

ROYAL GEORGE MINE.

The lodes of this mine were discovered and explored a little as far back as the Eighties by a local syndicate. During the following two decades other syndicates attempted their development and working on a small scale, but not with any degree of success. Not until 1911, when the Royal George Tin Mining Company was organized in Launceston, did the mine receive sustained attention. The history of its development is written in the records of that Company, which came to an end in 1922 after a rather troublesome career. The result of the work of the Company enables us today to form a true conception of the value of the deposits and a fair idea of their extent and value; and it is upon the data thus obtained that the following statements are based.

Since the acquisition of the properties by the present lessees work of a superficial character only has been performed. It is reported that the lessees contemplate the early resumption of development work as a preliminary to the re-equipment of the mine with plants of modern types.

Production -

The complete records of production of tin ore from this mine are not available, but the deficiency relating to the early operators. It is estimated, on the basis of reports by local residents, that the total production of concentrated tin ore (65 to 70 per cent grade) is not less than 900 tons of which the late Royal George Tin Mining Company contributed the bulk. The particulars given hereunder convey an idea of the small scale of operations of that Company.

The following shipments were delivered during the period May 1918 to March 1919:-

| Date of Shipment | Sold to             | Quantity  |                  | Price Per Ton |    |   | Amount Realized |    |   |
|------------------|---------------------|-----------|------------------|---------------|----|---|-----------------|----|---|
|                  |                     |           |                  | £             | s  | d | £               | s  | d |
| 1918             |                     | Tons Cwt. |                  | £             | s  | d | £               | s  | d |
| May 14           | Mitsui              | 3         | 15               | 405           | 0  | 0 | 1518            | 15 | 0 |
| May 28/29        | Elder Smith & Co.   | 3         | 0                | 382           | 0  | 0 | 1146            | 0  | 0 |
| June             | " "                 | 2         | 0                | 337           | 0  | 0 | 674             | 0  | 0 |
| June             | " "                 | 3         | 0                | 345           | 10 | 0 | 1096            | 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           | 0  | 0 | 1012            | 10 | 0 |
| August           | Elder Smith & Co.   | 2         | 0                | 373           | 0  | 0 | 746             | 0  | 0 |
| September        | Barre Johnson & Co. | 6         | 0                | 305           | 0  | 0 | 1830            | 0  | 0 |
| October          | Lempriere & Co.     | 3         | 0                | 315           | 0  | 0 | 945             | 0  | 0 |
| November         | Elder Smith & Co.   | 3         | 0                | 312           | 10 | 0 | 937             | 10 | 0 |
| December         | " "                 | 3         | 0                | 290           | 0  | 0 | 870             | 0  | 0 |
| 1919             |                     |           |                  |               |    |   |                 |    |   |
| January          | Lempriere & Co.     | 10        | 0                | 215           | 0  | 0 | 2150            | 0  | 0 |
| February         | " "                 | 3         | 0                | 200           | 0  | 0 | 600             | 0  | 0 |
| February         | G.D. Gardner        | 2         | 6 $\frac{1}{2}$  |               |    |   | 230             | 17 | 0 |
| February         | " "                 | 2         | 6 $\frac{1}{2}$  |               |    |   | 197             | 13 | 0 |
| March            | " "                 | 2         | 15 $\frac{1}{2}$ |               |    |   | 290             | 19 | 0 |

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  
100009/M " 61 "

10008/M of 39 acres  
 10007/M " 80 "  
 10006/M " 80 "

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

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.

Geology of the Ore-bodies

The rock of greatest interest and having the greatest economic bearing upon the deposition of tin ore is the granite in all its various forms. On this property are representatives of many differentiates of the original magma, each exhibiting peculiarities that dissociate it from neighbouring bodies, but showing a close relationship to the parent stock. Thus, from the stock magma, whose closest representative here is a very coarse-grained granite with biotite and large porphyritic feldspars, sprang dykes of graphic granite veined with pegmatite and greisen, quartz and feldspar porphyries also affected by agents of greisenisation, hard and barren-looking alaskites, occasional aplite and true pegmatite, and a medium-grained quartz-feldspar rock with a little biotite and muscovite.

