UR 1923/137-148

THE CLEVELAND MINE

AREA, SITUATION, ETC.

This mine is situated on the western foothill of Magnet Range, half a mile southward from the settlement of Luina on the banks of Whyte River. Outside the boundaries of the leases that enclose the Cleveland mine no important tin-bearing ore-bodies have been found in this area. In its isolation there is a resemblance between it and the Mt. Bischoff occurrence.

The mine is now held under Leases 8740/M of 65 acres and 8741/M of 30 acres by J. Luck and C. Thompson of Devonport.

These ore-bodies were discovered 25 years ago and the area was leased at first by S.C. Coundon of Waratah. The gossan outcrops were considered to be the cappings of silver-lead lodes until the late Harcourt Smith, Government Geologist, on a visit of inspection in 1908 detected tin oxide (cassiterite) in the gossan. Subsequent exploratory work revealed the presence of this mineral in profitable proportion. Many years passed, however, before an attempt was made to exploit the deposits for their content of tin. The first to undertake this work was the Cleveland Tin Mining Company N.L., formed in 1908. From the beginning this Company had been beset with difficulties. The initial expenses of the undertaking were so great that the Company was taxed to the limits of its resources before the enterprise had been fairly launched. Under the circumstances it is not surprising to learn that the enterprise failed.

The property is now easily accessible by road and tramway, the land has been cleared of heavy forest, a water supply has been obtained, and the several ore-bodies have been explored by open-cuts and adits; therefore the expenses in connection with these works will not be incurred by future operators.

ACCESS

The property is accessible from Waratah by way of Corinna Road to the 8-mile peg. From that point a tramway 2½ miles long connects with the mine. Nearly all the heavy machinery was transported to the mine in the early days by way of Luina. This route is not followed now owing to the difficulty experienced in passing the steep grades and the sharp curves of the road. The cost of transport from Luina to Waratah is thirty shillings per ton and by the other route twenty shillings.

GENERAL FEATURES

Boundaries of these leases pass over the summit of Crescent Hill, a long spur jutting out from Magnet Range. This hill is largely occupied by Cambro-Ordovician strata consisting of grey, blue, purple and red slates and cherts intercalated with thick beds of tuff and sheets of lava. All of these rocks have suffered alteration by the action of hot ore-bearing solutions, and in places some have been completely transformed into hard resistant quartzites.

These stratified rocks have a general north-easterly trend and dip to the north-west at angles varying from 60 to 80 degrees. They have been intruded by dykes of peridotite, pyroxenite, gabbro, and also by quartz-porphyry and syenite. The basic intrusives are much more prominent, and, like the stratified rocks, have a north-easterly trend. Only very small protrusions of porphyry occur. These have been greatly altered by the metasomatic action of ore-bearing solutions, so much in places that their original nature has been completely masked.

THE ORE-BODIES

The ore-bodies of this area belong to the replacement-fissure type and are of two kinds, namely:

(a) pyrrhotite-chalcopyrite;

(b) pyrite-quartz.

The pyrrhotite-chalcopyrite bodies are largely irregular replacements of chert and tuff extending 20 to 30 feet on both sides of fissures. Many of these fissures, which are narrow and irregular, are filled with tin-bearing pyrite and quartz, and it is not unusual to find that oxidation of the vein material extends far below the replacement sulphides. As a rule the fissure filling contains a greater proportion of tin than the replacement bodies, and this material being more amenable to treatment is usually attacked first.

In order of quantitative importance, the mineral constituents of the lodes are pyrrhotite, chalcopyrite, pyrite, quartz, arsenopyrite, and cassiterite. Calcite, which is a prominent constituent of the tuff gangue-rock is always abundant. The ores are characteristically fine-grained, and because of this fineness microscopic study is necessary in order to determine the textural relations and the association of the minerals. The texture is usually fine-granular; the structure is ill-defined and ramifying, and the shape conforms to the irregular outline of the original calcite of the replaced rock. The intercrystallisation of these minerals clearly indicates a contemporaneous deposition. Inasmuch as these ores are worked as a source of tin chief interest lies in the mode of occurrence of the compounds of that metal. Under the microscope, cassiterite in extremely fine grains has been detected in the pyrrhotite ore; but stannite, although proved to be present by analysis, has not been recognised.

