DEPARTMENT OF SUPPLY & SHIPPING

MINERAL RESOURCES SURVEY BRANCH.

GEOLOGICAL REPORT ON THE RENISION BELL TIN FIELD

Report No. 1943/23.

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GEOLOGICAL REPORT ON THE RENISON BELL TINFIELD

INTRODUCTION

FIELD WORK

A geological examination of the Renison Bell Tin Field was made in company with Mr.H.G.W. Keid, Field Geologist, Tasmanian Department of Mines, during January and February, 1942. Twentysix days, from January 15th to February 10th, were spent on the field. Workings, lode outcrops and ~~and~~ the principal topographical features were mapped by plans table on a scale of 100 feet to an inch, and all accessible underground workings were plotted on a scale of 40 feet to an inch. Surface exposures were poor, owing to dense growth of bracken and other scrub and were largely confined to the vicinity of present or previous workings, tramlines, tracks, roads and the railway line. In compiling plans, some use has been made of previously existing maps by Hartwell Conder, formerly Acting Assistant Geologist in the Tasmanian Mines Department, and by the Imperial Geophysical Experimental Survey. Following is the list of plans which have been prepared to accompany this report:

Plate 1: Surface plan, on a scale of 500 feet to an inch, showing general geological features and existing leases.

Plates 2, 3, 4 & 5: Detailed surface map in four sheets on a scale of 100 feet to an inch; of these Plate 2 embraces the Renison Bell section; Plate 3 the Dreadnought Federal lode system; Plate 4 the north-east corner of the field on which there are no important workings, and Plate 5 covers the Boulder section.

Plate 6: Longitudinal section of the Renison Bell lode system, together with a series of cross sections through the lode, all on a scale of 100 feet to an inch, except one more detailed section on a scale of 40 feet to an inch.

Plate 7: Three through sections across the field from the Rension Bell to the Dreadnought-Federal lodes, on a scale of 100 feet to an inch.

Plate 8: Longitudinal section of the Dreadnought-Federal lodes, with detailed underground plans and local sections.

Plate 9: A series of cross sections through the ore-bodies in the Boulder area.

Plate 10: Detailed underground plans of various miscellaneous workings, on a scale of 40 feet to an inch.

All these plans, with the exception of Plate 1, are of the same size, 38" x 27". Plates 2,3,4 and 5 fit together to form a composite plan of the field.

LOCATION AND ACCESS

The Emu Bay railway line from Burnie on the north-west coast of Tasmania to Zeehan passes through the north-west end of the field, actually cutting through the outcrop of the Renison Bell main lode. This railway line continues from Zeehan to Queenstown (Mt. Lyell) via Strahan on Macquarie Harbour. Renison Bell siding is 78 miles from Burnie. A rail motor passenger service operates daily each way, leaving Burnie 7.35 a.m. and arriving Renison Bell 11.40, and leaving Renison Bell for Burnie at 1.40 p.m. Through goods trains run three times a week in each direction. Freight charges are high.

Renison Bell is connected with Zeehan to the south-east by twelve miles of reasonably good all-weather motor road, which terminates just east of Renison Bell Creek (Plate 1 and 2). As Zeehan is connected to Queenstown by road and thence to Hobart and Launceston, Renison Bell can be reached by car and is, in fact, the northerly terminus of the West Coast road. A bus service operates twice daily from Zeehan bringing day shift workers out in the morning and returning them to Zeehan in the afternoon.

The principal mines on the field are connected by a 2-foot gauge Government-owned tramway, known as the Boulder Tramline. Workings at higher elevations feed by means of self-acting inclined tramways into ore bins along the main tramline. Renison Associated Tin Mines, N.L., have a small steam engine to draw their ore from their principal workings, which are situated near the southern terminus of the tramline, to their mill at the north-eastern end. Tasmanian Amalgamated Tin Mines, N.L., rely on horse transport.

Tracks suitable for foot and horse traffic only have been cut to various parts of the field. Principal of these is the Montana track from Renison Bell station and township across to the Boulder section.

TOPOGRAPHY

Surface elevation varies from 500 feet above sea level at the Argent River up to just over 1600 feet at the top of Renison Bell Hill. Terrain is in general moderately steep over the principal mining area and considerably more so immediately to the south where Commonwealth Hill and Pine Hill rise to several hundred feet higher than the Renison Bell. Datum level for surface mapping was taken from rail level at Renison Bell station, which is given in the Emu Bay Railway Company's time-table as 635 feet above sea level. 1*

Most of the timber has been cleared from the leases, except on the north-western slopes of Dreadnought Hill, but almost the whole of the surface is covered with a dense growth of bracken which is very difficult to penetrate except along cut tracks.

Rainfall is heavy, slightly in excess of 100 inches per annum, with the principal precipitation from April to November. Rainy conditions are the rule rather than the exception for most of the year. Renison Associated

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* This height was taken in error as 735 feet and all plans prepared on that basis. Hence reduced levels used on the plans and throughout this report are all 100 feet higher than actual height above sea level.

Tin Mines, N.L., draw their water by water-race from a dam some distance up the Argent River and for most of the year the supply is sufficient to generate 100 horsepower of electricity, in addition to satisfying plant requirements. Tasmanian Amalgamated Tin Mines, N.L., have a water-race from the junction of Dalcoath and Montana Creeks delivering to their mill.

PREVIOUS REPORTS

A number of reports upon the field, published and unpublished, are in existence and have been referred to during the compilation of the present report to a greater or less extent. As this investigation was concerned only with the central portion of the field, reference should be made to earlier reports for details of occurrences outside this area and also for fuller information on the general geology, topography, history etc., of the field. The principal reports available are listed below :-

1. Report on the Tin Ore Deposits of North Dundas, by G.A. Waller, Annual Report of the Tasmanian Department of Mines, 1901-1902.

2. The Tin Field of North Dundas, by L. Keith Ward, Bulletin No. 6, Tasmanian Department of Mines, also Annual Report No. 1908.

3. The Tin Field of North Dundas, by Hartwell Conder, Bulletin No. 26, Tasmanian Department of Mines.

4. The Dundas Mineral Field by A. McIntosh Reid, Bulletin No. 36, Tasmanian Department of Mines.

5. Report on the Dreadnought-Boulder, Renison Bell and Montana mines, by M.R. McKeown, private report to the Imperial Tin Syndicate in 1927.

6. Report on recent porpsecting results, Amalgamated Tin, N.L., private report by G. Lindsay Clark, 1927.

7. Report of the Imperial Geophysical Experimtental Survey, 1931, by A.B. Broughton Edge, T.H. Laby and Imperial Geophysical Experimental Survey Staff.

8. The Renison Bell Tin Field, Tasmania, report by P.B. Nye and M.A. Mawby to the Minerals Committee, 1942.

9. Mineral Composition of the Tin Ores of Renison Bell, Tasmania, by Dr. F.L. Stillwell, Mineragraphic report No. 245, 1942 and Addendum, 1943.

TENURE

Geological examination was confined to the main central section of the Renison Bell field, to which activity is at present restricted. Onwership of this area is vested in two Companies, Renison Associated Tin Mines, N.L. and Tasmanian Amalgamated Tin Mines, N.L. The former Company holds a series of leases which contain all the workings on the Renison Bell main line of lode south of the Argent River, the Dreadnought lode and the northern portion of the Federal lode, and the Boulder section, which comprises Battery, Cable, Luck's, Dalcoath and Dalcoath Creek lodes

(Plate 1). Tasmanian Amalgamated Tin Mines, N.L. property is contained mainly in a large consolidated lease which embraces the Motana workings, Dunn's lode and the southern portion of the Federal lode, as well as sundry less important showings. This Company also holds two more leases at the eastern end of the field.

HISTORY AND PRODUCTION

The presence of tin on the field was first established about 1890 and a little prospecting was done in the next few years. The construction of the Emu Bay railway in 1900 helped to open up the Renison Bell lode system. For some time, work was largely confined to surface sluicing of detrital material or oxidised outcrops, but later, from 1909 onwards, batteries were installed on several of the properties to treat the oxidised ore. A series of seven diamond drill holes was put down on the Renison Bell Main lode system during 1912 and 1913. In 1914 a calcining plant was installed to roast the sulphides before attempting extraction of the tin, but this did not meet with much success except in the case of high-grade sulphide ore. After 1917, work was mostly confined to tribute parties. In 1926 an option was obtained over the greater part of the field by Mr. Victor Leggo, in association with the Imperial Tin Syndicate, and a detailed examination was made by Mr. M.R. McKeown, Mining Engineer, a sampling campaign carried out, and several percussion bores put down on the Boulder and Montana sections. This option was not proceeded with and in 1935 the Renison Associated Tin Mines Company, N.L., acquired the Renison Bell, Dreadnought and Boulder leases and began treating the primary ore by first floating off the sulphides and concentrating the tin from the residues by gravity methods. Up to the present, recoveries obtained by this process have been little better than 50% extraction.

About the same time, Tasmanian Amalgamated Tin Mines, N.L., began operations on the Federal and Montana leases and erected a battery to treat oxidised ore first from Dunn's lode and later from the Federal mine. Their recoveries also have been low, largely owing to the extreme fineness of the tin and were probably little, if any, better than that obtained from sulphide ore.

A table showing production from the Renison Bell Tin Field compiled from official returns of the Tasmanian Department of Mines, is given on page 5. This table includes production only from the areas shown on Plate 1, not outside mines such as Penzance and Pine Hill. Conder estimated 430 tons of concentrates (equivalent to 300 tons metallic tin), from miscellaneous sources up to the end of 1917, but as it is not known where this was obtained, it is not included in the total, which amounts to a little over 2,000 tons of metallic tin. The value of this production has been estimated from the information available to be in the vicinity of £350,000 or if the 430 tons of concentrates mentioned above be included the total value of the tin produced from the North Dundas Tin Field is very close to £400,000. Figures for the tonnages of ore mines are very difficult to obtain owing to the scattered and varied nature of the workings, but it is possible to account for a total actually mined which is probably between 250,000 and 300,000 ton. This does not, of course, include the tonnage created by sluicing, which, on the Montana section along, must have been considerable. If the total tonnage mined, as estimated above, be divided into the total tin production (approximately 1750 tons) from the Boulder-Dreadnought, Rneison and Federal leases, where nearly all the mining has taken place, the indicated average grade of tin recovered is between .6 and .7 per cent.

