ST. PAULS TIN MINE, near Avoca.

Introduction

The lodes of the St. Pauls tin ore mine were discovered and explored a little as far back as the 'Eighties. Further work was performed in the late 'Nineties by other syndicates, but no attempt was made by any of the early exploration parties to mine the ore on a commercial scale. In the year 1911 the Royal George Tin Mining Company was organised in Launceston for the purpose of thoroughly developing the orebodies and providing the necessary plants for the treatment of the ore. The operations of this company ceased in 1922, and the mine then came into the hands of the St. Pauls Tin Mining Syndicate, the present lessees. The history of the mine is written principally in the records of its development by the Royal George Company, the operations of which are fully described in a later chapter. It may be appropriate to state here that the results of the work performed by that Company were not satisfactory largely because of the following reasons:-

1. Insufficient initial capital.
2. Badly designed lay-out of engineering plants.
3. Plants of obsolete types.
4. General method of mining not in accordance with modern practice.
5. The operations were performed on a scale too small to allow of good results being obtained.

The present lessees are about to continue the development of the orebodies in preparation for the re-equipment of the mine with modern plant and the working of orebodies commensurate with their size and quality.

Production

The complete records of production of tin ore from this property are not available, the deficiency relating particularly to the early operations, and also regarding the work of the Royal George Tin Mining Company.

The particulars given hereunder convey an idea of the scale of the operations of that company. It is estimated that the total production of tin ore (65 to 70%) is not less than 900 tons.

Area.

The Syndicate holds the following mineral leases from the Crown for a period of 21 years with the right of renewal at the end of that term:-

10010/M of 20 acres
10009/M of 61 "
10008/M of 40 "
10007/M of 80 "
10006/M of 80 "

These leases are charted in the names of R.E. and L.J. Smith.

The following shipments were delivered during the period May 1918 to March, 1919.

Date of Shipment	Sold to	Quantity Tons	Quantity Cwt.	Price per ton	Amount realised		
1918							
May 14th	Mitsui	3	15	405	1518	15	0
28th & 29th	Elder Smith & Co.	3	0	382	1146	0	0
June	Elder Smith & Co.	2	0	337	674	0	0
June	Elder Smith & Co.	3	0	345-10-0	1036	10	0
July	Lempriere & Co.	3	0	355-5-0	1065	15	0
July	Mitsui	3	0	400-5-0	1200	15	0
August	Lempriere & Co.	2	10	405	1012	10	0
August	Elder Smith & Co.	2	0	373	746	0	0
September	Barre Johnston & Co.	6	0	305	1830	0	0
October	Lempriere & Co.	3	0	315	945	0	0
November	Elder Smith & Co.	3	0	312-10-0	937	10	0
December	Elder Smith & Co.	3	0	290	870	0	0
1919							
January	Lempriere & Co.	10	0	215	2150	0	0
February	Lempriere & Co.	3	0	200	600	0	0
February	G.D. Gardener	2	6½		230	17	0
February	G.D. Gardener	2	6¼		197	13	0
March	G.D. Gardener	2	15¾		290	19	0

Situation and Access.

The mine is ten miles east of Avoca, a mining and pastoral settlement on the Fingal Railway, 49 miles from the port of Launceston. Its position in relation to the local features is a mile and a half south of St. Pauls River opposite Brookstead Estate, and south east of St. Pauls Dome. The Avoca-Swansea road passes through the property and a branch road connects the mine workings with the main road.

The facilities for transport and communication are good.

Topography

The properties lie on the south side of the broad valley of St. Pauls River. Corresponding rocks show on the immediate North and South sides of the river, but two miles further away on the north are coal-bearing strata of Trias-Jura age and a mile on the south side at the same elevation are the basal members of the Permo-Carboniferous formation, these indicating that the valley is one of erosion conditioned by following a line of faulting. St. Pauls River is a perennial stream flanked on the North by St. Pauls Dome and range and on the South by Snow Mountain Range, both of which are upwards of 2,000 feet above sea-level. The valley of the river was carried through the Trias-Jura and Permo-Carboniferous formations into the underlying Devonian granite in early Tertiary times, and in its deeper portions and especially in the upper parts of these, it has been filled with gravels derived from the rocks of those formations. That it was a river of considerable magnitude in the early Tertiary is clearly shown at the bridge where sands and gravels of that age covered with mid-Tertiary basalt and occupying a broad erosion valley have been cut through to the basal granite in recent times by the present stream.

