payable as they approach their intersections with the main faults.

The nature and effects of slides in mines are usually questions of importance. The effects are seen in the deviations and displacements of lodes and the displacement of the country-rock. In respect of lodes, the question whether they have merely suffered deviation or have been definitely faulted is sometimes an urgent one. A so-called "slide" may represent a movement which has displaced both country-rock and the veins which traverse it; or it may itself constitute a feature which influences and guides the course of a deviating vein.

The principal, or No. 1 slide, in the Montana Mine is a wide belt of displaced and crushed slate, corresponding in nature with the crush-fault channels called "Ruscheln" by German miners. At surface it is 200 feet in width, at a depth of 300 feet it is about 150 feet wide, and at

500 feet the width is reduced to about 100 feet. Below this depth it has not been traversed. Its footwall boundary is well defined, but on the hanging-wall side its limits are not clear. The broken and contorted slate of which the zone is composed seems to extend to the north beyond the assumed hanging-wall.

Without going into details, which will be dealt with afterwards, it is sufficient here to note that the general tendency is for the lodes to split into branches, and for these to be deflected in curves (called the "drag") as they arrive at their intersections with the footwall of this fault. The lode-fissures do not pass into the fault zone in the great majority of cases. But small irregular masses of ore occur in some of the ill-defined partings in the crushed slate.

Until recently it was thought that the lodes either terminated at the slide or had been heaved by the fault for an undefined distance. The late discoveries of ore at the Nos. 3, 4, and 5 levels, north of the slide, will, however, in all probability make it possible to identify one of the lodes both north and south of the fault.

Our examination tends to establish the origin of the fault as prior to the formation of the lode-fractures. It has faulted the country, but not the lodes. The fractures and fillings of the latter are of lesser age (perhaps only slightly so) than the slide.

This being so, two main facts of far-reaching significance can be disentangled from the multitudinous and complex occurrences which meet one in the examination of the extensive workings of this mine. These are—

(*a*) The lode-channels on the south side of the slide, near its footwall, have been proved by workings to be the main repositories of payable ore. The slide, in fact, has in some way been an effective controller of ore-deposition.

(*b*) No geological reason appears to exist why the lode fractures on the south side of the crush zone should not exist also on the north side.

We understand that the ground stoped below the 500-feet level has been poor, and, on the whole, unremunerative. The ore-shoots have shortened. In the bottom level the lode-channels are filled principally with a carbonate of iron gangue, with a little galena, blende, and pyrite observable. It would seem that in the natural course of things the payable shoots in these lodes have come to their downward termination, as all shoots do sooner or later.

When this happens a certain stretch of blank ground must infallibly occur. In such cases mineowners have to consider what chances exist of meeting with fresh shoots, in what part of the mine should search be made, and how far it is advisable to push the search.

In the Montana Mine this exploration work separates into two branches: (1) the work which is now being carried on north of the slide, and (2) proving the lodes below the present lowest level.

As work north of the slide is now being vigorously pursued little need be said here. As it proceeds known shoots of ore are likely to be reached still further north. An endeavour will no doubt be made by the management to intersect by crosscut work from one of these levels (a matter referred to later in this report) any northern continuations of the lodes south of the main fault.

The arguments in favour of work at an increased depth are briefly the following:—

1. As set forth in an earlier part of this statement, the lode-fillings originated in the extrusion of metal-bearing solutions from the cooling granite magma. Their origin is consequently deep-seated.
2. The channels or lode-fractures carrying the metalliferous solutions must also necessarily persist in depth and have a continuous connection with their source.
3. Shoots of ore (where a fissure is metal-bearing at all) may be expected to succeed one another at intervals, however irregular these may be. Experience has shown, as a matter of fact, that this has happened in many mines.
4. In the Montana Mine the continuous carbonate of iron gangue still persisting in the lowest level reached is a strong indication that no primary change in the nature of the ore is at hand.
5. It appears, also, that no secondary enrichment of the ore has taken place between the uppermost and the lower levels. The silver ratio remains intrinsically unchanged, being higher only where the shoots are larger.
6. The main slide, which is to be regarded as the great indicator of the proximity of payable lode-stuff, in all probability descends as far as mining can be profitably carried on.

7. It is scarcely necessary to observe that the depth attained in the Montana Mine is trifling in comparison with depths at which silver and lead mines are being worked in other parts of the world.
8. The ore-shoot south of the shaft, controlled by the intersection of the No. 2 slide with the fracture-planes on the south side of it, is known to continue downwards practically to the No. 8 level, and there is every reason to expect that this lode may be profitably worked at still greater depths.

It is altogether impossible for any investigators to indicate a depth at which metal will recur in the descending lode-channels. Nearly all mining work is governed by probabilities. When not actually on ore, shaft-sinking is always a mining risk. Further, it is not only ore, but payable ore, which is sought.

When such risks have to be faced it is usual to marshal and weigh the factors of the problem and the indications of success. For the Montana Mine the arguments above detailed suffice to show that, while the position of things calls for serious consideration, no solid reason whatever justifies the designation of the mine as a surface show; but a horizon has been reached in the lode-channels below which a fresh search has to be started. Yet a fuller knowledge of the main conditions controlling the distribution of the ore-shoots has been obtained from the experience of past developmental work, and the future prospecting of the downward extension of the ore-bodies is divested of a large measure of the uncertainties of the exploration work of earlier years.

Prospecting Methods.

Under the present circumstances a brief discussion of the methods of prospecting applicable to the Zeehan field may be here given. The various methods are considered apart.

(1) *Prospecting by Adit.*—This method has been used to great advantage in the past, and may still be employed where conditions are suitable. It is a cheap method, which possesses great advantages as regards drainage. But it is limited by the contours of the country to be tested and the relation of the lodes to the contours.

It must be remembered that only the upper portions of lodes can thus be reached; and that in some cases, where the circulation of surface waters has been free, a leached portion of the lode may be met with. The cases in which this has actually happened in Zeehan are few in number. One example which may be quoted is that of the adit workings on the Victoria-Zeehan Mine.