GEOLOGY OF THE FIELD

GENERAL OUTLINE

The general geology of the field has been well described by Ward and Conder. The principal rock types are sediments which form part of a series, known as the Dundas slates, to which a Cambro-Ordovician age is assigned. Subsequent upon faulting and regional metamorphism, the slates were intruded, in Devonian time, according to Ward and Conder, by a series of basic igneous rocks represented in the Renison Bell area by an intrusion of gabbro just south of the Dalcoath ore-body (Plate 1), and later by acidic quartz-porphyries which are considered to be directly associated with the source of the mineral-bearing solutions. The development of the porphyritic rocks centres in Pine Hill, to the south of the main tin-bearing area, but a long narrow dyke has been mapped running from this central body across Renison Bell hill to the Argent River. It is well exposed on the recently constructed road from Renison Bell to Zeehan, about 1,000 feet west of the Renison Associated Mill, where it is 25 feet in width.

A dolerite dyke, considered to be of Mesozoic age and hence much later than the mineralisation, has been mapped by earlier observers at intervals from near the top of Dreadnought Hill in a south-easterly direction parallel to Montana Creek, and crossing Dalcoath Creek on a more easterly course near its junction with Gormanston Creek. Outcrops of this dyke were obscured either by dumps or by dense growth and its course has been plotted from Conder's and Imperial Geophysical Experimental Survey maps.

Exposed in railway cuttings just south of Renison Bell railway station is a conglomerate of recent aspect with well-rounded boulders up to several inches in diameter and a fairly high proportion of interstitial clay.

The workings at the north-eastern end of the Dreadnought line of lode and in the gully at the south end of the Federal lode, expose a considerable thickness of more or less consolidated earth with impregnated limonite and occasional boulders of ironstone and gossanous material. It is considered probable that at an earlier stage of erosion, the gossan outcrops of the lode in these areas formed a bold bluff which eventually collapsed so that the material composing them and their hanging-wall country was distributed over the slope below.

The flat-lying ore-bodies of the Boulder Section have shed their fragments down the slopes in a more normal way. Often secondary cementation of this material by iron-bearing solutions percolating out of the oxidising lodes above has taken place. Gossans so formed are referred to in this report as secondary gossans. Many of them are tin-bearing and some have been sluiced profitably in the past.

Another type of gossan or pseudo-gossan has been formed by these iron-bearing solutions trickling down-hill and impregnating any porous rock or talus, or the soil, especially at a place where the surface slope flattens out, eventually forming a solid limonitic deposit, which may be only a crust, or may extend to some depth.

TABLE SHOWING ESTIMATED PRODUCTION OF METALLIC TIN
RENISON BELL TIN FIELD

YEAR	BOULDER - DREADNOUGHT LEASES	RENISON BELL LEASE	FEDERAL LEASE	MONTANA LEASE	TOTAL	REMARKS
1900-08	50	41.8	-	80.7 x	172.5	x Includes Duncombe & Maddox Section.
1909	46.5	33.0	-	55.7	135.2	
1910	58.4	117.5	-	52.0	227.9	
1911	49.0	91.0	-	23.2	163.2	
1912	24.5	61.7	-	19.8	106.0	
1913	44.5	96.8	-	18.2	159.5	
1914	21.0	56.4	-	9.7	87.1	
1915	51.6	33.6 x	-	11.0	96.2	x 17.6tons from Central
1916	68.5	16.4	-	6.6	91.5	
1917	46.8	33.0 x	-	-	79.8	x 27 tons from Central
1918	18.1	47.4 x	-	-	65.5	x 19.2 tons from Central
1919	-	18.4 x	30.8	5.6	54.8	x 1.7 tons from Central
1920	21.4	-	38.3	5.7	65.4	
1921	2.6	18.9	-	3.3	24.8	
1922	.8	23.4	-	2.5	26.7	
1923	1.3	21.8	-	3.4	26.5	
1924	1.2	10.4	-	2.8	14.4	
1925	1.9	8.1	-	2.1	12.1	
1926	?	?	-	?	8.8	
1927	-	2.4	-	-	2.4	
1928	-	-	-	-	3.4	
1929	-	-	-	-	3.7	
1930-33	-	-	-	-	Nil	
1934	-	4.2xx	-	3.0	7.2	xx Renison Bell General
1935	3.5 x	.2xx	-	.3	4.0	x 2 tons from Dreadnought
1936	16.0x	1.5xx	-	-	17.5	x from Dreadnough
1937	16.2		6.9 x	-	23.1	x From Dunn's Lod
1938	15.6		41.8 x	-	57.4	x From Dunn's Lod
1939	3.3					
1940	57.8		120.5 x	-	262.2	x Estimated from Co. returns; from Federal Lode.
1941	80.6					
1942	40x		40 x		80	x Estimated from Co. returns;from Federal Lode.
TOTALS:	747.0 x 732.0 xx		278.3	305.6	2078.8	x Includes Renison Bell since 1934. xx To end of 192

THE DUNDAS SLATES

The Dundas series in the Renison Bell area consists of shale and fine sandstone of varying character with an occasional coarser bed and one or two tuffaceous horizons. The general dip is to the north-east at a low average angle, generally between 10° and 30°, but steepening perceptibly towards the Dreadnought line of lode. At the north-west end of the field, the dip is comparatively regular, though local variations are common, but in the Boulder-Montana section it is very erratic. A definite anticlinal axis runs down between the Cable and the Battery workings towards the junction of Montana and Dalcoath Creeks (Plate 5) with a corresponding syncline to the west. East of the anticline, the dip is fairly consistently to the east or north-east.

A traverse of the field from west to east gives an ascending sequence through the series as developed in the Renison Bell locality. In Railway and road cuttings west of the Renison Bell lode, massive beds of fine sandstone and shale sometimes up to 2 and 3 feet thick alternate with thinner beds. Material similar to the topmost of these beds was observed near Dalcoath Creek lode on the lower tramline.

The quartz-porphyry dyke exposed on the Zeehan road has been intruded along the crest of a local anticline (Section I-I', Plate 7).

Overlying these beds is perhaps 300 feet of well-bedded shale which is typically exposed in the railway cutting near Renison Associated mill and in old workings east of the Gloryhole (Plate 2). Though generally uniform in character, this section includes occasional coarser beds, coarse quartzy sandstone of typical shoreline facies, and one band coarse enough to be called a conglomerate was noticed in the workings near the railway cutting. This shale is the host rock of nearly all the sill-like orebodies known as "floors" and in the vicinity of these floors and the lode fissures it is, as a rule, well silicified, differential replacements by quartz emphasising the lamination even more. In the Boulder section, the strata which appear to correspond to the railway cutting exposures are often slightly coarser in grain, particularly around the Battery open cut, though the more normal shale is well exposed along the tramways and in the various workings.

At the top of the laminated shale is a band of red shale sandstone, including several very massive beds and some tuffaceous horizons. As they dip with the slope of the hill and are resistant to weathering, these rocks constitute the outcrop over a considerable part of the eastern side of Renison Bell Hill.

Above the red beds, which seem to mark the upper limit of the main floor-bearing horizons, are further bedded shale and mudstone. Exposures are poor in this area, but the sediments appear to become more massive and felspathic in character going eastwards as the country rock along the Dreadnought-Federal lines of lode is quite distinct from the more westerly outcrops. The dip appears to become steeper, particularly near the Dreadnought and Federal lodes, but these occupy such strong lines of fissuring that a parallelism has been induced in the adjacent beds and it is difficult to distinguish shearing and fracturing due to this cause from bedding. East of this the dip seems to flatten again though some steeper dips were observed on the tramline.

Owing to scarcity of exposures and to the fact that the flat dip of the sedimentaries and the high surface relief combine to produce very irregular outcrops, it was not possible to plot in detail the boundaries between the various geological divisions, which in any case are by no means sharply defined, so no attempt has been made to show these boundaries on the detailed surface plan. Their general trend is indicated on the smaller scale lease plan, Plate 1.

ECONOMIC GEOLOGY

GENERAL

Lode structures and ore types on the field vary greatly and they have been described in detail by Ward and Conder. Stillwell's Mineragraphic Report No. 245 deals with the mineral constitution of the ores and his observations concerning the order ofcrystallization enables many previously existing erroneous conceptions with regard to the part played by the different minerals to be cleared up.

The two main types of ore occurrence are:-

(1) Steeply dipping fissure lodes known locally as "feeders".

(2) Sill-like ore-bodies making out from the feeders parallel to the bedding and referred to as "floors".

In the vicinity of the floors, and the feeders also in some cases, it is not unusual for mineralising solutions to have penetrated into the country rock, forming s small veins and partial replacements, so that the whole mass may carry an appreciable percentage of tin. Combinations of floors with diverse sets of fissures give rise to ore-bodies of extremely varied shape and size. Another type of mineralisation, well illustrated at Brumby's workings on the Dreadnought lode, is an impregnation and replacement of the country between two or more parallel or diverging fissures, particularly of the bedding planes are more or less at right angles to the fissures, forming an easy set of connections between them.

FISSURE VEINS

The dominant set of fissures on the field is in a north-west-southeast direction. These are referred to as the Main fissures. Not only are the feeders of the Renison Bell lode system and the Montana, Battery and Cable ore-bodies, andthe Dreadnought-Federal fissures aligned in this direction, but the quartz-porphyry and the dolerite dykes are also very nearly parallel to it. The tendency with regard to the lodes is for a set of fissures to be developed roughly in line or en echelon, often with lesser sub-parallel or branching fissures, rather than as one long continuous fracture. However, it is known that the fissures themselves occupy fault planes along which movement has taken place. In the Renison Bell railway cutting a fault zone affects the country for 50 feet west from the main lode fissure and the vertical displacement on a coarse sandstone or conglomerate bed appears to be about 45 feet downwards to the east. The Dreadnought-Federal system is obviously a strong line of shearing with a similar direction of displacement, and the movement has dragged the wall rock along with it, resulting in a set of fractures parallel to the lode and obscuring the original bedding. The longest fissure which can be traced continuously is the Renison Bell Main Lode, with an observed length of 1200 feet and possibly more.

The Dreadnought lode fissure system is proved by underground workings to extend for more than 2000 feet, but there are not sufficient exposures to establish its continuity throughout that length. Within the fissures lenticularity of lode occurrence is the rule and stretches of ore may be separated by comparatively barren patches in which either mineralisation has taken place with low tin values, or the ore channnel may be reduced to a little poorly mineralised slate or to a simple fissure. Bulges to a greater than normal width are also common in the mineralised sections. The longest continuous shoot without appreciable breaks is the Federal lode, which is developed for a length of 750 feet without exposing either termination, though a low-grade section occurs in the southern half of the ore-body.