The pyrite-quartz ore-bodies are commercially the more important, not only because they contain as a rule a higher proportion of cassiterite, but because this class of ore is more readily oxidised and the tin oxide it contains is thereby set free from the encasing pyrite. Well-defined crustification developed by deposition of these minerals on the walls of fissures or in irregular open spaces is not unusual. They occur also as replacement minerals after felspar porphyry, also after calcite in tuff, and in some few cases after pyroxenite. In association with these minerals, cassiterite is more coarsely crystallised than in the essentially pyrrhotite ore-bodies and is easily discernible by eye. Quartz is the dominant mineral component of these ore-bodies, followed in

order of abundance by pyrite and cassiterite. Fluorspar and tourmaline are sporadic. In some places they constitute 20 per cent. of the lode material, in others these minerals are not common.

The fissures strike in a general north-east direction parallel to the trend lines of the strata in which they occur. They dip, however, in different directions and at various angles. Thus, the easterly group dip to the north-west at angles of 45 to 60 degrees, the westerly group dip to the south-east, and some of the short irregular bodies between them appear to be vertical. On this evidence the converging ore-bodies should meet at depth and form one main ore-channel. Apparently the main body of granite from which the tin-bearing solutions were derived lies at a great depth at this point. It is noticeable that there has been considerable folding and not a little faulting in this area. The strata have been bent into sharp, broken anticlines, the axial trend of which is to the north-east with a pitch to the south-west. The folding is very irregular owing to the variation in the competency of the chert, tuff, and slate rocks to withstand compressive strain.

THE EFFECTS OF OXIDATION

In the ore-bodies contained in chert and consisting largely of pyrrhotite and chalcopyrite the rate of oxidation has been slow and these minerals occur unaltered within a foot or two of the surface. Near fractures and joints in the partly silicified slate, however, the chalcopyrite and pyrrhotite have suffered alteration, the former into malechite and the latter into limonite.

Oxidation of the pyrite ore-bodies has been much more rapid and extensive. In these pyrite and silica have been deposited contemporaneously and occur in intimate association. The soft porphyry in which these minerals are sometimes contained is easily decomposed and disintegrated by the action of percolating solutions, and the pyrite rapidly oxidises to sulphate and ultimately to oxide of iron. A considerable proportion of the sulphate is carried away in solution leaving the associated silica in the form of cellular quartz. On fresh faces of ore, sulphate of iron crystals are very common, and where the arsenopyrite occurs white arsenious oxide is found. Although bunches of pyrite occur in the present working faces partial oxidation has taken place below that level.

The oxidation effect of percolating meteoric waters is shown by the following reactions. The initial effect of the action of water on pyrite (iron sulphide) is to convert it into ferrous sulphate and sulphuric acid, thus -

$$FeS_2 + H_2O + 7O = FeSO_4 + H_2SO_4$$

Ferrous sulphate will further readily oxidise to ferric sulphate -

$$2FeSO_4 + H_2SO_4 + O = Fe_2(SO_4)_3 + H_2O$$

or to ferric sulphate and ferric hydroxide -

$$6\,FeSO_4 + 3O + H_2O = 2Fe_2(SO_4)_3 + Fe_2(OH)_6$$

The hydrolysis of ferric sulphate may first give a basic ferric sulphate which subsequently breaks down forming ferric hydroxide and sulphuric acid -