(2) *Underground Horizontal Prospecting from Shaft Workings by the Extension of Crosscuts and Drives.*—This method is the only one applicable in flat country where adit workings are out of the question.

The horizontal extension of existing workings is required in the case of those mines in which the occurrences of ore already known have been found to be controlled by definite geological factors. Each mine must be considered separately in the light of its own experience. Thus on the Montana No. 1 Mine the ore is found in several channels, and in greatest bulk near its intersection of these with the main slide. Recent development work has proved that a valuable ore-body exists to the northward of this slide, and the newly-discovered lode may be identical with one of the lodes lying on the south side of the slide. It is therefore clear that a crosscut must be driven on the northern side of the slide in order to ascertain if there exist northern extensions of the other known ore-bodies which have been traced up to the southern boundary of the slides. It is clear that the principal channels by which the ore-filling has been introduced are situated in the immediate vicinity of the slide. Therefore the crosscut should be driven near enough to the slide to be close to the known feeding channels, but far enough northward to be beyond the highly crushed country.

Much horizontal work yet requires to be carried out in a number of mines, and especially below those areas in which a network of small veins occurs at the surface. Crosscuts alone are not sufficient, for the driving on the lode-tracks intersected should be proportionate to the amount of crosscutting. For many years to come a considerable proportion of the ore-production of the field may be expected to come from the horizontal extension of existing workings.

(3) *Prospecting in Depth.*—In addition to the horizontal exploration, but not as a substitute for it, prospecting at greater depths than have yet been attained must be considered an indispensable adjunct to the other activities. Vertical and horizontal prospecting are complementary, not mutually exclusive; and the actual behaviour of the bodies in depth can be ascertained in no other way than by sinking.

On geological grounds we may recommend deeper working. It is pointed out elsewhere that, in the case of mines working siderite-galena ore, the galena occurs in shoots. When siderite only fills the lode-channel the sideritic belt has not been passed through. There is evidently some misapprehension on the field with regard to the mineralogical changes observable in the lodes. Where pyrites begins to take the place of siderite the fear has been expressed that the ore has disappeared. These fears are based on a wrong conception of the nature of the alteration. It is most important to remember that the replacement of siderite by pyrite is a change of gangue, and a phenomenon of primary origin. The alteration in the character of the gangue does not imply the disappearance of the galena. From the brief account of the vein-types given above it will be seen that galena has a very long vertical distribution, and extends in payable proportions from the contact metamorphic zone through the pyritic and siderite belts of the trans-metamorphic zone. Thus, when a lode is passing from the sideritic into the pyritic belt, galena may yet be expected to be found. The thinning-out of shoots at moderate depth is no indication that the galena-bearing horizon has been passed through.

The results from the only deep workings, viz., in the Montana and Western Mines, cannot be taken as having a conclusive bearing on this point. Before passing a condemnatory opinion the known lodes must be explored in depth at a greater number of points, and the workings at these deep levels must be considerably extended.

There are on the field several points, notably on the Argent Flat, where a large number of intersecting veins are found at or near the surface. These must, on any intelligent theory of the genesis of the ores, be considered to be connected with other deposits in depth. Such points certainly offer reasonable hope of success from deep workings.

The Spray lode, one of the largest and most productive lodes on the field, has been followed down only to a depth of 450 feet; although it has been proved horizontally by one company for 1400 feet without a break. We are informed that rich ore in bunches was found in the lode at the greatest depth reached (but the lodes as a whole at that depth proved unpayable). Unfortunately an inspection could not be made of these workings.

In all cases the depths hitherto attained on the field are insignificant compared with those of many silver-lead mines in other parts of the world.

In planning the deeper prospecting of the mines in the Zeehan field the special geological features of each must be taken into account. For instance, on the Montana Mine the dependence of ore-shoots upon the intersections of the lode-fractures with the slides is the fact to be kept constantly in view. In order to avoid the necessity for long crosscuts, such as would be necessary if the present main shaft were deepened, it would appear advisable, at least in the initial stages of prospecting, to sink an underlay winze on one of the known lodes to follow its downward course below the slide. From this winze it would be possible to prospect for the other known lodes in the vicinity of the slide.

The problem of deep development on the Spray Mine presents no complications which involve geological discussion. The ore-bodies are the fillings of simple fractures which have been proved to extend horizontally for very considerable distances, but which have been followed to very insignificant depths. The excellent returns which have been obtained from the worked portions of the lodes should offer every inducement to the company to proceed with the exploitation of these lodes in depth.

In the case of the Oonah Mine, which will be described in greater detail in the complete report, there are three main objects to be kept in view from the standpoint of exploration. All three of these considerations merit attention. In the first place there is the deeper development of the stannite lode, which has been worked to a depth of 436 feet from the surface. In the case of this lode any changes in depth have been for the better. Level after level shows a perfectly solid lode, and the development of the whole ore-body is being pushed forward with most satisfactory results. All the features of the lode indicate persistence in depth.

In the second place there is the galena lode, from which extremely good returns were obtained in the upper levels. These workings are now abandoned, and it is difficult to form an opinion of the deeper portions of the lode. But it may be explored in depth with the assistance of the workings necessary for the exploitation of the stannite lode.

Lastly, there has been recently discovered a small vein, rich in cassiterite, outcropping on the surface to the eastward of the stannite lode. The outcrop is almost wholly covered by superficial detritus, and it is possible that parallel veins of ore exist. While the lode indicates possibilities, nothing more can be said until further exploratory work has been done.

4. *Exploratory Boring by the Diamond-drill.*—This method of prospecting has the advantage of being rapid and comparatively inexpensive, but it is best applicable to the search for ore-bodies of very regular dimensions or considerable mass. Thus it is a highly useful method of proving and contouring lenses of iron ore and cupriferous pyrite, and is serviceable in picking up the faulted portions of gold-quartz reefs. Coal seams, too, are eminently suited for exploration by diamond-drilling.