Nearly all the lodes of the main fissure system dip at angles in excess of 60° towards the northeast. The one exception is the fissure which extends from Dunn's lode probably through the Battery workings and which dips southwest. A rule to which there is no exception is that the fissures dip in the same direction as the general dip of the country rock at that place, but at a steeper angle. The dominant strike direction of the fissures is from 40 to 50° west of north, but extreme cases vary from 10° to nearly 60° west. The average strike of the quartz-porphyry and the dolerite dykes, according to Ward's and Conder's mapping, is 30° west of north, some 15° more northerly than the average strike of the lode fracture system, although parallel to some of the individual lodes, e.g., the Upper Blow lode on Renison Bell Hill. Slickensides on the walls of the Renison Bell Main lode are horizontal or pitching flatly to the south.

A less important set of fissures runs almost at right angles to the Main lode series on strikes varying from 60° east of north to almost east-west. These cross fissures are developed principally in the area near the head of Renison Bell Creek, between the Renison Bell and the Montana sections, and in the Dalcoath Creek lode. They are more limited in length than the main fissures and have not been recorded to be more than 400 feet long. Dip is steep but variable; to the south in the Dalcoath Creek lode, but more often to the north in the Renison Bell Creek area. Slickensides on the walls of these lodes also pitch flatly as a rule. Although it is considered probable that the development of these fissures was more or less contemporaneous with that of the main northwest-southeast series, the whole combining to relieve a system of strains set up by the same dislocating force, there is a little evidence at some exposures that the cross fissures are the earlier of the two, or at least that movement along them ceased first, as they seem to be displaced slightly by the main fissures.

Steeply dipping faults more or less at right angles to the lodes are common. Those cutting the main lodes are roughly parallel to the cross lodes and vice versa. Displacement as a rule is not great. Fault fissures parallel to the main lode fissures, and strictly comparable to them in time and manner of formation, also occur frequently Practically all the faulting is considered to be earlier than the mineralisation, with the possible exception of a few minor cross faults.

ORE STRUCTURES

Not enough is known of the occurrence of ore to be able at this stage to indicate with any degree of accuracy, the probable factors which may determine the position of ore shoots within the fissures. In most cases only

the surface exposures are available, and these are often poor, observations on the attitude of the country rock are limited by paucity of outcrops, and the few accessible underground workings are at shallow depths below the surface, so that little information is obtainable about the attitude and relations of the ore shoots, or even of their locations, or of the details of the vein structures or the behaviour of the country rock. This state of affairs is due of course to the fact that only the oxidised ore of these lodes has been mined in the past and this extends only to very shallow depth. The direction of the bedding shown on the longitudinal sections (Plates 6 and 8) is generalised from the few known dips and strikes but should be accepted as tentative only, for if more complete information were obtained, the picture might be materially altered. As no limits have been exposed to any of the ore shoots except on the surface, little information can be given with regard to their pitch. The position of a barren section in the Federal lode (see longitudinal section Plate 8), suggests a flat southerly pitch, but it could be premature to apply this as a general rule.

Consideration of the structural history of the area does, however, indicate certain features which may be related to ore occurrence, and although these conceptions cannot be verified in the present backward state of development of the field, they may be useful if the veins are ever opened up. In the first place, the formation of the lode fissures is considered to be directly connected with the intrusion of the quartz-porphyries to the south and west. Their general parallelism with dykes given off from the main intrusion and the obvious association of the mineralisation with the porphyry are taken as confirmation of this hypothesis. Stillwell's microscopic examination of the ores has shown that tin (with unimportant amounts of wolfram) was the first mineral deposited and its localisation therefore, should be directly related to primary favourable structures within the lode fissures. The vertical displacement on all the main fissures and faults is downwards on the north-eastern side, that is, the normal faults. Displacement in a horizontal sense is more difficult to determine, but the consistent flat southerly pitch of the slickensiding on the walls of the fissures suggests that the horizontal compnent was important and also, when combined with the direction of the vertical displacement and the position of the porphyry mass which is thought to be responsible for the fissure formation (refer to Plate II, Geological Survey Bulletin No. 26, Tasmanian Department of Mines),that the southwest block moved to the northwest, that is, the displacement was righthanded. On this basis, open spaces in the fissures, or areas of least compression, and hence oreshoots, would be expected to be formed, in a vertical sense, wherever the dip steepened, and, looking along the vein, wherever it turned to the right, that is, on a more northerly strike. As mentioned above, insufficient information is available with regard to the ore shoots and the vein structures to provide confirmation or otherwise of these ideas, and they may be subject to drastic revision if such information is ever obtainable.

Another geological feature which may influence the formation of ore-bodies is the horizon within the sedimentaries, the more massive beds lending themselves to the formation of open spaces within the fissures, while the laminated beds might be expected to yield more by crushing and lateral adjustment. That such a relation does exist is suggested by (1) the strong lens of ore at the main Blow Lode where the walls are solid, massive shale (2) the narrow width

ofthe Renison Bell Lead Lode on the surface where the walls are finely laminated shales and (3) the considerable thicknesses of ore developed in places along the Dreadnought-Federal fissure system, where the country rock is again strong and massive.

FLOORS

These ore-bodies make out into the bedding from the fissures and in general conform to the attitude of the country rock, though cross fissuring and other features may cause irregularities. Characteristic features of the floors are :-

(1) They follow the bedding on either or both sides of the main fissure, but prefer the hanging wall side. In many cases the parent fissure cannot be directly observed. The connection may have been removed by erosion, it may be only poorly developed or not apparent at all.

(2) They are flatly lenticular in shape and lens out at all extremities, sometimes very gradually, sometimes bluntly, or the footwall may rise steeply and cut off against the hanging-wall as in the Cable open cut on the north, west and south sides.

(3) They are formed mainly by bodily displacement of the sedimentaries, the mineralising solutions having penetrated the bedding planes and forced them further apart as the ore mass was built up. Replacement of the country may take place along the margins of the floors and small veins and sheets may penetrate the sedimentaries for some distance from the walls of the solid sulphide floor giving rise to a marginal mineralised zone.

(4) The slates in contact with the floors, particularly on the hanging wall, are well silicified and this feature may serve as a guide to ore-bearing localities.

(5) Composition of the floors is mainly pyrrhotite, with arsenopyrite, cassiterite, pyrite, etc. in varying proportions (Refer to Stillwell's Mineragraphic Report). The iron-manganese-magnesium carbonates which are a feature of these ore-bodies occur around the extremities of the floor and seem to be a late stage in the mineralisation.

(6) The cassiterite content decreases in quantity and in grain size away from the fissure. The carbonates seldom carry tin.

(7) Slickensides on the walls and the enclosing slates are directed down the dip of the ore-body and the country, usually at right angles to the strike of the fissure lodes.

With regard to the location of the floors, they are confined to the more westerly lode system which extends from the Renison Bell, through the Montana, to the Boulder workings, and in a vertical sense are mainly restricted to the well-laminated shale and fine sandstone which outcrop along this belt of fracturing. The upper limit of the more important bodies is the band of massive red rock which outcrops over much of the east side of Renison Bell Hill,

and as far as known, exposures indicate they seem to prefer the upper horizons within the laminated shale. The reasons for their localisation within this band of country are almost entirely physical. The thin-bedded character of the shale and sandstone provides ready access for mineralising solutions to penetrate and commence the process of "floor" building and for the same reason they lend themselves better to replacement processes by mineral solutions travelling along the bedding and infiltrating the narrow intervening beds. An even more important factor, however, in the establishment of these laminated beds as hosts for the floors is their comparative susceptibility to shearing stresses. When the Dundas slates were folded, evidently at considerable depth, this well-bedded horizon was sandwiched between the competent alternating massive sandstone and shale beds below and the solid red rock and overlying shale becoming progressively less bedded above. These incompetent beds, therefore, suffered intense shearing and much minor faulting and puckering, rendering them ripe for mineralisation at a later stage when the ore solutions began to make their way up the steeply inclined fissures. Further differential shearing probably occurred in these beds during the formation of the fissures themselves.

The floors tend to occur wherever a line of fissuring cuts through the laminated beds. The most important inference to be drawn from this concerns possible developments on the Dreadnought-Federal lode system in depth. No floors exist on or near the surface in this area. The horizon which carries the floors along the Renison-Boulder line of fissuring dips north-east at an angle which is on the average probably fairly low (Cross sections, I-I', J-J' and K.K., Plate 7), and should cut the Dreadnought-Federal line of lode at a depth which on present indications might be expected to be of the order of 400 to 600 feet from the surface. There is no apparent reason why another series of floors should not occur corresponding to this intersection.

The same disabilities which prevent recognition of factors localizing ore-bodies in the main fissures also operate with regard to the lateral limits of the floors, but there is a suggestion that if the structures could be worked out in detail, it would be found that the floor-bearing areas, might be related in a general way to cross folding in the sedimentary rocks or other structural features. The general relation that is obvious at present is that the floors are developed where the feeders are definite lode fissures, though maximum development of the feeder by no means coincides exactly with the giving off of a floor. In fact, in more than one case, it is noticeable that the fissure lode is narrow adjacent to the floor, and much stronger along the strike or down the dip where there has been no such drain on its mineral supply, or where, perhaps, more favourable structural conditions exist within the fissures.

PARAGENESIS

The ore-bodies are generally massive sulphidic bodies with pyrrhotite, pyrite, quartz and carbonates as the most abundant minerals and cassiterite, the most important economically. Other metallic minerals are arsenopyrite, marcasite, galena, sphalerite, chalcopyrite, stannite, wolframite, magnetite, tetrahedrite, jamesonite, bismuth, canfieldite and gold, while minor gangue minerals include tourmaline, topaz and fluorite. This mineral assemblage is typical of the hypothermal zone of ore deposition. Wolfram and cassiterite are the first metallic minerals deposited, followed by the iron-bearing sulphides, then sphalerite, stannite and finally the lead minerals. Quartz is not confined to any one part of the mineralising sequence

and the main deposition probably took place then, some of it is known to be later than the pyrite. The carbonates were deposited during the final stages of crystallisation of the lodes.

The carbonate minerals in places as at the Cable, Battery, Dunn's workings and on the Renison Bell main lode occur in quite massive bodies. In composition they vary considerably in different parts of the field, being made up of varying proportions of the carbonates of iron, magnesium, with very little lime. (Refer to addendum to Stillwell's Minergraphic Report No. 245). A pink colour generally betrays the presence of a considerable proportion of manganese. Although one 5 feet section of the No. 4 diamond drill recorded as dolomite carried 1.14% Sn., wherever the carbonate has been met with in the mine workings it contains little or no tin. It is even recorded that a large body of carbonate in the middle of a good tin-bearing section of the Battery floor had to be rejected as carrying practically no values. The low values in the carbonates are due to their late stage in the sequence of mineral deposition, as revealed by the minergraphic investigation. As they occur mainly around the periphery of the earlier formed sulphides carrying the tin, they would naturally not be expected to contain values except where they have enveloped previously tin-bearing material.