$$2Fe_2(SO_4)_3 + 6H_2O = 2Fe_2O_3 + 3H_2SO_4$$

EROSION OF THE ORE-BODIES

There has been relatively little erosion of the ore-bodies. This is due in some measure to the hardness of the cherts and tuffs in which the ores are contained. However, erosion in some places has kept pace with oxidation as evidenced by the occurrence of pyrrhotite-chalcopyrite ore-bodies within a few feet of the surface. For long periods protection had been afforded by the covering of Tertiary sediments and basaltic lava; but no trace of these formations has been found on the property, and since their removal the tuffs, slates, and chert have been reduced at least 400 feet. The occurrence of alluvial material containing cassiterite in the Whyte River valley west of the mine and the presence of a considerable amount of tin-bearing wash in the bed of Deep Creek show that the ores extended far above the outcrops near the summit of the hill. It is interesting to note, however, that only very small outcrops of porphyry are exposed and that the ore-bodies occur in fan arrangement dipping toward a common centre. These facts suggest that the ore did not extend far above the present level and that their continuance in depth may be safely anticipated.

DEVELOPMENT

The nature, extent, and value of these ore-deposits have been observed at a number of points on the surface by open-cuts, quarries, and trenches; and underground by means of long adits, winzes and shafts. The underground works are fairly extensive and will prove of use in the further development of the lodes. Quarrying and open-cutting methods of excavation have been applied to the large pyrrhotite replacement ore-bodies, and mining methods to the comparatively narrow vein formations. The ore-bodies, it will be observed, are irregular both in their occurrence and their character, hence the apparent lack of system in the design of operations. Mine or quarry openings have been made in the rich ore-shoots leaving untouched the poor and barren sections between them.

The natural conditions are very favourable for economic development by means of adits and open-cuts. As the workings gain cover the adit system only should be employed. In fact it is doubtful whether the open-cut method is preferable under any conditions, for the extensive bodies of ore consist largely of pyrrhotite - a difficult ore to treat - and the vein fillings are as a rule richer in tin and are pyritic. After very close observation it is considered advisable to confine attention in future to the comparatively narrow lodes in which pyrite predominates over pyrrhotite. The main object to keep in view is the exploitation of the lodes to the best advantage to the Company, and not necessarily to produce a large quantity of material in order to show a low working cost per ton of crude ore. Successful mining depends upon the excavation of as little waste material with the ore as (it) is possible under suitable working conditions.

No. 3 or Mill Workings - This lode was discovered shortly after the milling plant had been erected. It passes underneath the mill in a south-westerly direction, and extends unbroken 200 feet to the north-east. It has been opened by means of two adits and a winze and has been stoped to surface. The adits are 110 and 160 feet in length and are 20 feet apart. According to reports received, the material removed from these workings contained tin in the proportion of four per cent. In the north end of the lower workings the ore-body is 3 feet wide, and consists of partly replaced white and grey slates, with a white slate footwall and blue slate hanging wall.

The original pyritic lode matter now consists of limonite associated with cellular quartz, dark green tourmaline, and fluorspar. The tourmaline is more abundant on the hanging-wall side and fluorspar in the centre of the lode. This tourmaline has been formed by the action of boron-bearing solutions on slate. Malachite occurs on the walls and in cracks and chalcopyrite is commonly found as blebs and veinlets. It is reported that a 60-feet winze sunk from the floor of these workings exposed ore containing 6 per cent tin.

Sample No. 25 from the end of drive contained 1.59 per cent tin.

Sample No. 4 from the same drive contained 1.74 per cent tin.

Sample No. 3 was taken from the Smithy Lode and contained 1.84 per cent tin.

No. 2 Workings - Close to this lode are two parallel formations of similar nature which have been opened by adits and open-cuts. From the entrance to these workings to a point 12 feet from the end the adit has been cut through chert. There it gives place to tuffs heavily charged with pyrite and pyrrhotite, especially the latter. In the end of the north-east drive the tuff is seamed with quartz dipping at 40 degrees to the north-west.

Sample No. 2 consisting of 12 feet of mineralised tuff at the end of the crosscut, contained 1.06 per cent tin.

No. 1 Workings - This consists of a small open-cut into the hillside. The ore-body is indicated here by the presence of pyrite, pyrrhotite, arsenopyrite, and chalcopyrite, which occur as disseminations and as reticulating veinlets in altered slate.