All varieties of dyke-rock, except the alaskite, which intrudes the others at an angle almost normal to their strike, are traversed along their courses by numerous veins of tin-bearing quartz, mica-quartz and quartz-tourmaline greisen from a few inches to ten feet in width. These closely veined dyke-rocks appear in the aggregate fully 300 feet in width and contain all the tin ore-bearing greisen. It is apparent, therefore, that the ore-bodies are very closely connected with the latest phases of rock differentiation.

As regards the various kinds of greisen, it is noteworthy that the older bluish quartz-tourmaline bodies are not as rich as the younger white quartz-mica-tourmaline ones, and that the latter are less rich in tin ore than the mica greisen and pinitic bodies. These gangue minerals mark the several stages of deposition under pneumatolytic to hydrotogenic conditions.

Pyrite and chalcopyrite (and its oxidation product malachite) are very common accessory components of the tin-rich vein material. Their presence, therefore, should be regarded with favour. Both sulphidic minerals like tourmaline, quartz, and cassiterite are sometimes found pseudomorphous after feldspars, sometimes metasomatically replacing them, and sometimes apparently of contemporaneous deposition. Crystals of cassiterite implanted upon quartz crystals, and filling cracks in quartz veins and quartz greisen, are not uncommon features of the ore-bodies.

Geologic Structure of the Ore-bodies

First, it should be noted that the tin-bearing greisens and pegmatites are contained in the dyke differ-

entiated of the stock magma and with them course in a general north-westerly direction. Second, that the main series of greisen veins mentioned come to an abrupt end against north-easterly trending dykes of alaskite, with which are associated another series of veins composed of quartz-tourmaline. The sequence of events may be stated as follows:-

1. The intrusion of graphic granite (closely allied to pegmatite),
2. The intrusion of quartz and felspar porphyries,
3. The intrusion of quartz-felspar-tourmaline, all bearing north-westerly, and
4. The intrusion of 1, 2 and 3 and the containing porphyritic granite by alaskite,
5. The cross veining of 1, 2 and 3 along lines almost parallel to 4,
6. The strike veining of 1, 2 and 3 by greisen.

We therefore, have two series of major fissures; one, filled with tin-bearing greisen, coursing north-west and dipping south-west; the other coursing north-eastward and dipping at a very high angle south-eastward. The former, especially where confined in the graphic granite dyke are richly tin-bearing; the latter (composed by dense quartz-tourmaline), except where reopened, are poor in tin ore. Apparently, the blue quartz-tourmaline material of the latter was deposited before the emanation of the tin solutions for on the hanging-wall side of the blue veinstone are later veins of quartz with a little green and black tourmaline and in parts much tin ore.

Reverting to the former, some of the two groups of veins on slightly different angles gradually converge, meet and coalesce; others cross without deviating from their normal courses. Occasional veins bearing north  $80^{\circ}$  west mark a line of minor fissuring. Such have not contributed largely to the tin production of the area, but one or two are fairly rich. These veins join but do not intersect the main lines.

A feature of particular prominence and importance is the pre-mineral faulting of the earlier granitic differentiates by the later alaskite. The direct result of this faulting may be seen in the throw of the dyke rocks in a north-easterly direction, and the subsequent opening of another set of fissures in the faulted extension of these rocks in Foster's Freehold.

A close examination of the containing rocks of lease 10006/M will show that they differ from the dyke rocks of lease 10007/M and unlike them do not represent the latest phase of rock differentiation.

#### Erosion of the Ore-bodies

The determination of the amount of erosion allows the investigator to arrive at an idea of the depth extension of the tin bearing veins. First, it should be understood that the granite (the carrier of tin ore) penetrated in Devonian time Cambro-Ordovician sediments and tuffs, but cooled under deep cover of that rock. Second, that during the later Devonian time agents of erosion were continuously active and large parts of the cover rock were completely removed from the intruding granite. In the course of that operation all

the ore deposited in the overlying Cambro-Ordovician was removed and the underlying granites were not only denuded but suffered from the agents of erosion themselves. During succeeding periods up to Cretaceous time sedimentation was continuous, when another cycle of erosion started the removal of the sediments lately laid down. That in turn came to an end before a great amount of damage had been done, and, after another but very short interval of sedimentation, the present cycle came into being.