But while the drill may locate an ore-body, it affords only a very small sample of the lode-matter traversed. In ore-bodies in which the distribution of the metallic contents is irregular the drill core may give entirely misleading information.

After a study of the physical features of the lodes in the Zeehan field, and the distribution of the metallic contents in the lodes, we have arrived at the conclusion that the cases in which diamond-drilling may be advantageously used are few in number. It may be of value on the Oonah property for the testing of the galena lode from the deeper development work upon the stannite lode..

The Extension of the Zeehan Field.

Before dealing with the question of the outward extension of the field we may remark that there are, within the boundaries of the present leases, a number of small lodes, any of which may develop into more important bodies if they are exploited.

At greater distances from the centre of the field the progress of mining has been retarded by a variety of circumstances, the chief of which are the cost of transport, the diminution of silver contents and increase of blende, the absence of tracks, and the difficult character of the unexplored country between the Zeehan field and the sea.

The value of this belt of country as a mineral area is quite unknown. Its geological position with regard to the granite outcrop suggests that it would be a good area to prospect. The lodes of the Zeehan field are known to be disposed in zones about the south-eastern extremity of the Heemskirk *massif*. There is no reason to doubt but that these zones extend round the southern border also.

Indications of the presence of lodes are also shown to the east of the field, and it is possible that in course of time further discoveries may be made in that part of the district.

In short, geological observations lend no support to the idea that Zeehan is an exhausted field. On the contrary, the indications point to the possibilities of expansion for a long time to come.

Our examination leads us to believe that much work, of high importance and almost essential to the full development of the field, remains to be done on properties which for different reasons are now lying idle. A complete remedy for this unsatisfactory state of affairs cannot be looked for until provided by improved legislation. This leads us to remark that the Zeehan field is languishing, not so much for want of lodes, as for want of the capital necessary to develop them.

V.—CONCLUSION.

It is generally admitted that the output of ore from the Zeehan field requires to be reinforced by supplies from the surrounding districts, in order to secure the tonnage required for continuous and profitable smelting. Under these circumstances it is essential that the large mines in the Mt. Read district should co-operate in maintaining the total output. There is thus such interdependence between the two districts that harmonious relations are essential to the prosperity of both.

Within the Zeehan field itself, in the absence of any considerable activity on the part of some of the companies, it would appear to be a wise policy on the part of both mining and smelting companies to offer every inducement to tributors and prospectors.

We feel our inability to do full justice to the very many questions which are involved in a discussion of the future of the Zeehan field in so brief a report. Many matters here only hinted at will receive detailed treatment in the final report.

The prime object of our visit has been, not to make professional reports, nor to assist in creating an inaccurate impression of the true state of the mines, but rather to ascertain and establish the basal facts with regard to the genesis, structure, and extensions of the lodes. The detailed discussion of these matters will, we venture to think, prove of material value in the future development of the field.

As a result of our examination we have come to the conclusion that—

1. The view that the Zeehan lodes are of superficial origin and extent is entirely untenable. In the

great majority of cases there is absolutely no evidence to support the idea that the worked shoots of ore are shallow concentrations by secondary processes.

2. The shoots of ore, being of primary and deep-seated origin, may be followed down to greater depths with the measure of confidence which obtains in ordinary mining operations. The very large amount of ore which has been already won from such shallow levels should inspire confidence in the deeper development of the field. The present condition of the field is largely due to the fact that so few deep workings are in existence. Two or three companies have simultaneously depleted their shoots, and the effect produced would not have been so acutely felt had work been proceeding on a larger number of leases.
3. One of the most encouraging signs in the district is the discovery of the new ore-body in the Zeehan-Montana No. 1 Mine, in what has hitherto been untried ground.
4. The district is already feeling the benefit of the successful mining and smelting of the stannite ore by the Oonah Silver Mining Company.

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Government Geologist.

L. KEITH WARD,
Assistant Government Geologist.

Zeehan, 4th November, 1909.