No. 4 Workings - This is a short drive on the Smithy lode which is poor at this point. The lode at the outcrop near the Smithy is 5 to 6 feet wide, but it appears irregular and bunchy. Here the ore consists of cellular quartz filled and lined with pyrite and other minerals. Pyrite is the dominant sulphide, but arsenopyrite and chalcopyrite are not uncommon associates. Pyrrhotite is conspicuously subordinate. In places the lode material consists largely of pellucid, pink, green, and purple fluorspar, but quartz is the more common gangue rock. Fine acicular crystals of green tourmaline and the massive variety are prominent. In the cavernous quartz, clusters of perfectly crystallised grey cassiterite (tin oxide) of pin-head size are very common.

Sample No. 5 represents the value of the material in the adit.

Sample No. 5 contained 0.81 per cent tin.

The country rock here is folded and faulted, and the richer ore-bodies - the fillings of irregular fractures - appear to peter out at a shallow depth. It must be remembered that the fissures represent the true lode channels and that the disseminated ores are replacements of the wallrocks. Care should be exercised in the location of the true lode channel for this is the medium through which the ore-bearing solutions found access. In places the dip of the lode changes to a very flat angle following the line of junction between the two dissimilar formations, chert and tuff. This has given rise to the belief that they do not persist in depth.

No. 11 or Main Open-cut Workings - The ore-bodies already described extend in a north-easterly direction half a mile. They have not been proved to continue unbroken, but rich bodies occur along the course at intervals. One of these occurs 600 feet from and 250 feet higher than the Mill Workings. It has been exposed in an open-cut 220 feet long, 20 feet wide and 30 feet deep, from which a large quantity of ore has been taken. The ore consists of silicified and mineralised grey slates and cherts overlain by a soft grey slate hanging-wall, dipping 80 degrees to the north-west. A band of unaltered grey slate occupies the centre of the ore-body. The replacement portion of the ore-body consists of pyrrhotite and chalcopyrite, with also a little quartz and arsenopyrite. The quartz is frequently found with idiomorphic outlines in the pyrrhotite ore, which is extremely hard and dense. Pyrite is usually found filling joints or associated with the quartz-rich ore in fissures. The saccharoidal quartz and pyrite fillings of the two fissures that traverse this ore-body contain in association much coarsely crystallised tin oxide.

Sample No. 16 represents the quality of a 4-feet band of pyritic material on the footwall of the ore-body, and sample No. 17 a 6-feet body on the hanging-wall side.

No. 16 contained 1.44 per cent tin

No. 17 " 1.87 " " "

Samples of the pyrrhotite ore from this ore-body were not as rich.

No. 13 contained 0.43 per cent tin

No. 12 " 0.23 " " "

No. 12 Workings - This is a small open-cut on the eastern side of the same lode channel about 250 feet farther to the north-east. The ore here is essentially similar to that exposed in the main open cut and is extremely hard. It consists of a dense pyrrhotite-Chalcopyrite replacement of chert. No. fissures were observed.

Sample No. 14 contained 1.28 per cent tin.

No. 13 Workings - Two hundred feet due north of No. 12 Workings is an open-cut on the main ore-body. The cutting is 150 feet long, 40 feet wide, and 60 feet deep. Passing along the sides are two lode channels containing ore of more than average quality. Specimens of the ore were obtained showing fine-grained crystallised cassiterite (tin oxide) implanted on crystals of quartz and filling interstices in the quartz matrix. Associated minerals are pyrite, fluorspar, and gilbertite, likewise of later formation than the quartz. Arsenopyrite and pyrrhotite are prominent replacement minerals outside the lode channels. Between the fissures is a large mass of unreplaced chert and slate. In the pyrite-quartz lodes a considerable amount of tin oxide can be detected by eye. These bands unfortunately do not continue unbroken for any considerable distance. Their richness has been recognised by the operators who have persistently followed them in preference to the pyrrhotite bodies.

