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REPORT

ON

THE MOINA TUNGSTEN TIN DEPOSITS

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with appendices of:-

(1) Ore Reserve

(2) A Drill Log

MOINA TUNGSTEN TIN MINE.

Location, Access and Facilities. This mine is on the site of the Shepherd and Murphy Mine, Moina. The approximate coordinates of Moina on the State 4-mile map of Tasmania are 407400 East and 890900 North.

The mine is accessible by road from the North-West Coast at Devonport (35 miles to the North), via Wilmot (12 miles North of Moina). Wilmot is the nearest school centre and source of supplies. Electric power and telephone facilities are available at the mine. An adequate water supply for milling purposes is available from the Companies' dam on Bismuth Creek.

Object. The object of this report is to provide some information on the underground workings of this mine prior to possible flooding. With a cessation of pumping, 2 and 3 levels will be flooded, but 1 level being drained by No.3 Adit will remain accessible.

General. The examination of the mine was made more difficult than usual by the presence of extensive drive timbering, inaccessible stoping, mined-out areas, and collapsed workings. The company now in liquidation, worked mainly on previously started stopes.

At the time of examination, the mine had ceased production, and no ore was being taken to the mill. This prevented any sampling campaign by the author.

The mine management had not established an absolute value for the grade of run of mine ore. In a mine with an erratic mineralisation, regular daily (or weekly) run of mine ore sampling is imperative.

For the purposes of calculating ore reserves, a reasonable grade of mine ore was obtained from a large number of assay results. Though bismuthinite and molybdenite occur in the mine, their occurrence is extremely erratic and should not be taken into account in the valuation of this mine. Metallurgical studies suggest that the recovery of the bismuthinite, at least, is warranted.

Plans. The geological mapping is recorded on plans of a recent survey of the mine. This survey was carried out since cessation of development and is therefore up-to-date.

History. The lodes were discovered in 1893, by Messrs. Shepherd and Murphy. The lodes were mined continuously until the mill was destroyed by fire in 1919. A new mill was completed in 1922 and the mine then worked until 1924. Declining metal prices probably contributed to the cessation of mining activities.

From 1933 to 1950, J. Godwin carried out work on alluvial and detrital deposits, and a limited amount of underground stoping and prospecting.

The company now in liquidation, Moina Tungsten Tin N.L. was formed in 1953 and had by the end of 1954 treated some 2,500 tons of ore. In the petition to the court for liquidation the directors stated that due to low metal prices they were unable to operate at a profit.

Geology. The host rocks of this mine are the Tubicolar Quartzites, and altered equivalents of the Gordon River Limestone. The Tubicolar Quartzites are stratigraphically equivalent to the Caroline Creek Sandstones of established Tremodician (basal Ordovician) age.

The limestone in the vicinity of the mine has been thermally metamorphosed into a dark blackish dense Skarn rock. Magnetite is common in the Skarn and materially contributes to the weight and colour of this rock. The limestone prior to metamorphism must have been rather impure since the Skarn has some characteristics of a hornfels.

Williams (1957) describes the Skarn as a calc-flinta produced by metamorphism of impure limestone. "The limestones have been converted to a garnet pyroxene rock which is light brown in colour and flecked with patches of greenish proxene" adjacent to the lodes the garnet-pyroxene rock frequently gives way to a dark rock consisting essentially of fine grained magnetite, fluorite and garnet with some greenish biotite and minor pyroxene. Hess (1919) suggested the name tactite. The mine term is skarn".

Some portions of the skarn are very silicious and have the nature of a chert. Many veinlets occur in the Skarn, some of which are apparently dark quartz (< 1/8" wide) while larger veins (up to 1") wide are composed of orthoclase.

The metamorphism of the limestone to Skarn was probably caused by heat from the nearby Dalcoath granite which is also the likely source of mineralising solutions.