Strata of Permo-Carboniferous age still cover the granite except in the lowest parts of the valley, showing that since the Devonian the ore-bodies have not suffered greatly but have been well protected through the ensuing ages. In consequence of this it may be anticipated that the ore-bodies will continue undiminished with respect to tin ore content to depth not less than 500 feet.

Lease 10007/M of 80 acres

Mining operations on a commercial scale have been confined to the ore-bodies within the boundaries of this lease. Such mine openings consist of a long open-cut, an adit a few feet under the open-cut, an underlay shaft and drive therefrom at a depth of 80 feet below the open-cut, and a number of trenches.

The open-cut is 850 feet long, 80 feet wide at the middle, tapering to 10 feet at the ends, and 40 feet deep. It opens the main ore channel; but does not take in all the tin-ore veins, some of which have been exposed in trenches 30 to 50 feet beyond its walls. The middle of the cut is the meeting place of two groups of gradually converging veins. At their intersection a massive body of veinstone 34 feet wide shows in the shaft-level workings. In point of fact at that level each body is more sharply defined, wider, stronger, more sulphidic, and richer in tin ore than it is higher up. One group of veins courses north 45° west, the other north 40° north west. The first mentioned is made up of closely spaced veins of greisenised coarse graphic granite. In some places greisenisation has produced a tin-bearing stone consisting almost wholly of secondary quartz; in others pinite and secondary mica alterations of original feldspars are noticeable features; again other changes such as that of quartz-mica greisen are not uncommon; and, especially, in the lower levels pyrite, chalcopyrite and tourmaline are abundant ore components. The sulphidic ores in aggregates of very fine crystals are pseudomorphous after feldspar and the tourmaline, although frequently interstitial may often be seen encased with quartz in crystals of feldspar, this illustrating contemporaneous formation. Cassiterite (tin ore) may likewise be found in fine crystal aggregates after feldspar, but also in blebs and veinlets, and as infillings with quartz of joints and cracks in quartz greisen. The richest ore is a soft mica greisen.

Near the centre the containing rock is a quartz porphyry consisting of phenocrysts of quartz set in a groundmass of quartz and feldspar. With this comes in a

group of narrow veins of quartz and quartz-mica greisen so closely spaced as to lend the appearance of ribbon structure. These veins are only 2 to 6 inches wide, but they are spaced only 2 to 6 inches apart and are in the aggregate twenty feet wide. Not only are the veins above average grade, but the unaltered intervein material contains tin in the proportions of 0.15 to 0.32 per cent. The whole body is broken as ore and sent unsorted to the mill. In this material malachite, pyrite, and chalcopyrite are prominent ore materials and tourmaline is particularly abundant.

In the open-cut part of the workings the richest ore has been removed yet may be seen occasional veins entering the walls and large masses of second-grade stone which under good conditions may receive attention. At the northern end the rich stone pitches northward into Roy Hill territory where the body has been traced 300 feet beyond the boundary. At the southern end the veins although of average grade appear to diverge leaving ever widening bands of unaltered granite between them. Beyond the south end of the cut a number of trenches expose tin-bearing veinstone.

The underground workings consist of the adit or No. 1 level 40 to 60 feet below surface, and No. 2 or shaft level 60 feet below the adit. No. 2 level is opened by way of an underlay shaft inclined at an angle of 50° north-westerly or in the direction of the strike of the ore-body. In consequence of this extraordinary design the shaft if continued would not prove of much use. A short cross-cut from the footwall side of main vein connects with main drive 621 feet in length. Main vein from the crosscut to 408 feet is of average width 8 feet, at which point another body containing 9 feet of solid veinstone joins it and the two widening form a massive body 34 feet across. Between points 480 and 530 feet the ore has been blocked out on ground floor over the full width (34 feet) and between 530 and 621 feet has been removed in part.