The early Tertiary gravels exposed there were almost barren of tin ore: this indicates that the earlier lead or gutter higher up stream covered with the waste of the eroded upper portion of the granite is not likely to contain tin ore in rich concentrations.

The Quaternary and Recent flood plain in which the river is now entrenched, contains the waste of the tin ore bodies and, in particular parts, the concentrations of tin ore are rich enough to allow of profitable operation.

Geologic Relations.

On the immediate north and south sides of the St.Paul R.Valley the foundation rock (Devonian Granite) of the district has been denuded of its cover of Permo-Carboniferous and Trias-Jura sediments, and many of its contained tin orebodies have been exposed to view. In some places the granite has been again covered first with Tertiary gravels and sands, then with basaltic lava; in other places tin-bearing Quaternary and Recent gravels and sands form deep mantles over the granite. Farther from the river the mountain ranges are capped with mesozoic diabase, a rock highly resistant to erosion. The succession observed in the mountain ranges is highly tilted Ordovician slates and sandstones; Devonian granite; horizontally disposed Permo-Carboniferous conglomerates made up largely of granite waste, and which in places contain fairly rich concentrations of tin ore; sandstones, mudstones, limestones

and slates also of Permo-Carboniferous age siliceous sandstones, shales and felspathic sandstones with seams of coal; sills and dykes of Upper Mesozoic diabase. In the south west quarter the diabase is seen resting directly on the granite, showing that the sill-like intrusion of the former was very erratic and not confined to particular beds of sediments.

Geology of the Orebodies

The rock of greatest interest and greatest economic importance is the granite in all its various forms. It is in normal form the same coarse-grained granite with biotite and large porphyritic felspars which is so well exposed in neighbouring areas of Brookstead, Roys Hill, St. Pauls Bridge and elsewhere. Some of the felspars in the normal rock exceed an inch in length and are idiomorphic. The biotite component is conspicuous by its paucity; the phenocrysts of quartz and felspars are set in a ground mass of the same minerals and are almost equal in proportion. This granite is intruded by a dyke or dykes of aplite, finer grained porphyry, occasional pegmatite, and a coarse-grained quartz-felspar rock with a little biotite and muscovite and lithia mica. In the porphyry and aplite in particular are nodules of quartz, quartz-tourmaline, and black tourmaline: these nodules are very abundant in the rocks of the dyke-like formation.

All varieties of the dyke-rock are traversed by numerous bodies of quartz greisen, quartz mica greisen, and quartz tourmaline veins from a few inches to eight or ten feet in thickness, and generally coursing west of north, but at such angles that some meet and coalesce, while others cross without deviating from their normal courses. The dyke-rock containing these numerous veins is fully 200 feet wide. In certain sections the tin-bearing quartz tourmaline and greisen veins lie very close and parallel and are very sharply marked, there being very little alteration of the intervening rock which is generally almost barren of tin ore. However, the dyke-rock bordering the veins in some places is fairly rich.

As regards the various types of greisen it is noteworthy that the bluish quartz - tourmaline bodies are not as rich as the white quartz ones, and these in turn are less rich in tin-ore than the mica greisen and pinite bodies. These minerals mark also the various stages in temperature of deposition, from pneumatolytic to hydatogenetic conditions. The dense bluish quartz-tourmaline bodies are not rich in tin (about 0.5%), but are generally associated with the occurrence of tin ore. In places the granite is only partly greisenised the felspars having been altered to pinite and a secondary mica. Tin ore is associated with such occurrences, and is either disseminated through the mass or in veinlets on joint planes. These are the richest of the deposits. Pyrite is a common accessory component of the vein material and is tin-bearing. Malachite after chalcopyrite is prominent.