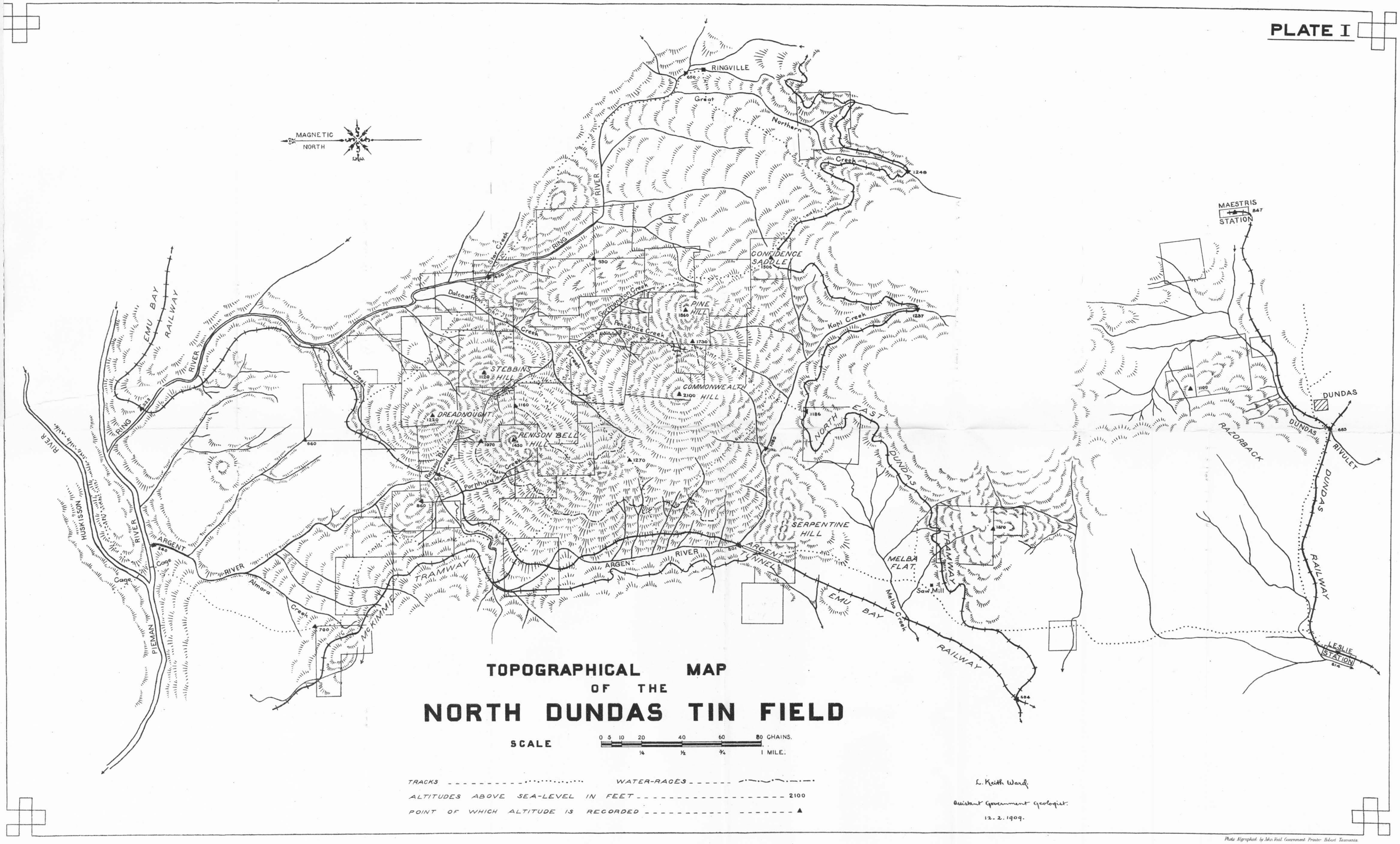
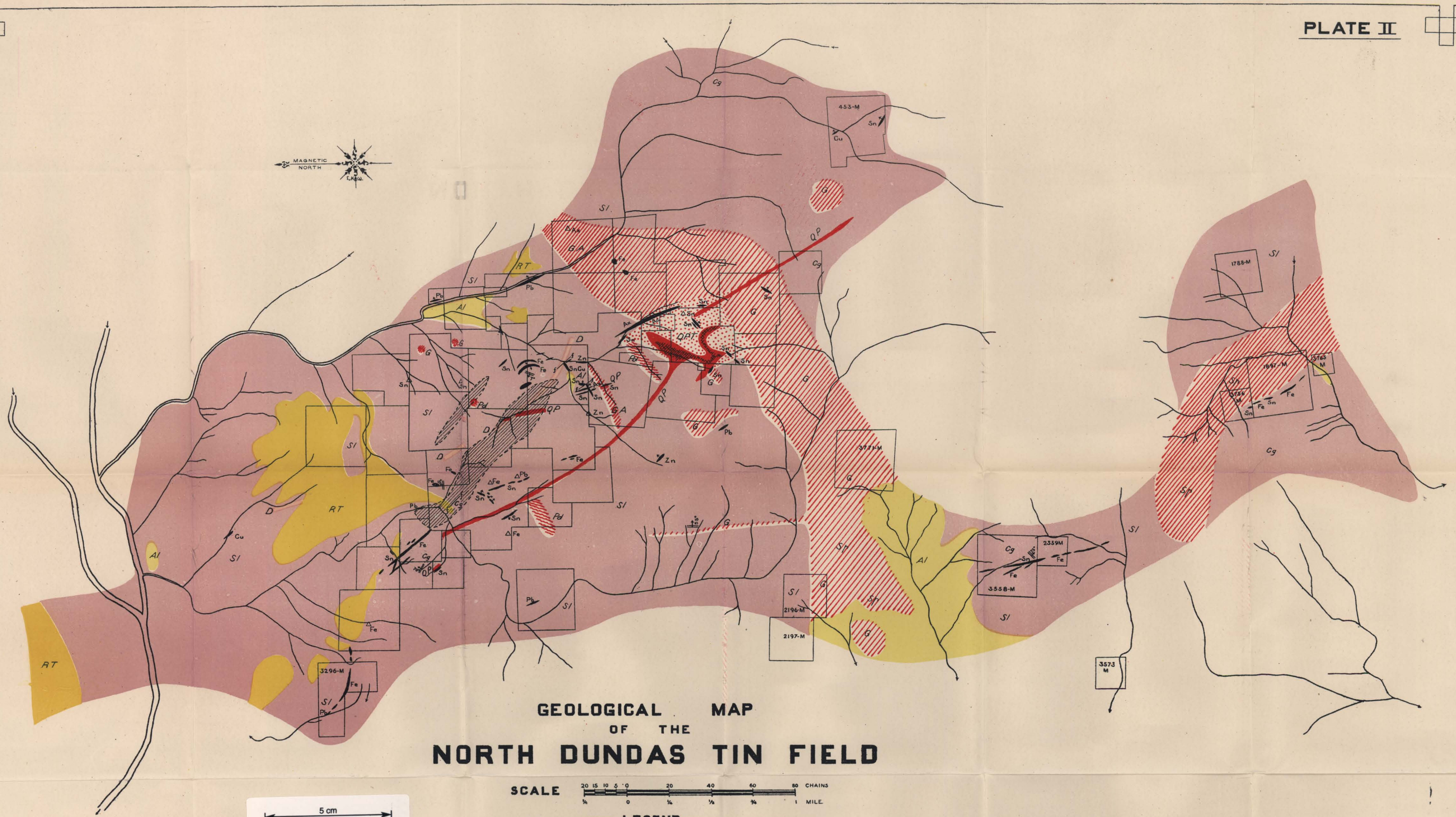