No attempt has been made by crosscutting to open any of the many parallel bodies.

That constitutes the whole of the effective work performed within the territory of this lease.

Lease 10006/M of 80 acres

Coursing in a general south-easterly direction almost diagonally through this 80 acre lease are a number of ore-bodies, some parallel, others intersecting, composed of quartz-tourmaline, quartz-greisen and quartz-mica greisen from a few inches to five feet in width. The main ones follow the axis of a sharp ridge rising gently in a south easterly direction to the foothill of diabase-crowned Snow Mountain where they pass underneath mudstones of Permo-Carboniferous age. These veins have been opened at short intervals in trenches and shafts from the northern to the southern boundary. In places they are rich; but the rich stone forms a narrow part only of the vein section, in some cases being not over six inches in width. Samples, carefully selected to ascertain the value of the several kinds of fissure filling and greisen, showed consistent results as regards each kind of material but varying results as regards the different kinds. Thus the 'blue' veins, composed of an intimate association of quartz and tourmaline, are invariably poor, but with occasional patches of tin ore; quartz with secondary mica and a little tourmaline (green predominating) in separate veins

or as later infillings of reopened quartz-tourmaline blue veins is usually rich. A good example of the latter is Bailey lode, a cross intersecting vein bearing N. 80°E. This has been opened in two shafts, each 60 feet deep and about 150 feet apart, and in an adit 200 feet in length driven along its course. The continuation of the adit would serve to further explore this cross vein and to crosscut the main lines of fissuring.

Although exploratory work only has been performed and their value is not known, some of the many veins give promise of richness, but not comparable in magnitude with those of lease 10007/M.

#### Lease 10008/M of 39 acres

Two trenches about 100 feet apart expose to better view an outcropping body of coarse graphic granite veined and greisenised in a direction N. 50°W. This body lies close to the western boundary near the southwest corner and soon passes into the adjoining Roy Hill property.

It is about 15 feet wide and tin-bearing, and is composed of pinitised pink felspar, secondary mica and quartz replacement of felspar with much tourmaline and a little malachite. That constitutes all the available information regarding the body.

#### Ore Reserve

The ore reserves of such bodies as those with all available data at hand would be very difficult of estimation; with incomplete data an attempt at an estimation would lead one into the bounds of conjecture. The writer in an earlier report endeavoured to put into figures such information as he had obtained from reliable sources, but on later consideration futility of the attempt appeared so obvious that he, in this report, decided not to court justifiable criticism. No doubt the ore reserve of veinstone of 0.5% tin grade is very high indeed, but that reserve cannot be expressed in figures, because, except in one small section of the mine, two dimensions only are known. Moreover, although very many tin-bearing veins have been opened in trenches, adits, and shafts, two ore-bodies only have been worked on a commercial scale. Their value, lineal extent, and width have been determined; but their depth limit has not been determined.

The greater part of the ore in what has been described as "the main lode channel of lease 10007/M" has been removed above No. 1 or adit level. The many parallel veins, however, have not been attacked from that mine opening. In those lie large potential reserves of unknown value.

Between Nos. 1 and 2 levels (60 feet apart) on main ore-body the opened ore has been estimated at 23,000 tons of 0.74% tin grade.

As regards the reserve of ore contained in the veins opened in the ground of the other leases little can be said. There again the necessary three dimensions are not known.

The average value of the lode material

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. Unfortunately, fractions only of these records are available.

During eleven months of the year 1918-1919 the Royal George Tin Mining Company treated 17,895 tons of material to get 92 tons of tin, showing that the yield then was at the rate of 0.514 per cent. Tests of the tailing showed a lowest value of 0.15 per cent. tin, therefore, the average grade of crude material mined and treated at that time was not less than 0.664 per cent. tin. That operation showed, moreover, that only 74.5 per cent. of the tin in the ore was saved in the milling and concentrating operations.