Sample 18 represents the quality of the 6-feet lode on the hanging-wall side of the open-cut; sample 21 was taken from two bands of soft pyritised material 3 feet wide; sample 22 indicates the tin content of a 3-feet band of pyrite-quartz lode matter on the south side of the cut.

Sample 18 contained 1.59 per cent tin.

" 21 " 1.31 " " "

" 22 " 0.67 " " "

Mining methods should be employed instead of open-cutting because the vein-fillings only contain tin in profitable amounts.

Traces of this ore-body have been found in tin-bearing arsenopyrite veins and in tin-bearing detritus several hundred feet farther on. No exploratory works have been performed to test their value.

No. 10 Workings - The ore-bodies exposed in these workings are probably the most important on the property. Like the eastern group already described, they have a general north-easterly trend, and follow the ridge of Crescent Hill; but, unlike them, these dip to the south-east. They occur over a width of 50 feet and consist of the fillings of two fissures and the partial replacement of the intervening tuff and chert. The ore consists almost wholly of limonite and quartz, the former largely derived from pyrite by oxidation. Tourmaline is abundant and in places forms a considerable part of the gangue rock.

The ore-body was sampled in 10-feet sections over the full width.

Sample 1 consisted of gossanous chert and tuff with black tourmaline; sample 6 was of similar material; sample 7 consisted of gossanous quartz in decomposed tuff and chert; sample 8 contained disseminated blebs of finely crystallised zinc blende associated with cubic pyrite and fine particles of chalcopyrite in a chert and tuff matrix; samples 9 and 10 were taken from the end of the main drive; sample 11 from the north crosscut.

Sample 1 contained 0.35 per cent tin

" 6 " 1.80 " " "

" 7 " 0.88 " " "

" 8 " 0.45 " " "

" 9 " 0.43 " " "

" 10 " 0.28 " " "

" 11 " 0.38 " " "

No. 16 Workings - The same ore-body has been exposed in an adit and a winze about 200 feet to the south-west. In the adit a 12-feet body of gossanous material has been driven on a distance of 90 feet. Its value at the end of the adit is indicated by the following analysis:-

Sample 15 contained 1.08 per cent tin

In the winze workings 30 feet lower the ore-body has been further explored by driving 200 feet along its course. Here the ore, which is essentially similar to that in the upper level, is not of average grade.

Sample 19 from the north end contained 0.73 per cent tin

and sample 20 " " south " " 0.35 " " "

A winze underlying to the south-east connects this level with No. 8 workings. This part of the workings was not accessible owing to the collapse of the roof. It is reported that some of the richest ore in the mine was taken from this section of the lode. A considerable amount of ore has been stoped in the northern part of the No. 8 Workings.

Workings 6, 7, 9 and 15 expose small irregular ore-bodies of no great importance according to surface indications.

Sample No. 23 taken from No. 6 Workings contained 0.10 per cent tin

" " 24 taken from No. 7 Workings contained 0.18 per cent tin

The line of the western group of ore-bodies has been intersected 600 feet to the north-east by the Khaki Company 's workings. A little tin was found, but no defined lode channel exists.

MILLING AND CONCENTRATION

* In 1908 a 10-head battery of stamps and concentrating machinery was erected by the Mt. Cleveland Tin Mining Company to treat high-grade, non-pyritic ore. As mine development progressed it was found that the material consisted of a mixture of gossan and sulphide ores and that it contained tin oxide in the proportion of one per cent only. Ore of such low grade and complex nature is difficult to treat in a plant except one specially designed for the particular class of material, therefore good results could not be expected of the original plant.

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* Herman, H. Australian Tin Lodes and Tin Mills, Trans. Aust. Inst. Mining Engrs., Vol. 14, 1914.

Careful sampling and testing showed that the loss of tin oxide in the process of concentration was excessive, and that operations under such conditions could not be conducted at a profit to the Company. The necessary alterations to the plant were made, and better results were obtained.