PLATE I
MAGNETIC NORTH
RINGVILLE
Great Northern Creek
RING RIVER
EMU BAY RAILWAY
CONFIDENCE SADDLE
PINE HILL
Kapi Creek
Penzance Creek
Dalcoath Creek
STEBBINS HILL
COMMONWEALTH HILL
DREADNOUGHT HILL
RENISON BELL HILL
Porphyry Creek
NORTH EAST DUNDAS
SERPENTINE HILL
ARGENT RIVER
ARGENT TUNNEL
PIEMAN RIVER
HUSKISSON RIVER
Almora Creek
McKIMMIE TRAMWAY
MELBA FLAT
Melba Creek
Saw Mill
MAESTRIS STATION
DUNDAS
RAZORBACK
DUNDAS RIVULET
DUNDAS RAILWAY
LESLIE STATION
TOPOGRAPHICAL MAP OF THE NORTH DUNDAS TIN FIELD
SCALE 0 5 10 20 40 60 80 CHAINS. ¼ ½ ¾ 1 MILE.
TRACKS
WATER-RACES
ALTITUDES ABOVE SEA-LEVEL IN FEET 2100
POINT OF WHICH ALTITUDE IS RECORDED ▲
L. Keith Ward
Assistant Government Geologist.
12. 2. 1909.

5 cm

PLATE II



GEOLOGICAL MAP OF THE NORTH DUNDAS TIN FIELD

SCALE 20 15 10 5 0 20 40 60 80 CHAINS
¼ 0 ¼ ½ ¾ 1 MILE

LEGEND

PORPHYROID .... Pd.	CAMBRO-ORDOVICIAN DUNDAS SLATES SLATE.........Sl. CONGLOMERATE.Cg.		COMPLEX LODE SYSTEMS ....
BASIC ROCKS..... SERPENTINE Sp. GABBRO G. GABBRO-AMPHIBOLITE GA.	PLEISTOCENE OLDER RIVER TERRACES.......R.T.		RETICULATING VEINS IN QUARTZ-PORPHYRY......
QUARTZ-PORPHYRY.........Q.P.	RECENT RECENT ALLUVIAL..........Al.		LODE-MATTER OF UNDETERMINED STRUCTURE.... △
DIABASE.................D.	QUARTZ-PORPHYRY TALUS.Q.P.T.		LODES........ FAULTS........
			STRIKE AND DIP OF STRATA............

LODE CONTENTS: TIN....Sn. LEAD....Pb. ZINC....Zn. COPPER.....Cu. AXINITE.......Ax. ACTINOLITE........Ac. GOSSAN........Fe.

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12.2.1909.

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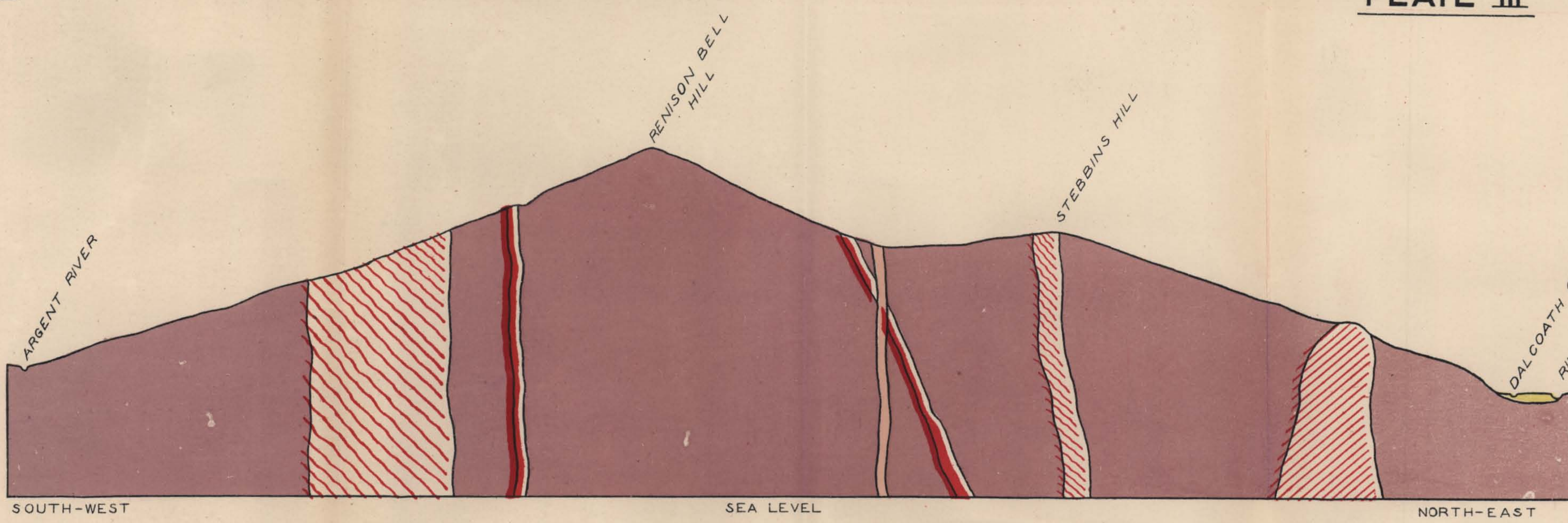
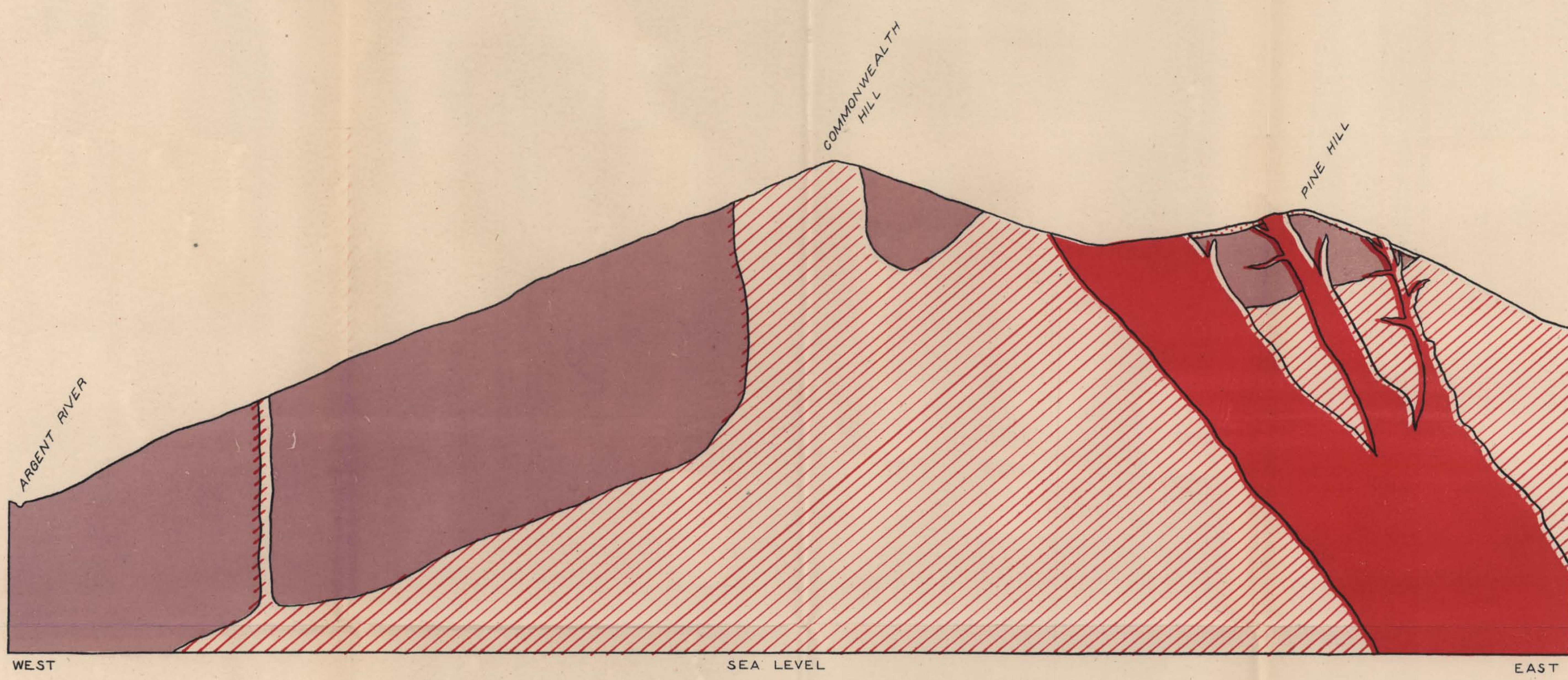
PLATE III