Erosion of the Orebodies

The amount of erosion of the orebodies is very important in arriving at the probable extension of the tin-bearing veins on their dips. First it should be understood that the granite intruded in Devonian time, sandstones, slates and quartzites of Ordovician age, but cooled under deep cover of that formation. During the Devonian period the agents of erosion were active, and very large parts of the cover rocks were removed exposing the main granite body. At the close

of the Devonian, sedimentation set in and continued until the Cretaceous, when another cycle of erosion commenced and has continued with interruptions and is still proceeding. The later erosion has not greatly reduced the orebodies for strata of Permo-Carboniferous age cover the granite except in the lower parts of the valley.

Mining Lease 10007/M

Mining operations have been confined to this 80 acre lease, exploratory works such as shafts, adits and trenches only having been performed on other leases.

On this lease the workings consist of an open-cut, an adit level, and a shaft level about 80 feet below the open cut.

The open-cut is 850 feet long, 60 to 80 feet wide except near the ends where it is only 20 feet in width, and is 20 to 40 feet deep. It opens the main ore channel and cuts across numerous smaller but important veins inclined thereto at very acute angles. At the northern end the containing rock is a coarse granite consisting of quartz and felspars in equal proportion and a little bleached biotite and some cassiterite. Where the rock is partly greisenised the felspars altered to secondary mica and pinite - the rock is richly tin-bearing, the cassiterite being in the form of blebs and veinlets and is coarsely crystallised. In the yellowish-green secondary mica the outlines of original felspars are easily discernible. Black tourmaline in blebs, veinlets and nodules is prominent, and occasionally large radiating columnar masses are found. Near the centre the containing rock is quartz-porphyry consisting of large quartz phenocrysts in a finer groundmass of quartz, yellowish-brown and white felspar, and malachite. It is possible that the malachite is primary, but it is more likely to be an alteration product of chalcopyrite, although the latter is very rare. Pyrite is abundant. Tourmaline is again very abundant, especially the black variety. Here the quartz is smoky and vitreous. The rock here is so closely veined with parallel beds of greisen that the whole face is broken as ore, and the material without sorting is sent to the mill.

At the southern end of the open-cut similar quartz greisen bodies are exposed and mica greisen also. Here are seen bodies of granite porphyry in which greisenisation is exhibited in all gradations. Felspars altered to kaolin and pinite; concentric alteration and incipient greisen noticeable.

The orebodies are opened 850 feet in this cut, and are showing at both ends. Many other orebodies cross the sides of the cut and have not been followed beyond its walls. Because a large amount of waste rock will be required for filling in the stopes from lower levels, the open-cutting of these cross lodes can be performed to good advantage.

The underground workings consist of the adit or No.1 level 40 to 60 feet below the surface, and the No.2 or shaft level 60 feet below No.1. Access is gained to the No. 2 level by an inclined shaft (12 feet by 4 feet) of three compartments one of which is used as a haulage way. This shaft is inclined at an angle of 50 degrees in a

direction S 28° E., contrary to that of the dip of the orebodies S 48° W., and is in consequence of little further use as a means of developing ore and as a way for its haulage to the surface. A short cross-cut connects the shaft with the drive which opens the lode 621 feet in length. Main lode from the cross-cut to 408 feet is of average width 8 feet. At the point 408 feet from the cross-cut another orebody 9 feet in width approaches and at 408 feet joins the main orebody and the two widening form a body 34 feet wide, 70% of which is of average grade milling ore. The ore between points 480 feet and 530 feet has been blocked out on the ground floor at this level the full width (34 feet) and between 530 feet and 621 feet has been removed in part. That constitutes all the work performed on this lease.