The following is a brief description of the process:-

*The ore is conveyed from mine bins in half-ton buckets along an aerial ropeway, self-dumping over a grizzly to the stone-crusher floor. The original plant did not include a rock-breaker, the large lumps of ore being spalled to a size suitable for feeding to the stamps. The expenditure incurred in breaking the ore and feeding the battery by hand amounted to half the cost of milling and concentration. Wire battery screens of 25-mesh (linear) were used in the mill, and the concentrating plant, besides hydraulic classifiers and spitzkasten, included two card tables, one Wilfley, and four slime tables of the rotating type, 16 feet in diameter - two with a surface slope of 9/16 inch per foot, two with a slope of one inch per foot.

The following sizing tests of the feed and tailing indicate the efficiency of the plant at this stage:-

Gossan ore crushed to pass through 25-mesh screen.

Feed.

# Proportion of Battery Pulp		Free Tin Oxide Estimated as Metallic Tin		Occluded Tin Oxide Estimated as Metallic Tin		Free & Occluded Tin Oxide Estimated as Metallic Tin	
		a	b	a	b	a	b
Bulk	100	1.02	67.33	0.49	32.67	1.51	100
30	1.0	trace	--	0.82	0.54	0.82	0.54
40	6.3	0.1	0.42	0.90	3.08	1.00	3.50
60	11.2	0.3	2.22	0.88	6.51	1.18	8.73
80	9.6	0.88	5.61	0.93	5.90	1.81	11.51
100	2.9	1.58	3.02	0.57	1.09	2.15	4.11
150	7.8	2.28	11.74	0.45	2.32	2.73	14.06
150	60.5	1.11	44.33	0.34	13.48	1.45	57.81
	99.3		67.34		32.92		100.26

Columns (a) show the proportions of tin (Free, combined and occluded or total) in the various-sized products; columns (b) the proportions of the total tin in the ore that each-sized product contains.

* Note: Part of the plant was recently destroyed by fire, and part has suffered from rust and decay.

Probably part of the occluded tin occurs in combination with sulphur in the pyritic ore.

Tailing.

	Proportion of Tailing	Free Tin		Combined and Occluded Tin		Total Tin	
		a	b	a	b	a	b
Bulk	100	0.1	25.0	0.3	75.0	0.4	100
30	1.35	Nil	--	0.693	2.34	0.693	2.34
40	5.10	"	--	0.784	10.00	0.784	10.00
60	10.10	"	--	0.812	20.50	0.812	20.50
80	8.75	"	--	0.735	16.08	0.735	16.08
100	3.70	"	--	0.507	4.69	0.507	4.69
150	5.40	trace	--	0.285	3.85	0.285	3.85
150	65.60	0.154	25.25	0.094	15.50	0.248	40.75
	100.00		25.25		72.96		98.21

At this stage as the ore delivered to the mill was becoming very sulphidic, it was decided to erect a small roasting furnace. A single-hearth furnace with two Leggo mechanical rabbles was built. The capacity of this furnace was five tons per week of concentrate containing seven per cent of sulphur. Alterations and improvements brought the capacity to eighteen tons per week (of 7 days). The sulphur contents having meanwhile increased to thirty per cent reduced the capacity to fifteen tons per week, the sulphur content being reduced to 0.1 per cent. The roasted ore was retreated on the Wilfley table and a recovery of 93 per cent was obtained.

On referring to the sizing test of the tailing, the losses are found in the coarser sizes to be wholly combined or occluded tin. This pointed to the necessity of grinding finer and adding more efficient slime-saving appliances. Accordingly, a Bigelow positive pan, Callow revolving screen, two Card tables, and a double-belt vanner, were erected. The addition of this machinery reduced the tailing loss from 0.4 per cent to 0.13 per cent tin (by vanning assay). The battery screens were changed from 25 to 8-mesh, the pulp went direct to the Callow screen (50-mesh), screen undersize to hydraulic classifiers, oversize to the grinding pan, and from the pan back to the screen - all the ore being finally ground to pass 50-mesh.