ARGENT RIVER TO RING RIVER



ARGENT RIVER TO PINE HILL

GENERALIZED SECTIONS

SCALES

HORIZONTAL: 0 5 10 20 40 CHAINS

VERTICAL: 0 100 200 300 400 500 1000 1500 FEET

— LEGEND —

DUNDAS SLATES	RECENT ALLUVIAL
PORPHYROID	GABBRO
DIABASE	QUARTZ-PORPHYRY
QUARTZ-PORPHYRY TALUS	

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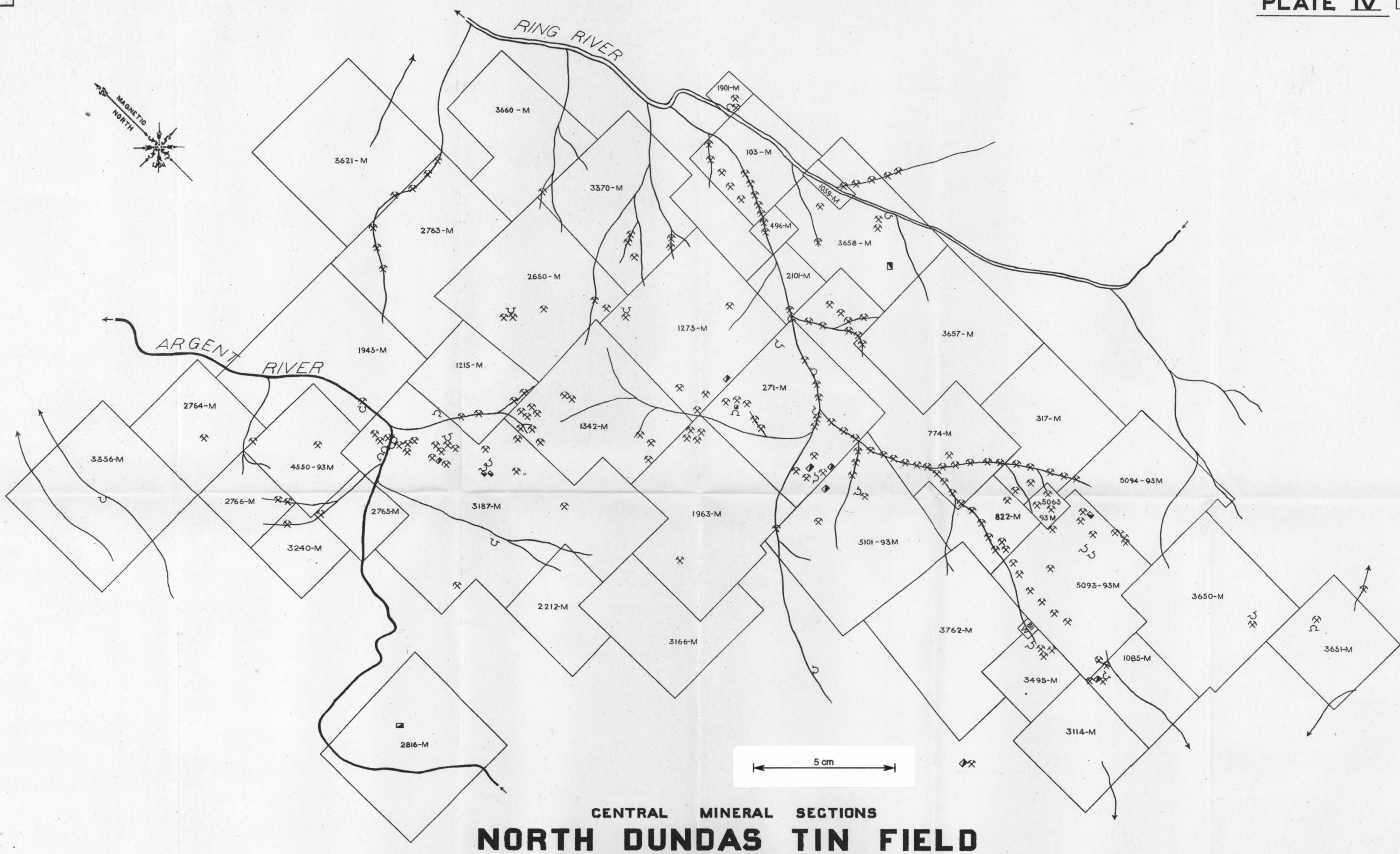
PLATE IV