Reserves of ore

The greater part of the ore on what is described as 'the main lode channel' has been removed above No. 1 or adit level, but no attempt has been made to explore the many veins that cross obliquely the line of the mine openings and which are contained in the granite porphyry dyke. There is here a large potential reserve of undetermined value. Moreover 100 feet from the south-west end of the open-cut is another undeveloped body of ore apparently of large dimensions.

Between Nos. 1 and 2 levels of main orebody the reserve of ore opened up is estimated at 23,000 tons containing 0.74 per cent tin. This quantity could be greatly augmented by opening and attacking the many other parallel veins from this and the upper level. The reserve of 23,000 tons is calculated from that section between Nos. 2 and 1 levels of which three dimensions are known. No account is taken of the very large 'probable' reserve based on two dimensions. The deepest point of the workings below the surface is only 120 feet.

As regards the reserve of ore in the southern section very little can be stated. The orebodies have been exposed in shafts and trenches from one end of the leased ground to the other, but not one body has been completely opened.

Value of the ore

The striking feature about this mine is the small size of the waste dumps: this is the more pronounced when it is known that very little waste has been required as filling in stopes. The inference is that the bulk of the excavated material has been sent to the milling and concentrating plants for treatment, and this is confirmed by the great extent of the tailings dump.

During the recent investigation a thorough sampling of the orebodies was impracticable, but bulk samples of particular bodies were taken in order to arrive at an idea of the value of the undiluted ore - it is impossible to separate the whole of the broken wall-rock from the ore in the process of mining - and the results of the analyses are shown in the accompanying table.

The only reliable means of ascertaining the actual value of the run-of-mine ore is to accept the milling records as a basis for calculation. During eleven months of the year 1918-1919 the Royal George Tin Mining Company

treated 17,895 tons of material, the concentrated tin ore from which was produced 92 tons of tin, or at the rate of 0.514% tin per ton of lode stuff. The lowest value of the tailing from samples recently taken is 0.15 per cent. tin. Therefore the average value of the ore may be accepted as 0.664 per cent tin. In operation 77.5% of the tin ore is saved.

Bulk samples of the ore and wall-rock in the bins at the mill yielded tin in the proportions of

0.67 per cent
0.45 " "
0.51 " "
An average of 0.542 per cent.

Samples of ore from particular bodies contained tin as follows:-

Nature of Stone.	Sample taken from.	Width Sampled in feet.	Content of tin %.
Porphyry dyke rock with malachite	Open-cut	6	0.33
Porphyry dyke rock with malachite	Open-cut	8	0.33
Quartz-mica greisen	Vein in east wall of O-cut.	3	1.22
Quartz-mica greisen	Vein entering west wall of open-cut.	4	1.37
Quartz greisen	Centre of open cut	8	0.77
Mica greisen	Vein in northern part of open-cut.	2	3.83
Quartz greisen	South-east end open-cut	5	0.44

Those figures are helpful in arriving at the value of the ore and indicate that a very considerable amount of wall rock has found its way into the ore-bins. If, for example, 30% of wall-rock is included in the lode stuff sent to the mill the cost of concentrating the ore is increased in that proportion. Assuming that 700 tons of 0.74% ore per week is handled and that the cost of mining and treating is 10/- per ton, the value of 700 tons of clean stone containing 0.74% is 518 units of tin which is worth - with tin at 40/- per unit - £1,036. If, however, 30% wall-rock is added, the milling value falls to 0.518% tin which works out at 362.6 units at 40/- worth £725-4-0 or a milling time loss of 42 hours costing £310-16-0. Now this waste rock has had to bear its proportionate amount of the cost of the whole cycle of operations, namely, 10/- per ton, which amounts to £105 on 210 tons. This must be debited with the cost of breaking and stowing in the mine and credited with its value as filling in the mine; breaking and stowing cost 1/6 per ton; filling 9d. per ton; or a debit against £105 of 9d. on 210 tons leaving a working deficit of £97-2-6 as actual monetary loss per week. The total loss is therefore £407-10-6 incurred through the admixture of 30% of barren material in the ore.