Those results receive confirmation from analyses of bulk samples of the lode material taken from the bins at the mine and at the mill as given hereunder:-

|       |                  |      |      |          |     |
|-------|------------------|------|------|----------|-----|
| No. 1 | sample from mine | tin  | 0.67 | per cent | tin |
| No. 2 | "                | "    | 0.54 | "        | "   |
| No. 3 | "                | "    | 0.68 | "        | "   |
| No. 4 | "                | mill | 0.45 | "        | "   |
| No. 5 | "                | "    | 0.51 | "        | "   |

This average value of 0.57 per cent. tin represents the grade of stone in the shaft level; that is, the grade of stone being worked when the late Company ceased operations. No doubt a considerable amount of wall-rock found its way into the ore-bins - it may be seen there mixed with the tin-bearing stone - but not as much as that mentioned in the estimate of the engineer. Probably not more than 15 per cent. of the material delivered to the mill consisted of tin-barren wall-rock. Excluding the 15 per cent. of waste the average value works out at 0.655 per cent. tin.

Owing to the presence of water in the lowest part of the open-cut workings the ore-bodies there could not be investigated during this visit. Samples taken of the stone left on the sides and middle of the open-cut at surface contained tin as follows:

| Nature of Stone                   | Sample taken from                   | Width of stone samples in feet | Content of Tin per cent. |
|-----------------------------------|-------------------------------------|--------------------------------|--------------------------|
| Porphyry dyke-rock with malachite | West side of open-cut               | 6                              | 0.33                     |
| "                                 | "                                   | 8                              | 0.33                     |
| Quartz-mica greisen               | Vein entering east wall of open-cut | 3                              | 1.22                     |
| Quartz-mica greisen               | Vein entering west wall of open-cut | 4                              | 1.37                     |
| Quartz-greisen                    | Middle of open-cut                  | 8                              | 0.77                     |
| Mica-greisen                      | North centre of open-cut            | 2                              | 3.83                     |
| Quartz-greisen                    | South-east end of open-cut          | 5                              | 0.44                     |

| Nature of Stone                | Sample taken from     | Width of stone samples in feet. | Content of Tin per cent. |
|--------------------------------|-----------------------|---------------------------------|--------------------------|
| Greisen veinlets and wall rock | East side of open-cut | 6                               | 0.31                     |
| " "                            | " " "                 | 10                              | 0.28                     |
| " "                            | " " "                 | 12                              | 0.12                     |

These figures, although not having any computative value, indicate that by careful selection a large quantity of valuable stone in the upper parts of the open-cut might be removed for treatment and that the full width of the ore channel has not been determined. Large scale operations would allow of such comparatively low-grade material being mined and treated at a profit.

Just before the cessation of mining by the late Company bulk samples of the lode material taken from workings below open-cut over a width of 34 feet yielded tin in the proportion of 0.74 per cent. On the basis of all this evidence it may be safely assumed that the average grade of the ore is not less than 0.5 per cent.

#### Equipment of the Mine.

When the mine was under operation by the Royal George Mining Company the general equipment was of obsolete types, as considered even at that time. Today such machinery is not in common use, certainly not in any well-designed plant.

A Brief description follows:-

Two Cornish type boilers, each 6 feet in diameter and working under a steam pressure of 120 lbs. per square inch, provided power to two horizontal high pressure engines, one condensing, the other non-condensing. One steam engine drove the milling and concentrating plants, the other provided power for the crushing plant, the winch at the pit-head, and a generator for the electrically driven pump at the river.

The milling plant then in use consisted of 30 stampers in three batteries of ten heads each. Ten heads weighed 900 lbs and twenty heads weighed 700 lbs. each. This plant at maximum crushed 700 tons per working week of six days.

The concentrating plant received the coarser portion of the pulverised ore first in two compartment jigs, the tailing from which passed to Forward-Down grinding pans, and then to settlers of Spitzkasten type. Six Wilfley tables and a Buss slime table concentrated the tin ore and the associated pyritic minerals and separated them. The pyritic concentrate, after having been calcined in a nine rabble Leggo furnace and re-ground, was retreated on three Card tables.

What remains of the plant is now of little or no commercial value.