CENTRAL MINERAL SECTIONS

NORTH DUNDAS TIN FIELD

SHOWING POSITION OF WORKINGS

SCALE 10 5 0 10 20 30 40 50 60 70 80 CHAINS
1/8 0 1/4 1/2 3/4 1 MILE

— SIGNS EMPLOYED —

SHAFTS

SURFACE WORKINGS

TUNNELS

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PLATE V

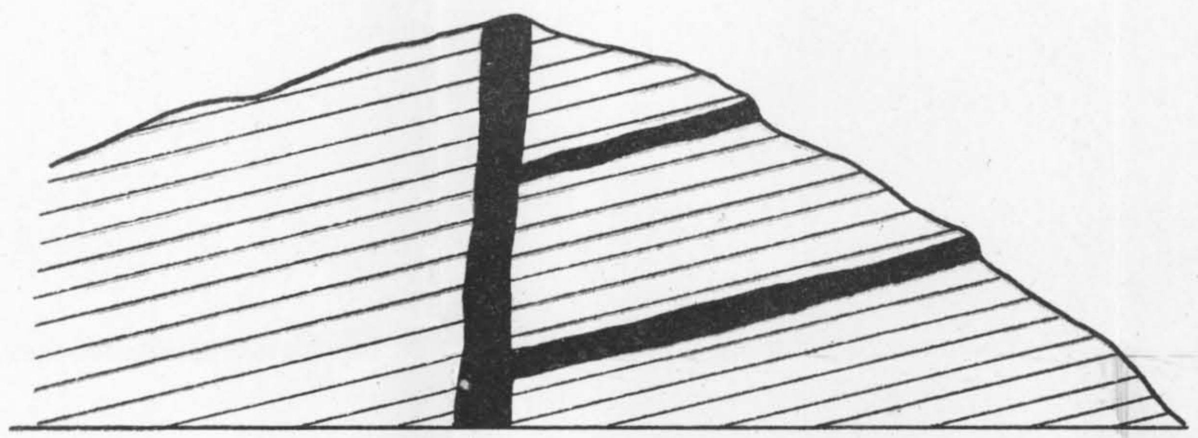

FIG. I.

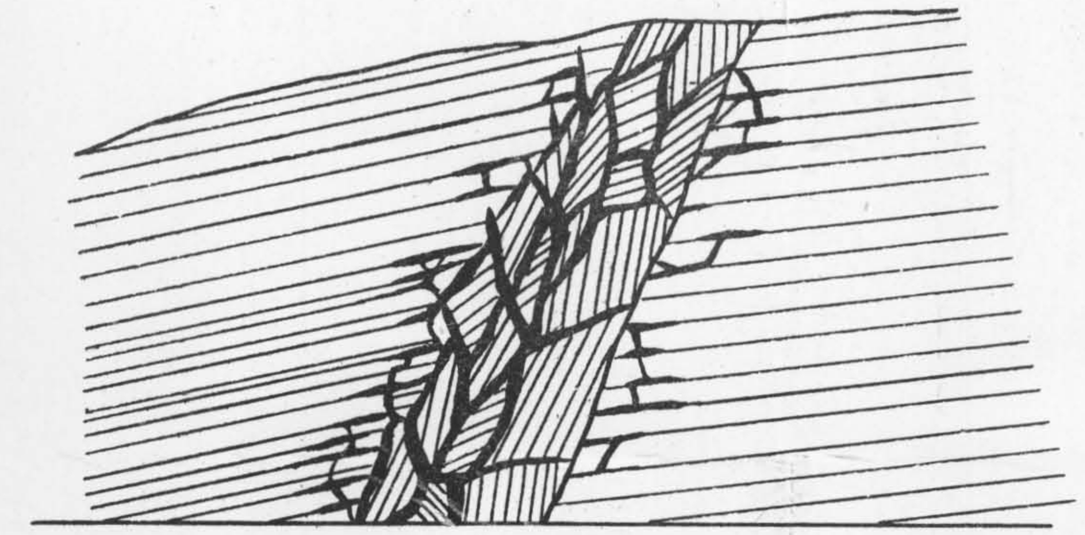

FIG. II.