In the ore-bodies, the tin is fine grained and seldom visible to the naked eye except in a few places where it may occur as rich veinlets in the sulphides, as at the Dalcoath and Brumby's workings. The most reliable guide to values has been found to be the presence of a siliceous skeleton to the ore. When sulphides have been oxidised and removed by leaching, this skeleton shows up as a lattice framework of small well-formed quartz crystals. Tin values are erratic locally, but consistent on the whole over the sections of the ore-bodies which carry payable values. For instance, a series of samples along a drive or across a face may return somewhat as follows :-

1.0, 0.2, 0.6, 3.5, 0.4, 0.9, 1.7, 0.3, 2.2, 0.7.

The average value of these samples is 1.15% Sn., and in mining it would probably be found that this average value was fairly well realised, but they demonstrate the fallacy of placing too much reliance on any individual sample. Consequently an exposure which consists of a single cut through the lode, such as a cross cut or a similar section a few feet away may be either a fraction of or many times its value, and a number of such sections is required to obtain a reliable average. A bulk test from a cross cut would naturally be much more dependable than a channel sample.

is called the Renison Bell Main lode at the north end generally. In the vicinity of the railway line and the workings immediately to the south, it is known as the Lead lode because it carries an appreciable quantity of galena. Higher up the hill, it is known as the Blow Lode, and the topmost workings are referred to as the Upper Blow lode. The White lode is an indefinite zone of mineralisation branching off the Main lode just north of the Railway line (Plate 2).

North of the Argent River the lode fissure can be traced to the end of the open cut where it appears to die out. It dips north-east at 60° and strikes (projected to the horizontal) 42° west of north. The width is most commonly 2 to 3 feet with variations either way. Lode matter where exposed is brecciated slate with more or less mineralised quartz and pyrite, which oxidises to a ferruginous lode mass. In the upper portion of the cut, a large oxidised ore-body of the "floor" variety makes out easterly from the fissure and a considerable amount of ore has been extracted from it. In the lower part of these workings, a parallel fissure was noticed and earlier reports that widths in excess of 10 feet were being stoped probably refer to a section like this where mineralisation extended across the country between parallel fissures or else to the upper section where part of the floor was included in the stoping.

South of the river, the lode has been open cut to a shallow depth for a total length of some 800 feet. A drive (Plate 2, and Longitudinal section, Plate 6), known as the River adit or West River adit, put in in a southerly direction at R.L. 614', a few feet above the river, cuts the main ore channel in three cross-cuts and in the drive itself where it turned to the east. This drive is not now accessible but the sections of ore exposed appear to have been associated with carbonates, particularly on the footwall side. Assay values obtained by M.R. McKeown are as follows:-

No. 1 cross-cut, width	10'	-	1.787% Sn	1.13
" " ". " "	"	-	. 48%	
Main drive , width	5'	-	0.06%	.15
" " "	5'		.24%	
No. 2 cross-cut, width	5'	-	.40%	.3
" " " " "	5'	-	.32%	
No. 3 cross-cut, width	5.5'	-	.45%	

At R.L. 715', 27 feet below the railway line a drive was put during 1942 for 135 feet along the main lode, which dips north-east at 55° to 70°, and averages 7 to 8

Though the sulphide in most of the ore-bodies, both floors and feeders, is dominantly pyrrhotite, an important exception is the drive on the Renison Bell Main lode underneath the railway line where the mineralisation is almost entirely pyrite. Samples from this drive showed an equal porportion of iron and sulphur, or a slight preponderance of sulphur, corresponding very closely to the formula FeS_2, while samples from the pyrrhotite lodes returned a considerable excess of iron over sulphur content, approximating the pyrrhotite formula FeS, to a greater or less degree. The manner of tin occurrence seems to be little affected whether the iron sulphide is pyrrhotite or pyrite.

In the oxidised ore, a reasonable idea of the tin values can be gained by an experienced operator by panning. Oxidation is locally very variable but in general extends only to shallow depths, some of the massive sulphide bodies in particular being quite unoxidised right to grass-roots. Greatest depth of oxidation is naturally shown by some of the fissure lodes and on the Federal in particular it reaches in places over 100 feet from the surface. Most of the payable oxidised ore has now been removed. The effects of oxidation have been described in detail by Conder.

INDIVIDUAL LODES

BASIS OF VALUATION

Throughout this report the standard of ore values is that adopted on the accompanying plan; good ore refers to ore with better than 1% tin content; fair to fairly good covers the range from .5 to 1% Sn., and poor or low grade ore contains less than .5%. The values in all cases have been generalised to give an idea of the average mining grade of the ore and no attempt has been made to illustrate the erratic local variations which are so common. The available sources of information upon which this grading is based include :- Mr. M. R. McKeown's report, which contains a valuable and reliable record of values at a great number of exposures, sampling records and mill returns of the two operating companies, various samples taken during previous geological and other examinations, diamond drill sampling records, drilling results from Mr. G. Lindsay Clark's report, past production figures, and a limited figures, and a limited number of samples cut during the present examination.

RENISON BELL MAIN LODE SYSTEM.

This lode system extends for more than 3000 feet from north of the Argent river to the top of Renison hill. The parent fissure is not apparently continuous and goes by different names in the various sections. In this report, following the general usage on the field, it

feet true thickness. The lode here is pyritic, carries a little lead and averages, according to the results of 59 progress samples taken by the Company as the drive was being put in, .835% Sn. The result of a large channel sample taken across the face is :-

	THICKNESS	Sn%	Fe%	S%	Pb%
Footwall half.	3'6"	.85	23.0	23.1	.95
Hangingwall half.	3'6"	.14	32.9	35.0	.50
Average.	7'	.5	28.0	29.0	.7

This tin average coincides very closely with the values obtained by Renison Associated Tin Mines, N.L., during the last few feet of driving.

Near the portal of this drive, referred to as the Railway adit, a branch lode is given off on the western side, which consists of sporadic mineralisation associated with strike faults and varying considerably from place to place. This lode has been called the White lode and is seen in the railway cutting to be a flat folded formation lying underneath a bed of massive sandstone-conglomerate (Section H-H', Plate 6). Above the tramline west of the fault the same ore occurs at a higher horizon for a distance of 300 feet or so, making into a series of small flat lenses almost on the surface, which have been mined out.

No. 9 adit (Plates 2 and 10) passes through a flat-lying low-grade gossanous body and at the end a chamber has been opened up in massive sulphide ore, which was sampled by Mr. McKeown for an average of .908% Sn over 25 feet width or .774 over 28 feet. This ore seems to be the downward continuation of the White lode exposed at the mouth of the Railway adit and evidently represents a local bulge in the ore-body. A central band of oxidised ore has been stoped up for 20 feet or so and at the northern end the sulphide gives place to carbonates.

In the railway cutting, the Main lode, as it is here referred to, contracts to a narrow fissure a few feet above rail level. A sample taken across the lode in mixed sulphide and friable soft material 3 feet above the rail returned an average of .74% Sn, and 10.5% Pb, over a width of 5 feet. Galena is plentiful in this section, hence the name Lead lode. Small consignments of picked ore from this body were sold in the early days of the field.

East of the Lead lode in the railway cutting, a massive lens of sulphide, reported to carry good tin values is exposed, surrounded by pyritic slates carrying a certain amount of tin in veinlets and impregnations.

Near the surface, south of and above the railway line, floors have been mined and a little farther south a massive pyrrhotite body known as the Black Face is exposed on the surface, and continues south to the Gloryhole Plate 2.) Its total dimensions are considerable, and it is known to carry values over a length of 200 feet, has been proved down the dip for as muchas 100 feet, while the thickness in places exceeds 20 feet. "Q" tunnel, the lowest adit under the Gloryhole, cuts through some 13 feet of fairly massive pyrrhotite with a seam of gossan along the hangingwall and it is not definite whether the footwall has been reached.

Two samples cut across the sulphides returned as follows :-

	Thickness	Sn%	Fe%	S%
Footwall section	5'6"	.49%	39.8%	25.3%
Hangingwall section	8'	.78%	43.4%	32.0%
Average.	13'6"	.66%	42.0%	29.3%

In the gloryhole most of the oxidised ore has been removed and the sulphides are said to carry good values. Mr. McKeown's sampling in this vicinity indicates an average grade fairly close to 1% Sn.

The relation of this ore-body to the feeder system is obscure. It can hardly be connected with the continuation of the Lead lode fissure (Plate 2). Dip of the pyrrhotite in "Q" tunnel is 70° to the north-east and it is not unlikely that this represents the feeder of this part of the system, developed en echelon to the main lode fissure.

Down the dip of the Black Face on the surface, the values become less and the grain size of the tin is reported to be smaller. In this section the pyrrhotite shows hypogene alteration to marcasite over an area of several thousand square feet and rapidly decomposes on exposure. Carbonates are also present in the low-grade section of the floor. This association of carbonates with decomposing marcasite seems to be characteristic of the poorly mineralised sections of the floors throughout the field and is well displayed in some of the ore-bodies of the Boulder section, particularly at the Cable workings.

The Lead lode feeder is quite well defined as far as the south face of the upper workings (Surface Plan, Plate 2), but has not been exposed beyond that point. A drive underneath this section just below the road shows the lode channel to be mostly narrow and poorly mineralised except near the entrance where a sample cut in cavernous quartz from which all sulphides have been leached, returned 1.98% Sn., over a width of 2 feet.

South of the Lead lode workings there is no surface exposure on the direct line for nearly 300 feet. A local belief exists that strong cross-faulting has taken place in this area, but no direct evidence of it was observed. The first workings on the Blow lode section are a series of shallow cuts from which oxidised floors have been removed. The lode channel is poorly defined except in the more northerly cut where massive pyrrhotite is exposed. The next workings are those on the main Blow lode, a massive fissure lode of lenticular habit up to 20 feet wide and said to have carried good values in the oxidised portions. Stopes have been carried in on this ore until sulphide has been reached. Mr. McKeown obtained an average of .72% Sn., over 20 feet here, the result being composed of one high-grade and three low-grade samples. One of the old adits, No. 2 (Plate 2), was stopped after just reaching sulphide, which returned .48% Sn. over the 3 feet penetrated.

After another blank of 400 feet, in which the only ore intersection is the .48% sample referred to above, another cut 260 feet in length, now badly overgrown, exposes

a strong lode formation up to more than 15 feet wide. A cross-cut through this lode, now inaccessible, was sampled by Mr. McKeown for a consistent value of 1.1% Sn. over 18 feet.