### ECONOMIC CONSIDERATIONS

In the consideration of the economics of any mining scheme the following are important factors:-

1. The necessity for effecting a combination of interests of all lessees or mine owners in the one economic area.
2. The provision of a sufficient reserve of ore of profitable grade to warrant the estimated capital expenditure,
3. The provision of a large and unfailing supply of water,
4. The provision of power at cheap rates,
5. The provision of adequate lines of transport and communication.

Notes on each of the subjects as enumerated will now be given as applied to this area:-

1. The first effect upon the mind on looking over the Royal George workings appears the desire to criticise the design of the early operators, but when all the circumstances are taken into account, the reasons for the lay-out becomes apparent. One becomes impressed with the idea that the natural sites for the treatment plants and the mine openings lie in the adjoining Roy Hill property. First, it may be mentioned that the hill slopes steeply towards Lea Creek on that property and that a large area of flat land extends towards Main Road, thus providing a large area for dumping tailing, suitable sites for the milling and concentrating plants, and a site for main adit opening to attack the ore-bodies from the deepest drainage level. Moreover, not only do the Royal George ore-bodies extend into the Roy Hill property, but they dip in that direction. An 800 feet cross-cut would tap main ore-body of Royal George Mine at a depth of 180 feet below the summit of the hill and intersect any parallel bodies on the way. That crosscut would provide a way of attack upon a large reserve of ore before the necessity for shaft sinking need come up for consideration. Again, the natural site for a main shaft lies within the boundary of the Roy Hill Property. From the foregoing it appears evident that either mining easements should be obtained over a section of the Roy Hill ground or an amalgamation of interests should be effected between the lessees of one and the owners of the other. The latter scheme appears the better because the ore-bodies of Roy Hill would provide other sources of supply. As large scale operations are essential to success the advantage to both parties cannot be over emphasised. In the case of the Royal George Mine, it may be said that additions of ore from Roy Hill are not essential to successful operation, but the Roy Hill in itself cannot be regarded as of any present individual value. On the east side of Royal George mine but not adjoining lies Foster's Freehold property (now owned by Michael Hannah of Launceston) which could with advantage to the owner be included in the amalgamation scheme.

2. The proving of a large reserve of ore as a first work in the scheme is quite obvious. Many mistakes have been made, as shown in the past history of both mines, by the erection of treatment plants before adequate reserves of ore had been developed. It may be claimed

that a large reserve is in sight and that past operations have determined the average value, but the desideratum now is information for future operations.

As regards the Royal George bodies, the main ones only have been tapped and their size, lineal extent, and value have been determined; but little can be said about the many other promising bodies that lie parallel thereto. The deepest workings are only 80 to 120 feet below the surface.

Roy Hill main workings are only 50 feet deep, and the large Dyke lode is opened in shallow cuts only.

The fact that 900 tons of tin ore have been produced from the Royal George and 100 tons from the Roy Hill lends encouragement to the belief that exploration with the diamond drill will reveal ample reserves of average grade (0.5 per cent. tin) material..

3. Water supplies may be obtained from two sources:-

(a) St. Paul River, and

(b) Swan River at Snow Mountain.

Water may be pumped direct from St. Paul River or gravitated by way of a water race from a point ten miles by contour line higher upstream. Suitable sites for the construction of dam walls and the conservation of large supplies are available beyond Glencoe. Ditching would not be costly.

It is possible to conserve large supplies and divert the waters of Swan River into Snow Creek. This scheme may be worthy of consideration. In any case no apprehension need be held as to serious difficulty in impounding sufficient water for large scale operations.

4. The Hydro-Electric Department has under consideration a scheme for the provision of electric power for this district, and a Bill, with that purpose in view, is receiving the attention of Parliament.

5. The mines are well-served by a good road and the Fingal Railway.

The perusal of these reports will show that the prospects of establishing another branch of the tin-mining industry here are much brighter today than at any time in the history of the district.

Sgd. A. McIntosh Reid.  
DIRECTOR OF MINES

Mines Department, Hobart  
30th November, 1928