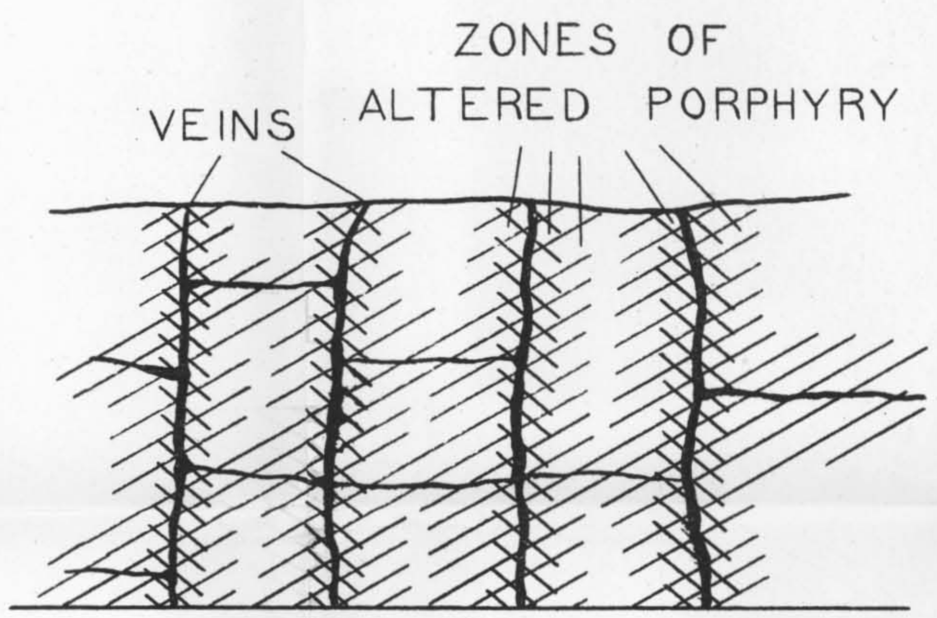

FIG. III.

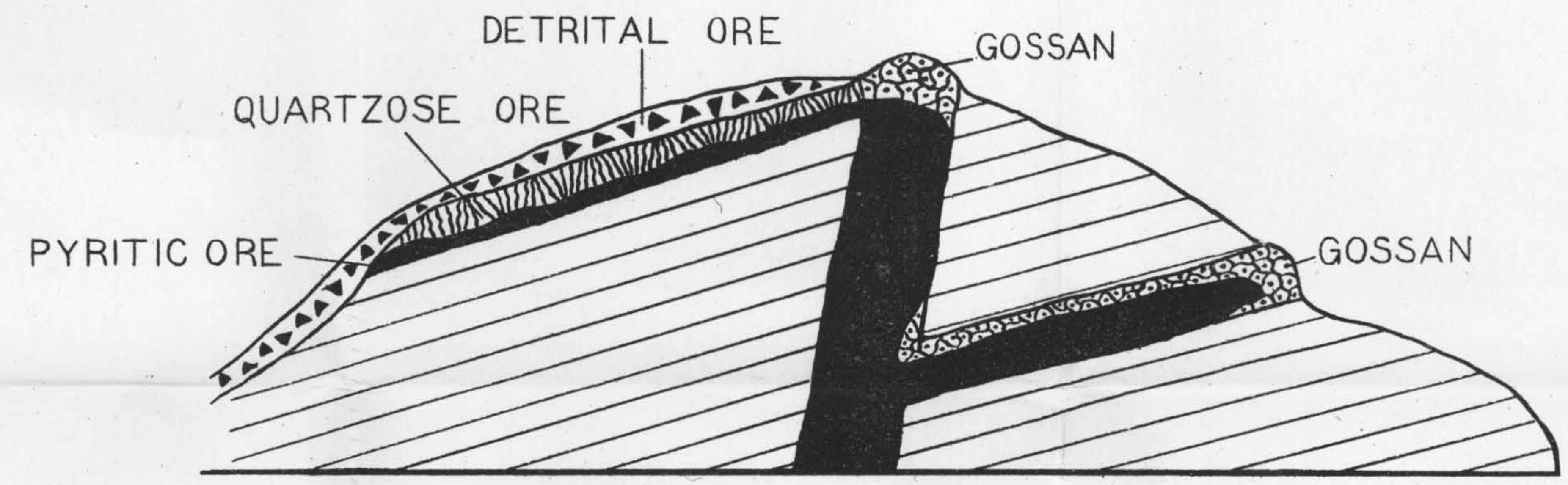

FIG. IV.

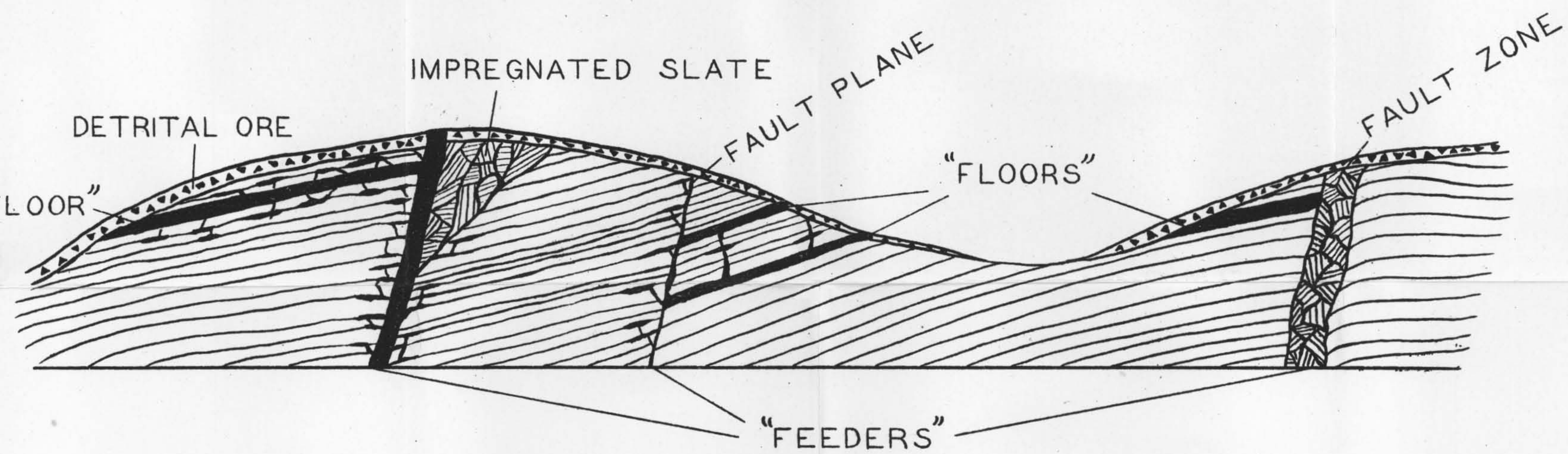

FIG. V.

DIAGRAMMATIC SECTIONS OF LODES

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