In the uppermost workings, commencing 100 feet farther on, the lode has floors associated with it. On the footwall side the floors are narrow, but continupus along the strike of the fissure, and the line of demarcation between fissure and floor is obscure. Mr. McKeown's samples from here range from .1 to 1.18% and two averages were obtained of .31 and .65% Sn., over 24 and 25 feet respectively but without personal knowledge of the samples, it is difficult to assess their significance. On the down-hill or hangingwall side of the main lode channel, an extensive body of gossan and sulphide exists, but except for one narrow high-grade vein lying on top of the main floor exposure, values seem to be low, but they may possibly improve nearer the fissure.

Considering the Renison Bell main lodes and Blow lodes as one fissure system, the total length exceeds 3,200 feet and it is proved from the lowest drill hole just below the river adit (Plate 6), to the uppermost workings on Renison Bell hill, for a vertical range of over 900 feet, from below R.L. 600' up to R.L. 1500'. This does not mean that it is proved throughout a vertical stratigraphical interval of 900 feet with reference to the country rock. If the generalised structure shown on the Longitudinal Section (Plate 6) as inferred from exposures available, is correct, the width of strata represented is probably less than half the total vertical height of 900 feet.

The dip throughout is to the north-east at angles between 55° and 75°, averaging probably about 65°. The strike varies considerably but this is partly an expression of the surface topography as the outcrop follows closely the spur of the Renison Bell hill and the dip of the lode throws the outcrop progressively more to the west going uphill. Reduced to a horizontal surface the system still shows several variations in strike and a general arcuate shape, concave to the west. Average true strike of the main lode section is 45° west of north of the Blow lode about 20° to 25° west, and of the Upper Blow lode 30° west. Floors to the lode system occur principally from No. 9 adit to the north end of the Blow lode workings with lesser developments at the extreme ends, north of the Argent River, and near the top of Renison Bell Hill. Ore shoots occur in the north workings, from the Argent river to above No. 4 diamond drill (one long shoot or a series of shoots, and at least 3200 feet, the length of lode shown on the surface, that is, lode 2300 feet, and length of shoot which may be considered proved to carry payable values is perhaps a little more than half this figure.

(a) Lack of exposures, collapsed adits, overgrown cuts etc.

(b) Lenticularity of occurrence, and

(c) Confusion due to floors abutting against the lodes both in surface exposures, particularly the Blow lode, and in the drill holes.

It is known to vary up to more than 20 feet, but there are considerable lengths on the surface on the Renison Bell Main Lode where the average width is only 2 to 3 feet, hence greater thicknesses in drill holes in the same area are regarded with suspicion. As the dip of the lodes is steep and that of the country rock at a low to moderate angle in the same general direction, mining conditions should be reasonably good, although both lode walls are not always well defined.

Ore Reserves - Renison Bell System

It must be realised that any calculation of possible ore, being based almost entirely on surface exposures, and those not particularly good, are extremely tentative, but are included as an attempt to indicate the general scale of operations which might be contemplated. In all calculations the figures refer to total ore content, without allowance for dilution, pillars, etc. For sulphide ore a factor of 10 cubic feet to the ton has been adopted. This corresponds to ore containing about 50% pyrrhotite and 50% gangue and shale. Actual percentage of sulphide is nearly always higher than this, but would seldom be more than 75% which would correspond to 9 cubic feet per ton, so that 10 is a good working figure, allowing a slight margin for low sulphide sections, pore and fracture space, etc.

Referring to the longitudinalsection, Plate 6, a block of ore, some 600 feet in length by 140 feet depth seems to be reasonably well-established, just south of the Argent river by the following intersections :-

LOCATION	WIDTH	ASSAY VALUE	SAMPLING AUTHORITY
Railway cutting	5'	.74	Reid & Fisher
Mouth of road adit	2'	1.98	"
Railway adit, face	7'	.50	"
Railway adit, bulk	7'	.84	Average 59 Company samples, 1942.
River adit, No. 1 cross-cut	20'	1.13	M.R. McKeown
River adit.	7'	.15	"
River adit, No. 2 cross-cut	7'	.36	"
River adit, No. 3 cross-cut	5.5'	.45	"
No. 5 Diamond Drill	10'	1.14	Drill sampling record
No. 1 Diamond Drill	20'	.90	" "
No. 4 Diamond Drill	5'	.23	" "
Average	8.7'	.765 .797	Arithmetical average Weighted average.

Ore content of the block on this basis would be 73,000 tons averaging between 0.7 and 0.8% Sn. Four-fifths of this is above the level of the river adit and hence mineable without recourse to shaft sinking. A reduction in this reserve might be effected by the necessity to omit low-grade portions from mining, while further confusion may arise from the possibility that in No. 5 and No. 1 diamond drills ore rightly belonging to floors given off from the lode may be included in the figures given. The extra ore thus obtainable from the floor, should however offset the error due to the increased width assumed for the feeder lode.

Of the total length of 1700 feet, over which the Blow lode is more or less exposed, open cut workings add up to a length of 1100 feet. Taking length of ore as one half the total dimensions, which is not unreasonable on surface exposures, this would account for 850 feet which at an assumed average width of 10 feet would be 850 tons per vertical foot. The only value basis for this ore derived from four sections across the lode varying in width from 18 to 20? feet sampled by Mr. M.R. McKeown and averaging .66 (arithmetic) and .64 (weighed). Sampling of the sections indicates that some of the ore carries only low values and would be discarded in mining.

The Blow lode outcrop as referred to ranges from 350 to 850 feet above the level of the river adit, an average of 600 feet, which on the above estimate of 850 tons per vertical foot would amount to a little over 500,000 tons. Above the railway adit, the lowest working connected direct to the ore bins of the present mill, the average height is 500 feet and the corresponding tonnage 425,000. It is emphasized again that these figures can lay no claim to accuracy but are given merely to indicate the order of magnitude suggested by the surface showings.

Further ore in the Renison Bell Main lode system includes the massive lens in the railway cutting, perhaps 1200 tons, and the large Black Face floor and its extension southwards under the gloryhole. Values in this ore are known to decrease down the dip, but are proved to extend for a width of about 100 feet and a length of at least 200 feet. Thickness is variable (Sections E-E' and F-F' Plate 6) but an average of 15 feet would give 30,000 tons. The mean value of fifteen samples taken from various sulphide exposures within this ore-body (thirteen by McKeown, two by Keid and Fisher) is .77% Sn, (arithmetic) or .84% Sn. (weighted). No. 6 diamond drill commencing just about the hangingwall of this body passed through 65 feet of ore recorded as pyrrhotite, dolomite and pyrrhotite, pyrite, pyritic, slate, pyrite and quartz, averaging .7% Sn. It is possible that the bottom 10 feet, assaying 1.82% Sn., represents a fissure lode connecting to the floor just above this horizon.

It is noticeable that the average values calculated for the reserves in all the above sections of the ore-bodies are remarkably constant at about .7 to .8% S., although there is a wide variation in individual samples. This figure is in close agreement with the known value of the sulphide ore as mined and this consistency suggests that it may be taken as a reliable guide to the sulphide values of the principal ore-bodies on the field.

Mr. McKeown records that up to 1927, 90,000 tons; chiefly oxidised ore, had been mined from the Renison Bell Lode System, with an indicated average grade of .92% Sn. This is a little higher than the values obtained above in the different sulphide sections, but in any case it is difficult to accept this figure as a basis for comparison as it is probable that mechanical secondary enrichment had increased the values of some of this ore, while on the other hand, the low cost of mining of ore so close to the surface, some of which was treated by sluicing methods, enabled poorer sections to be treated profitably.

The disadvantages associated with the use of the diamond drill in the testing of lodes in which the distribution of values is so locally variable have already been mentioned, and exploration would be much better carried out by driving of adits along the lode. The most convenient and probably the most informative approach would be by

continuing the Railway adit along the lode channel, with a cross-cut east under the gloryhole to test for parallel feeders in that locality. Exploration on the Blow Lode could be carried out by a drive under the main workings, by cleaning out and extending the old No. 7 adit, and by another drive underneath the uppermost workings (Plate 2 and Longitudinal Section, Plate 6).

MISCELLANEOUS WORKINGS SOUTH AND EAST OF THE RENISON BELL MAIN LODE.

In the south-west corner of what used to be the old Central property, but now included in Tasmanian Amalgamated Tin Mines, N.L. Consolidated Lease, a series of cross-cut expose a body of gossan which form all reports carries only very low tin values (Plate 10 and Section G-G' Plate 6). This body is undoubtedly a continuation or off-shoot from the Black Face floor exposed in the gloryhole and represents the low-grade down-dip section. Oxidation is rather deeper here than farther north. The adits all pass through red rock, partly tuffaceous, similar to that exposed in "Q" tunnel and the gloryhole, and underneath the gossan, which dips flatly north-east, they expose laminated well-bedded shales identical with those in the railway cutting east of the Lead lode fissure.

The next showing of importance is that known as the Cross lode, sometimes referred to as Heatherington's workings. The central feature here is a cross fissure, bearing 65° to 80° east, almost at right angles to the main fissure direction. Details of the structure are not clear; the fissure dips steeply north at the western end, while a pyritic body in the eastern or lower portion of the cut appears to dip in the reverse direction. A large irregular oxidised floor is associated with the fissure, especially on the northern side, and this extends north-west towards the old workings described above and west up to a small exposure of floor and fissure intermediate between the Cross lode and the Blow lode workings (Plate 2 & Section J-J' Plate 7). Some payable returns were obtained from the gossan, mostly by tributers, but little is known of the values in the sulphides. McKeown records four samples between .11% and .31%.

East of the Cross lode workings is an exposure of fissure, floor and fault of which little is known except that a considerable amount of sluicing of gossan and detritus was done here.

Sundry other showings of mineralisation occur between the Cross lode and a series of shallow workings on the ridge between the heads of Renison Bell and Montana Creeks where a flat-lying pyritic floor up to 8 feet is exposed in workings which were directed towards the recovery of tin from gossan. No information is available as to the values All these occurrences seem to be connected with minor rifts due to relief of stresses intermediate between the principal lines of shearing.

Other minor developments, some of which have produced a little tin, occur on the eastern side of Renison Bell,Creek, but none of them seems to be important. One adit above the Montana track cuts a body of soft manganiferous gossan carrying low tin values.