The heading from the Card and rotary tables contained 12 per cent tin, 30 per cent sulphur, and from 8 to 9 per cent copper, the last derived from the chalcopyrite-pyrrhotite ore-bodies. After treating the roasted ore the concentrate contained from 0.1 to 0.4 per cent copper.

Power was supplied by Pelton Wheels working under a head of 290 feet and employed as follows:-

One 4-feet diameter, with 1¼-inch tip, driving the battery, pan, screen, elevator and breaker;

One 3-feet diameter, with half-inch tip, driving tables, calciner, and vanner;

One 2-feet diameter, with half-inch tip, driving generator for lighting.

The water for these Pelton wheels was conveyed in a line of pipes, 800 feet long and 13 inches in diameter, from a race connecting with Deep Creek. In summer the water supply was too small to be of use for power purposes and an auxiliary steam plant was employed instead.

Very little of the existing plant is of any use now, the iron work having been seriously damaged by fumes from the calcining plant.

A better site for the milling and concentrating plant could be found on the western fall of the hill.

PRODUCTION

The period of active production of tin ore from this mine extended from 1908 to 1917. The mine was operated by the Company until 1914 when it was let on tribute to different parties for each succeeding year until 1917. Although the collapse of the tin market directly brought about the cessation of operations the erratic nature of the ore-bodies and the inefficient methods employed in the transport and treatment of the ore contributed largely to the failure of the Company.

The results of the analysis of the samples taken during this investigation clearly indicate that, as a rule, the pyrrhotite replacement ore-bodies are unprofitable and that attention should be directed to the pyrite-quartz lodes.

Details of production are given hereunder:-

Year	Crude Ore Milled (Tons)	Tin Oxide Recovered				Tin Oxide recovered from Crude Ore Milled	Value of Crude Ore per ton	Net Value of output
		Tons	cwt	qrs	lbs	Per cent	£. s. d.	£. s. d.
1909	4500	36	0	0	0	0.8	14. 5	3278.14. 7
1910	8757	75	6	0	21	0.86	13. 8	5985.16. 3
1911	6976	58	7	2	1	0.836	15.11	5574. 4. 4
1912	5848	56	6	2	22	0.963	1. 0. 5	5965.14. 7
1913	5245	44	2	0	27	0.84	1. 1. 7	5675.14. 9
1914	4140	25	10	1	12	0.616	13. 4	2758. 6. 3
1915	845	10	18	2	7	1.29	18. 8	789.10. 6
1916		20	10	1	24			1990.10. 6
1917		16	12	1	7			1794. 0. 6
Total output		343	14	1	9	valued at		£33, 812.12.3

It has been estimated that 45 per cent of the tin content of the crude ore was lost in treatment. Although

the loss was undoubtedly heavy this estimate was not based on reliable data, and, consequently, cannot be accepted as even an approximation.

ORE RESERVES

Insufficient data are available upon which the quantity and value of the reserve of ore can be estimated. Development has not been kept ahead of mining, and, therefore, according to the recognised rules, there is no reserve despite the fact that profitable ore occurs in many of the workings. On the resumption of operations at the beginning all expenditure should be applied to exploration underground in order that a large reserve may be established. If it is found that the ore is not of profitable value the mine may then be abandoned at any stage of development without incurring undue loss. Except under unusual circumstances mining development should always precede surface expenditure.

THE FUTURE OF THE MINE

At the present market rate for tin the free-milling oxidised ore opened up in Nos 10, 8 and 16 Workings could be worked at a profit to the operators. These resources should be tapped while the development works are in progress in other parts of the mine. Based on the information obtained during this investigation it may be stated that the geological conditions are decidedly favourable, and that the prospects for the future success of the enterprise are much better now than they were when the Cleveland Company was operating the mine. An adequate working capital is the first essential to success, but a large outlay will not be necessary in plant. At the present stage of development the mine cannot be regarded as a large one. This fact should be borne in mind when consideration is being given to the design of future operations.

(Signed) A. McINTOSH REID

GOVERNMENT GEOLOGIST.

Geological Survey,
LAUNCESTON, 19th March, 1923