No doubt a considerable amount of waste found its way into the ore bins, but it is doubtful whether the estimate (30%) of the Consulting Engineer to the late company can be accepted as correct. More likely the proportion is closer to 15%.

Equipment: Power Plant.

Power was obtained from two Cornish boilers each six feet in diameter working under a steam pressure of 120lbs. per square inch. Wood fuel was used.

These boilers provided power to two horizontal high pressure steam engines, one condensing, the other non-condensing. One steam engine was used to drive the milling and concentrating plant, the other to provide compressed air for the crushing plant, the winch at the pit-head and also to provide power to a generator for the production of current to the electrically-driven pump at the river.

Lease 10006/M

Coursing in a south-easterly direction almost diagonally through this 80 acre lease are a number of parallel and intersecting veins of tin-bearing quartz-greisen, quartz-tourmaline, and quartz-mica greisen from a few inches to several feet in width. They follow the axis of a sharp ridge which rises in a southerly direction to the foothills of the diabase-crowned Snow Mountain Range. At the south-eastern corner of the lease the orebodies and the containing granite pass underneath mudstones of Permo-Carboniferous age and are not again exposed to view. These orebodies and the containing granitic formation are essentially similar to those of the main workings in the northern section but their actual value is not known. Samples of the material on the dumps of trenches and shafts indicate a value of 0.5 to 1.1% tin. The veins have been exposed at short intervals from the northern to the southern boundary in trenches and in shafts. A considerable amount of the detrital material has been sluiced for its content of tin ore: that constitutes the whole attempt at exploitation. Although exploration work only has been performed on this property the orebodies are of considerable promise and may prove, when completely opened, to be of equal magnitude to those of the northern section. Their comparative remoteness from the milling and concentrating plants accounts probably for their neglect by the late company.

Other leases.

No exploratory work has been performed on these. The whole area is occupied by similar granitic rocks, and several bodies of tin-bearing stone outcrop but little is known of them.

Other properties in the Neighbourhood

The more important of the orebodies not included in these leases are those within the boundaries of Foster's Freehold, Roys Hill Freehold and Brookstead. Of these the two first mentioned appear worthy of very careful investigation. Perhaps an amalgamation of interests could be made with advantage to all concerned.

Summary of Results of Operations and Recommendations

From the rather meagre records of the operations of the late Company and from actual observations the opinion has been formed that their partial failure - only one dividend was paid - has been due to lack of initial capital and to general mismanagement. The whole structure of the Works clearly indicates that the nondescript plant was added to from time to time as funds became available for the purpose. Mismanagement is shown by the location of the plants in relation to the Mine workings. Why the milling and concentrating plants are separated from the crushing section and why they are placed so far away is incomprehensible. However, the company performed a good work in opening the orebodies 850 feet in length and establishing their value. On the basis of the results obtained in their operations it is possible to speculate as to future prospects. Firstly, there is no reason to believe that the ore will prove of lower value within 500 of the surface; secondly, many promising orebodies have not yet been tested, this remark relating particularly to those exposed within the boundaries of the southern section; thirdly, a much greater output (at least 1000 tons per week) is desirable; fourthly, the use of modern plant and the application of modern methods will result in greatly reduced cost of production; fifthly, the new plant should be erected close to the works and should be assembled under one roof or if not convenient altogether one section should be so placed with relation to another that the desired purpose is served.

If it can be accepted that the results obtained by the late operators during the period 1911-1922 afford a fair representation of the value of the ore their future operations on the lines laid down in this report should be productive of very good results. Encouragement is added to this idea by the quality of the ore exposed in the lower level workings - at no point more than 120 feet from the surface - which appears to be of higher grade than that in the upper level.

In the short space of time available a more thorough survey of the southern section could not be made. In this connection it may be mentioned that it is the intention of the Department to have the work continued this year in order to collect the necessary information for the preparation of a complete bulletin on the geology of the ore deposits of the Avoca district.

A. McIntosh-Reid,
DIRECTOR OF MINES.

Department of Mines,
HOBART.
26th March, 1927.