THE DREADNOUGHT LINE OF LODE

The Dreadnought lode has been exposed by a series of adits driven in a general southwest direction from the northeast slope of Dreadnought hill and by two sets of open cut workings known as Brumby's and Evendon's respectively. McKeown mentions that they have yielded approximately 30,000 tons of payable oxidised ore. Northwest of Brumby's the surface of the lode is hidden beneath a thick mantle of detrital material consisting of soil, gossan and stones, apparently caused by the collapse of formerly existing bluffs composed partly, no doubt, of resistant gossanous lode outcrops. The total length over which workings have exposed the Dreadnought lode is nearly 2,000 feet, without including the Federal lode, which is described separately, but ore occurrence is very patchy according to the limited exposures available for inspection at the present time. No mineralisation was encountered in the No. 3 and No. 5 tunnels north, but No. 4 north shows a lens of broken ore with quartz and pyrite, associated with faulting and lesser mineralisation on either wall, and playing out along the drive to the southeast. McKeown records six samples from .21% to 1.38% Sn., averaging .535% S., over 29', or .7% Sn. over 20 feet, in the main cross-cut, and .417% Sn. over 16 feet in the more southerly cross-cut (Plate 8). Nos. 1 and 2 tunnels north each pass through 25 to 30 of gossanous or puggy lode material in which the values, according to McKeown's sampling, are uniformly low, ranging from .13 to .51 and averaging .35 for 25 feet in No. 2 and .26 for 31 feet in No. 1. The country rock in all these workings is a massive shale, felspathic in character, and of slightly tuffaceous aspect. The dip is erratic on account of faulting and is particularly hard to determine in the neighbourhood of the lode channel which apprears to have been the locus of strong shearing movement. In general the dip of the lode is to the north-east at a steeper angle than the average in the Renison Bell section and the strike is 50° west of north. Exposures are not adequate to delineate local variations in strike.

In Brumby's open cut, a fairly well-defined lode up to 10 feet wide occupies the hangingwall, and a narrower lode, more or less parallel over much of its length, but diverging at the south end, lies along the footwall. The occurrence here has some features in common with the Federal lode. The hangingwall lode is cut off by a strong fault at the north end, while at the south end in a drive put in along the lode, the mineralisation peters out. Fractures connect the two lode fissures obliquely and lesser parallel lodes are in evidence. Strong movement of rather a peculiar character has taken place along the lode fissures, causing intense shearing and distortion of the dips of the country between the fissures relative to that out-side them. This central country has been mineralised by solutions travelling inwards from the fissures, resulting in the formation of an ore-body of appreciable size and rich enough in the oxidised section to repay mining as a whole. The nature of the mineralisation is well illustrated at the southern end of the cut, where shales dipping 30° south are replaced by sulphides to the extent of some 20%, and narrow veins running through this material, and consisting of crystalline pyrite, tourmaline, arsenopyrite and cassiterite, carry the tin values. A sample of 3'6" width, representative of the partly replaced shale, and probably including some of the small rich veins, returned .54% tin, 9.6% Fe., and 9.24% S., while a sample of the veinlet material assayed 13.92% Sn.

The haulage tunnel known as G16, 88 feet below the bottom of the open cut, passes through some 65 fee of silicified country which is slightly mineralised in parts, with several faults and one or two more obviously mineralised streaks. Mr. McKeown's sampling in this adit returned as follows :-

		% Sn.	
5 feet	-	0.52	
5 feet	-	0.89	
5 feet	-	0.75	(check 2.61)
5 feet	-	2.57	
5 feet	-	0.35	
5 feet	-	0.43	
5 feet	-	0.22	

It is not known exactly where these samples were taken, but the values are much better than the apparent degree of mineralisation in the adit would suggest and the writer finds difficulty in accepting them unreservedly, without being able on the other hand to see any obvious reason why these results should be higher than the actual values.

In Evendon's workings, south-east of Brumby's a narrow but comparatively consistent vein 3 to 4 feet in width has been mined by open cut and stope, apparently for as long as the values persisted in the oxidised ore (Plates 3 and 8).

On the whole, the Dreadnought lode does not exhibit the strength of mineralisation that is a feature of other lodes of the field. Sections of the lode in Brumby's workings and adjacent tunnels, now oxidised, seem to have been fairly solidly mineralised, but usually the lode consists of partly mineralised broken rock with seams and patches of quartz and pyrite ramifying through it and irregularity of ore occurrence is very marked. Present information is too limited to be able even to suggest a figure for expectation of ore in depth, but this lode system should certainly receive attention in any systematic exploitation of the field. Two convenient avenues for exploration are the Haulage tunnel, which could be driven south on the lode and north for nearly 400 feet, as far as the No. 2 tunnel north, with cross-cuts at intervals; and the No. 4 tunnel north, 125 feet below the level of the Haulage tunnel and 213 feet below the bottom of Brumby's open cut, could be continued south-east with appropriate cross-cuts as far as may be necessary along the lode channel. The possibility of better fissure development in depth or of floors occurring where the more favourable horizon of the laminated shales intersects the lode-channel, should always be kept in mind with regard to the Dreadnought lode system. In this connection, it is noteworthy that near the Renison Bell Railway Siding, more or less on a continuation of the Dreadnought line of lode (Plate 3), there is an outcrop of the silicified and mineralised laminated shales which are usually found overlying the floors, and which might be worth drilling if plant were available.

THE FEDERAL LODE

This lode is bisected by the lease boundary between the properties of Renison Associated Tin Mines, N.L., and Tasmanian Amalgamated Tin Mines, N.L.

The northern section in Renison Associated ground has been referred to as the Dreadnought south and the whole ore-body considered to be a continuation of the Dreadnought lode. This is probably not correct, unless some rather peculiar faulting has taken place just north of Dreadnought Gully, as their strikes are somewhat different, and, in any case, the characteristics of the lodes on the whole are quite distinative.

The Federal lode is a strong fissure which gives the impression of being a double, bedded lode, though away from the walls of the ore-body the attitude of the country rock is by no means conformable with that of the lode. Neither termination has been defined, but south from the most northerly exposure in Dreadnought Gully, it continues for 500 feet on a strike of 20° west of north as a double strongly mineralised fissure with a consistent horse of mullock, mainly felspathic shale or slate, separating the two sections of the lode. Dip is consistent to the north-east at 70° to 75°. At this point the lode channel bends sharply to the left through 30° or 40°, a feature which is accentuated by the slope of the hill, and thenceforth strikes 50° to 60° west of north. A break seems to have taken place across the bend and the southern section consists of a single lode only, with lesser streaks of mineralisation running parallel in places. In the northern section, from which practically all the oxidised ore has been mined out, the two lodes and the intermediate horse of mullock are usually from 5 to 10 feet wide, increasing near the bend in the lode. Both sections consist of massive sulphide, or strong cellular gossan with some quartz where oxidised, but the hangingwall lode is reported to have carried consistently much better tin values than the footwall section. Depth of oxidation varies from close to the surface near the lease boundary and in Dreadnought Gully to a depth from the surface exceeding 100 feet near the widest portion. In the vicinity of the break, the horse of mullock dies out and mineralisation makes across the full width of nearly 40 feet. This is followed by a low-grade section which appears to pitch flatly towards the south-east (Longitudinal Section, Plate 8) and the lode continues as a single fissure 6 to 12 feet in width. In the gully at the south-east end, a considerable quantity of surface detrital material, similar to that found at the north end of the Dreadnought workings, obscures the outcrop. This material also cuts across the end of a drive from an adit which was put in at R.L. 900', beneath the south end of the open cut workings with a view to exposing the lode farther south (Plates 3 and 8). Sulphide comes close to the surface again in this section. Thirty feet below this adit another cross-cut passes through the ore-body and both of these, as well as the south end of the open cut, are connected by an ore-pass with Conder's adit 86 feet lower down (R.L. 814') through which ore from the open cut workings is trucked to the mill. Conder's adit passes through "made ground" for 115 feet, then through felspathic and silicified shale, dipping mostly at 15° towards the portal, until it cuts a massive pyrrhotite lode 6 to 7 feet thick. A drive was carried north on the lode for 45 feet and the rise now used as an ore-pass was put up to the surface. The cross-cut was not extended west to test for parallel ore-bodies in the footwall country.

Sulphide ore is also exposed in the inclined haulage drive, now full of water and inaccessible, where the main hangingwall lode, according to a section prepared by Tasmanian Amalagamated Tin Mines, N.L. is strongly developed with further mineralisation above it, while the footwall section is much narrower.

Ore Reserves - Federal Lode

McKeown estimated that altogether 37,000 tons of ore had been extracted from these workings up to 1927. This ore is referred to as carrying 1% Sn. Since then probably another 30,000 tons have been mined. Tasmanian Amalgamated Company's operations have returned them a recovery of a little over .5% Sn. Their mill as at present constituted can treat only oxidised or semi-oxidised ore and reserves of such ore restricted to the section of the main lode now being mined at the south end of the open cut, and to lenses and streaks of oxidised ore on the footwall of the main cut which are said to contain payable tin. Even with very detailed measurements, it would be difficult in the present state of the workings to give a figure for the amount of such ore still to be mined, but it is extremely limited.

No attention has yet been directed towards the working of the sulphide ore, hence the only intersections of sulphide are incidental to the mining of oxidised ore, and are limited to Conder's adit and the workings above it, and to the inclined haulage drive. Referring to the longitudinal section, Plate 8, R.L. 930 feet may be taken as the average height of the upper limit of sulphide ore. On surface measurements, calculating both from lode dimensions and back from the quantity of ore extracted, the reserve value of the lode is estimated to be at least 900 to 100 tons per vertical foot or just over 100,000 tons above Conder's adit. No allowance is made in this figure for variation in depth and in addition neither a wide margin exists in either direction.

The only values known in this section are from the Company's records. An average of thirteen miscellaneous samples in the drive on the lode off Conder's adit is .68% by vanning assay, corresponding to a tin content of just over 1%. Ten samples at intervals up to the rise from Conder's adit average .78% vanning assay or about 1.2% Sn.

At the bottom of the inclined drive, a Company plan shows three assays in the hangingwall, over narrow widths, of .82, .95 and .40, then in the main lode 18 feet averaging 1.52 and 7 feet averaging 0.7. No confirmation has been obtained of these values and it is not known whether they represent vanning or chemical assay. The only other information on tin values in the sulphide portion of the lode is that provided by the assays of two samples taken by McKeown. One sample was probably taken (over a length of 12'6") in the adit shown about the middle of the north section of the lode, just underneath the open cut (Longitudinal section, Plate 8) and returned 0.278% Sn; the other sample taken in the open cut above the adit, returned 0.37% Sn. This range of values, while admittedly scrappy and scattered, corresponds pretty closely to the averages already obtained in the various sections of the Renison Bell main lode workings and elsewhere and suggests that on the whole a similar average grade may be expected.

The Federal lode shows more persistence of mineralisation than any othe fissure lode and for that reason is more adapted to exploration by diamond drilling. In addition the terrain here is especially suited to diamond drilling as the lode dips in the same direction as the surface slope and good drilling sites are available near the tramline. By a series of holes at different angles of depression, it might be possible to solve the important question of whether a floor system is developed to the Federal lode within a reasonable depth from the surface.

Apart from diamond drilling, the obvious method of exploring the Federal lode would be by extending the drive off Conder's adit along the lode in both directions, with cross-cuts into the footwall to see if the double character of the ore-body in the northend of the open cut persists to this level. Continued extension of the north-east drive would test the Dreadnought lode at this elevation which is just 100 feet below the level of No. 4 funnel North on the Dreadnought, the lower of the two adits from which it has been suggested that lode channel might be explored. Below Conder's adit it would be possible, if the lode were being operated as one property, to obtain another mining lift by driving an adit from the bank of Dreadnought Creek to the north end of the ore-body.

THE MONTANA SECTION

The Montana workings comprise a steep hill slope on the west bank of the Montana creek where approximately 300 tons of tin have been won in the past, mainly by sluicing, from an area about 500 feet by 500 feet, water being brought by high-level races around Renison Bell hill from the heads of the Argent River. The ore treated represented the oxidised outcrops of various lodes and floors and the detrital matter on the slope derived from them. Much of the face of the hill is now covered with tailings and dumps from these operations which are said to carry reasonably good tin values. Two sets of fissures striking northwest-southeast and dipping steeply to the northeast and several outcrops of pyritic floors are exposed. The country rock is laminated shales, well silicified and crumpled, exhibiting great irregularity of dup and strike.

Little is known of the sulphide values in these workings. Conder records five samples taken by himself returning 0.4% to 1.4% Sn., and four by the Mt. Lyell Company from 0.3 to 1.3%, the whole averaging .69% Sn. One bore hole No. 50 G (Plate 5 and Section O-O', Plate 9) is reported by Mr. Lindesay Clark to have passed through 20 feet of ore from 15 to 35 feet, assaying 2.2% Sn. This ore represents a floor on the footwall side of a fissure lode which is well exposed on a steep face of sulphide. Several otherpercussion and hand-jumper drill holes were put down, most of which penetrated sulphidic floors, but values appear to have been for the most part low, though definite figures are not available. The possible existence of payable sulphide ore-bodies of appreciable size in this area is by no means excluded however, though no figures relating to their probable dimensions can be given.

DUNN'S WORKINGS

Both this and the Montana workings are included within the consolidated lease held by Tasmanian Amalgamated Tin Mines, N.L. All the other workings in the Boulder section are held by Renison Associated Tin Mines, N.L. Dunn's workings are connected to the Boulder tramline very near its terminus by inclined self-acting-tramway. In 1937 and 1938, Tasmanian Amalgamated Tin Mines, N.L., mined and treated 4,600 tons of oxidised ore from this lode for an average recovery of 1.05% metallic tin. Ore occurs as floors of limited dimensions, practically on the surface, making out on both sides, but particularly on the footwall side, of a fairly well-defined narrow fissure lode which dips at 65° to the southwest. This lode, 2 to 4 feet wide, extends through the length of the workings for 250 feet and lines up very

well with the feeder associated with the Battery Lode to the southeast. A considerable body of sulphide, pyritic slates, and "dolomite", partly outcropping, exists at the southeast end of Dunn's workings. An adit 50 feet below the open cut passed through gossanous material with some carbonates for 75 feet and from that point continued as an inclined rise on a floor of solid "dolomite" overlain by gossan (Section 0-0' Plate 9). Of the two other adits under these workings the more northerly one was inaccessible, while the low-level adit 90 feet in length had never been pushed far enough to reach the lode position. From the fact that better values than the average were obtained in the oxidised ore, and from its proximity to the important Battery workings, this lode should be worth further exploration if the whole field were being developed, though only 100 feet of backs would be available above the tramline. It has been suggested that this section should be exploited by a long tunnel driven from Conder's adit at the Federal workings. The distance from the end of Conder's adit to Dunn's workings, (Plate 3), is 1,200 feet and as the reduced level of that adit is 814 feet and that of the floor of the open cut in Dunn's workings about 1,060 feet, it will be seen that only about 240 feet of backs would be obtainable by this means.

THE BATTERY ORE-BODY

This is the most important working face in the field at present. It is mined by open cut, overburden varying in thickness from 3 to 15 feet being first stripped off and dumped and the ore then broken, loaded into trucks, and tammed first by hand and then by self-acting tramline to ore bins on the lower Boulder tramway. From there it is taken in 4-ton trucks drawn by small steam locomotive to the Renison Associated mill. Mining efficiency could be greatly increased by the introduction of mechanical means of handling ore and overburden or by extending the lower Battery drive and glory-holing.

The Battery ore-body is a large floor which dips in general south-west parallel to the surface of the hill and only a few feet below it. The ore is mainly massive pyrrhotite with a good quartz skeleton. The open cut was started at the south end of the ore-body and is working north-west towards the lease boundary. On the south, west and east the floor lenses out, but its behaviour to the north is not known. It has been proved by boreholes 35A and 36A (Plates 5 and 9), both of which cut 35 feet of ore, to extend nearly to the lease boundary. The lode is more or less conformable with the country rock, which consists of fine laminated sandstone, well silicified and showing considerable contortion and local variations in strike and dip. Not far east of the Battery workings, between them and the Cable, the dip reverses to the more normal east or north-easterly direction. A drive put in from the floor level of the open cut exposes the footwall of the ore-body, steepening in dip from 40° to 60°, and it is possible that this may represent a feeder to thelode. South-east of the open cut, a narrow fissure lode 2 to 3 feet wide dipping 70° south-west is exposed in a shallow cut for 170 feet. No definite sulphide lode was observed in the lower level adit, 32 feet below the cut.

Section M-M' and P-P', Plate 9, illustrate the structure and extent of the Battery ore-body.

Ore Reserves - Battery Ore-Body

If an average thickness of 20 feet is assumed over the area between the north face of the open cut and the lease boundary, a tonnage of 66,000 is obtained. Grade of the ore milled during 1942, which came mostly from this face, was .87% Sn. Drill hole No. 35A passed through 35 feet of ore, from 10 to 45 feet, averaging .9% Sn. and No. 36A also through 35 feet, from 20 to 55 feet, averaging .95% Sn. hence it is fairly safe to assume that an average grade of at least .8% Sn. will be maintained for this ore-body. Delineation of further reserves north of the lease boundary towards Dunn's workings would require drilling or prospecting shafts. A number of shallow drill holes put down east of the Battery workings passed through ferruginous clay and unmineralised slate except Nos. 1 and 9 which cut the edge of the Cable lode (Plate 5, refer also to Page 106 D.G.E.S. report).

Cable Lode

The structure of the Cable ore-body is not clear. As exposed in the open cut, it appears as a bulky floor which terminates abruptly on steeply rising walls on

north, west and south sides and dips easterly in the bottom of the cut. The east wall of the cut consists mainly of carbonates and pyrrhotite in the lower portion, overlain by gossanous material which is largely detrital in character (Section M-M', Plate 9). The upper drive, after passing through some of this surface gossan and a fault, follows a body of decomposing marcasite, carbonates and semi-replaced shale on the left side, with gossan on the right of and overlying the sulphides. This drive is on the level of the floor of the open cut (Plate 10 and Section Q-Q', Plate 9). The lower adit, which was being driven at the time of examination, followed a vertical faulted junction between shale on the left and gossan on the right which may be part of the fundamental fissure of the system. A short adit on the level of the tramline, 110 feet below the level of the upper drive and the bottom of the cut, exposes a little pyrrhotite in the back. A strong fault, which can be traced for several hundred feet in both directions, runs parallel to this adit and is probably closely related to the Cable lode system. The displacement on this fault seems to be downwards on the northeast side as the laminated shales on the west cut against the fault.

A long tunnel driven in a westerly direction from the creek (Plate 5, and Section M-M' Plate 9), 300 feet vertically below the bottom of the open cut and not now accessible for more than 120 feet, passes through a strong north-south fault near the mouth, and is said to have cut several sulphide ore-bodies and 4 feet of massive pyrrhotite near its western end.

Ore Reserves - The Cable Lode

On open cut dimensions, the Cable sulphide ore-body contains 200 to 250 tons of ore per vertical foot, but if its occurrence is similar to that of the other floors on the field, it will have no great vertical extension. The exploration now in progress should give much more definite information on this point and also on the question of whether a feeder exists. The large body of gossan, both detrital and in situ, which is associated with the ore, contains patchy but generally low tin values.

LUCK'S WORKINGS

In these workings which lie to the south of the Cable and just above the tramline, a narrow arcuate steeply-dipping fissure is exposed, together with a pyritic floor 5 to 10 feet thick, which dips north-west at 45^{0} or slightly less. A vertical fault cuts obliquely across the lode near the north end, but does not seem to cause much displacement. The oxidised portions of both floor and fissure were worked in the early days and are said to have returned about 100 tons of tin oxide for a recovery of 1% tin. A drive from the level of the tramline exposes the upper section of a massive sulphide body for 45 feet. This lies on the opposite side of the fissure from the floor exposed in the upper workings. The only values known in Luck's workings are the results of assays of two samples taken in the cut by McKeown, one of which in sulphide returned 3.45% Sn., and another of detrital material and capping .98% Sn. This section is another of these for which no figure for expectation of ore can be given, but which requires further sampling and exploration.

DALCOATH CREEK WORKINGS

The Dalcaoth Creek lode, also known as Reid's is a fairly well-defined fissure lode exposed for 300 feet alng an east-north-east strike and dipping 50° to 70° to the south. It occupies a similar position relative to the Dunn's-Battery lode system as the Cross lode does to the Renison Bell Main lode. It is some 200 feet lower than most of the Boulder workings and appears to occupy a stratigraphic horizon below the laminated and silicified sandstone and shale which are so conspicuous to the north and west. Width of the lode varies up to 10 feet or so and in places the walls are poorly defined. Cross faults cause displacements of a few feet and at the eastern end it is cut off by a strong 2-foot cross lode in a fault zone, which is parallel to the other faults and which has all the characteristics of the normal fissure lode of the field. This lines up very well with the direction of Dunn's-Battery lode system. A small floor occurs at the junction of the fissures. At the western end, the Dalcoath Creek lode appears to feather out. Arsenopyrite is especially abundant in this lode as well as in parts of the Dalcoath lode. Tin values appear, from the information available, to be about the average of the field. An old tunnel put in at a lower level than the present tramline, which follows the bottom of the open cut workings, was apparently not driven on the lode at all. It was started from the west side of the creek near the junction of Gormanston and Dalcoath creeks and continued in a general western direction, and hence could not possibly have cut the lode, which dips to the south.

Being situated in the bed of the creek, the Dalcoath creek lode does not contain any important tonnage of ore which could be extracted without recourse to shaft sinking and would not command attention in preference to the many other more accessible ore-bodies.

DALCOATH LODE

The structure of this body, like that of the Cable, is somewhat obscure. The underground workings are mostly inaccessible but appear to follow the boundary of a sulphidic body which strikes 20° to 30° east of north and dips at a moderate angle to the north-west. Tin values in these workings were mostly low. Ore is being extracted from the open cut and shipped to the Renison Associated mill via an inclined self-acting tramway and the Boulder tramline. The ore mined carries good tin values, much of it narrow veins with coarse-grained tinstone, the coarsest known on the field. The shoot seems to be irregular in shape and limited in size and it is not possible on the openings available at the time of examination to give any estimate of tonnage. The country rock dips east at 30° to 65°. An axinite dyke was cut in the workings and gabbro occurs immediately to the south (Plate 1). Lower down the hill a trench and short tunnel expose the western edge of a narrow pyritic floor which dips east at 35°. The Dalcoath ore-body is another which merits further attention. Much more information will be available about its structure when the present open cutting operations have progressed further, particularly if the underground workings could be cleaned out and mapped in detail.

RESUME BOULDER-MONTANA AREAS

Ore occurrence in these sections is even less systematic than elsewhere on the field. Fissure lodes, where present, are indefinite and discontinuous while on the other hand conditions seem to have been exceptionally favourable for the formation of floors, which are numerous and vary

greatly in size, structure and composition. Extensive secondary gossans show that even more such ore-bodies have existed. The country rock is typically a little coarser in grain than farther to the north-west, well silicified over considerable areas and greatly disturbed by folding. No doubt the proximity of this area to the main porphyry mass is largely responsible for secondary dislocations of the sedimentaries and for the peculiarities of distribution of the mineralisation. If the belief is correct that the floors will be restricted to the favourable horizon of the laminated shale and fine sandstone their extent is thereby definitely limited. The establishment of important ore reserves in this section from a long-range point of view would depend upon finding a much stronger fissure system than is apparent at the surface. The best area for testing in this respect would be the section from Dunn's lode to the south and of the Battery workings, though lack of backs above any possible adit would be a drawback to mining here. The existence of the definite cross fissure lode in Dalcoath Creek, more than a hundred feet below the main floor horizon, gives ground for hoping that the fissure lodes will be more strongly developed in depth. The possibility of additional floors being discovered is not, of course, precluded. Geophysical methods were tested in this area in 1929 by the Imperial Geophysical Experimental Survey and several strong indications were obtained by the various methods used. The limited amount of drilling which was subsequently done by the Tasmanian Mines Department to test these indications did not reveal any new ore-bodies, though No. 21 bore south of Dunn's workings, passed through carbonate and barren sulphide to 25 feet.

METHODS OF EXPLORATION

DIAMOND DRILLING

It has been pointed out that owing to locally erratic distribution of values and other factors the lodes are not ideally suited to diamond drilling, and exploration would be best carried out by drives along the lodes as outlined in describing the different ore-bodies. Under the present labour conditions such a course would be impracticable if production is to be maintained, but it might be possible, if consideration is to be given to the development of the Renison Bell Field, to carry out a diamond drilling campaign. In that case the order of preference listed below is indicated, though no attempt is being made at this stage to lay out a detailed programme. Objectives aimed at include establishing sufficient ore reserves to maintain the present rate of production, proving the ore-bodies down to existing adit levels, and obtaining sufficient information to determine the most profitable lines of development below those levels.

1. A series of short vertical holes north of drill holes 35A and 36A (plate 5) to test the northward extension of the Battery ore-body and ascertain the life of the present workings.

2. Two lines of holes inclined westwards from above the tramline to explore the Federal lode down to R.L. 750' and to determine the horizontal extensions of this lode (plate 3, Section K-K', Plate 7, and longitudinal section, Plate 8). According to the result of this drilling, deeper holes could be put down from the most favourable position to test

behaviour at greater depths and the possibility of existence of floors.

3. Inclined holes from east of the Blow lode outcrop to examine the lode at a depth of 100 to 200 feet from the surface (Plate 2).

4. Further drilling upon the Renison Bell, Dreadnought, Dunn's and Montana lodes would be subsequent to, and largely dependent upon, the results obtained by the foregoing.

GEOPHYSICAL METHODS

The work carried out by the Imperial Geophysical Survey was largely experimental in character and confined to the Boulder-Montana area. The results were remarkable for the strength of the indications obtained, particularly by magnetic and spontaneous polarization methods, due to the fact that large ore-bodies, consisting mostly of pyrrhotite, which has intense magnetic properties, are under-going oxidation very close to the surface. As the main ore mineral is pyrrhotite and as practically all large masses of pyrrhotite carry tin or grade into sections carrying good values, the field as a whole is well adapted to the application of geophysical methods. Messrs. Nye and Mawby recommended in their report that a geophysical survey of the field should be carried out by the Geophysical Section of the Mineral Resources Survey Branch and this recommendation is repeated here. It is considered that special attention should be given to:-

1. Obtaining as much information as possible with regard to the behaviour of the Federal lode both down the dip and along the strike.

2. Outlining ore localities along the Dreadnought line of lode.

3. Making a detailed geophysical survey of the Renison Bell lode system, with the object of determining the position of ore-shoots and the extent of floors.

4. Conducting a reconnaissance magnetic survey of the field to ascertain whether ore-bodies not yet exposed may exist.

RESUME OF ORE RESERVES

The estimates made to furnish an approximate idea of ore expectation above lowest adit level on the various ore-bodies for which such a tentative figure canbe given are summarised below.

Renison Bell Fissure lode system (above River adit.....	500,00 tons.
Black Face lode.....	30,000 tons.
Rederal lode (Above R.L. 770').....	150,000 tons.
Battery lode (South of lease boundary...	66,000 tons.
	746,000 tons.

This gives a total of approximately ¾ million tons of ore, without taking into account such additional sources of possible ore as the Dreadnought lode, Dunn's lode, the Montana section, extension of the Battery ore-body north of the lease boundary, Cable, Luck's, Dalcoath Creek and Dalcoath lodes, and various other showings. Average grade of this ore may be taken to be about .75% Sn.

Messrs. Nye and Mawby estimated the critical grade of ore on the field at varying tin prices to be :-

Price of Tin	Critical Grade of Ore % Sn.
£100	1.43
£200	.73
£300	.48
£400	.36

Assumptions on which these figures are based are :-

1. Mining at the rate of 1,000 tons per day.
2. 70% recovery of the tin.
3. Cost of Mining 10/- per ton.
   " " Development 1/6 " "
   " " Milling & Realization 6/6 " "
   " " Overhead etc. 2/- " "
   Total, say.....20/- " "

On the above ore figures, it would not be possible to contemplate mining at the rate of 1,000 tons per day, and about half that figure would be the probable maximum. Consequently mining costs would be higher and when the manner of ore occurrence and the necessary transport problems are taken into account, it is obvious that both mining and development costs would be considerably higher than the above estimates. Costs at the Electrolytic Zinc Company's Read-Rosebery mines nearby should furnish a useful basis for comparison. The recovery figure depends upon successful solution of the metallurgical problem presented by the Renison Bell sulphide ore, as mill recoveries up to the present have been little better than 50%.

Taking as a basis for comparison over-all costs at 30/- instead of 20/- per ton, a recovery of 54% from .75% Sn. ore would just break even on present tin price of £371 per ton. Profit margin would be achieved by :-

1. Operating costs lower than 30/- per ton.
2. Recovery better than 54%.
3. Average grade of ore higher than .75% Sn.

It is assumed in all the foregoing remarks on ore reserves and exploration as a necessary condition of any scheme of development that all the ore-bodies on the field would be available to be worked by one co-ordinated system of operations. Every previous report on Renison Bell has stressed the urgency of operating the whole field under a single control, and it is again emphasized here. The lease

boundaries cutting through the Federal lode (Plate 3) and the Battery ore-body (Plate 5) have had a particularly adverse effect on mining operations.

SUMMARY

The Renison Bell Tin Field is situated nine miles north-east of Zeehan in Western Tasmania. Over 2,000 tons of metallic tin has been produced, valued between £350,000 and £400,000. The country rock of the field is the Dundas slates, which dip generally north-east at a low angle. A mass of quartz-porphyry is considered to have been associated with the origin of the mineral solutions, and its intrusion was probably reponsible for the formation of the ore fissures.

The lodes occur as "feeders" - fissure lodes striking usually north-west and dipping steeply north-east- and "floors" - flat-lying bodies making out into the bedding from the fissures and playing out along the dip of the sedimentaries. A less important set of fissures strikes almost at right angles to the main fissure direction.

The mineralisation is distributed along two parallel zones. The north-east line of fissuring comprises the Dreadnought and Federal lodes; the south-west zone, the principal one, contains the Renison Bell lode system, the Montana, Dunn's, Battery, Cable, Luck's and Dalcoath workings and other showings. Floors occur only in this zone and appear to be restricted to a horizon of laminated slate and fine sandstone which dips north-east to cut the Dreadnought-Federal line of lode at an undetermined depth. As cassiterite was the first mineral deposited, ore shoots are likely to be directly related to structural features, but lack of exposures and the poor state of development of the field prevent a detailed analysis being made.

The dominant ore mineral is pyrrhotite and a siliceous skeleton to the ore indicates good tin values. The iron-bearing sulphides follow cassiterite and wolfram in order of deposition, then sphalerite, stannite, tetrahedrite and galena. Carbonates containing varying proportions of iron, manganese and magnesium were deposited in the final stages of the mineralisation and seldom carry tin.

The establishment of important ore reserves depends mainly upon the fissure lodes, the most promising of which are the Renison Bell and the Federal. Surface exposures suggest that the Renison Bell system may contain 500,000and the Federal 150,000 tons above the lowest level which can conveniently be worked by adits. The Battery lode contains at least 66,000 tons and the Black Face lode, a floor of the Renison Bell system, perhaps 30,000. Average grade of the ore is .6 - 1%. It is not possible to give figures for the Dreadnought, Cable, Dunn's, Montana and Dalcoath ore-bodies. All lodes are described in detail.

The two most important factors in the future of the field are :-

1. Operation as a single project.
2. Establishment of a satisfactory metallurgical process for the treatment of the sulphide ore.

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