Coinciding with the line of Bismuth Creek, a fault (the Shepherd and Murphy fault) exists. Though actual exposures of the fault are not available, the presence of the fault is established from rock distribution and strike/dip evidence. The supposed exposure on the Cradle Mountain Road is very puzzling as the drag folding and drag dips suggest south block up movement. This is contradictory to the movement obtained from rock distribution. Since the Cradle Mountain Road exposure may be complicated by cross faulting, the south block down movement obtained from rock distribution is therefore accepted.

The trace of the fault up the Bismuth Creek gully is such as to suggest a near vertical dip.

Blake (1955) comments that the age of the Shepherd & Murphy fault is post-mineralisation on the basis of off-set wolfram veins. Though the correlation of such veins is difficult, the overall impression is that the fault is post-mineralisation.

The Mineralisation. This is of the quartz-wolfram-cassiterite type. Bismuthinite occurs erratically. Other sulphides known to occur are pyrite, chalcopyrite, molybdenite and galena. Toward the end of 2 lode West Drive 3 level, the lode is all chalcopyrite to the exclusion of all else.

In the host rocks, at the edges of the veins, there is sometimes a thin salvage of a dark substance thought to be magnetite. In the Skarn, vein quartz seems to have penetrated into some of the veinlets of Skarn minerals close to lodes (within 6" of the lode). These vein edge phenomena are not universal and there is generally no sign of true hydrothermal wall-rock alteration.

Pyrite and bismuthinite occur in the host rock (chiefly the quartzites) away from the lodes, but not to any

known commercial extent.

A minor amount of scheelite occurs as an alteration product after wolfram. It is the author's opinion there is no likelihood of a scheelite orebody in the skarn in the vicinity due to original impurity.

Williams (1957) commenting on this point says. "Firstly there is considerable evidence to indicate that the limestone was contact metamorphosed before the material now filling the veins, was introduced. Optical data indicate that the garnet which was formed by the metamorphism approaches grossularite in composition and not the iron-rich form andradite. However the presence of the tactite and the early generation lode magnetite indicate that the first phases of the mineralisation were rich in iron. If they had been present at the time of formation of the garnet the andradite variety should have been produced as in the King Island Scheelite Mine".

Williams is of the view that the available Calcium in the limestone was strongly bound up before the mineralising solution invaded the limestone, with the result that no large quantities of scheelite could be formed. He comments that with the mineralising solutions so iron-rich, wolfram is the only tungsten mineral likely to form.

However at King Island, rocks described as pyroxene-grossularite beds (or calcflinta) are supposed to be the typical metamorphosed equivalent of impure limestones. These pyroxene-grossularite beds have an average (CaO) content of about 25% as opposed to the approximate 50% (CaO) in the unreplaced marble of the orebody beds. The analysis of a Moina limestone on record at Lorinna (Registered No. 577 Mines Dept. Laboratory) showed a (CaO) content of 16.7%. The same limestone about one mile west of the Moina Mine at the Iris river has a (CaO) content of 47% (Registered No. 855 Mine Dept. Laboratory). In view of the fact that the Moina Skarn has also been called calc-flinta (William 1957) and the analysis shown, above, the author maintains his view that due to lack of purity, the limestone at Moina could not be expected to be a potential scheelite orebody. This might not be the case away from the mine, and is possibly worthy of prospecting.

The veins have the nature of fissure fillings. The fissures are chiefly east-west faults, though tension cracks, joints and even bedding planes have been infilled. The transverse faults (those trending north east, north and north west) are with but two possible exceptions not infilled. The two exceptions are that of the North West Branch of 6 Lode and a similar branch of 5 Lode. All the transverse faults seem to cause displacement of the veins (generally of an amount too small to show on plans, but occasionally as much as 10'.) The east-west faults (that are the lode channels) seem to be free of pug, but some pug occurs in the transverse faults. Many of the faults show reworking in the brecciation of vein stuff and complexity slickensiding. In general the movement of the lode channel faults is not known due to reworking.

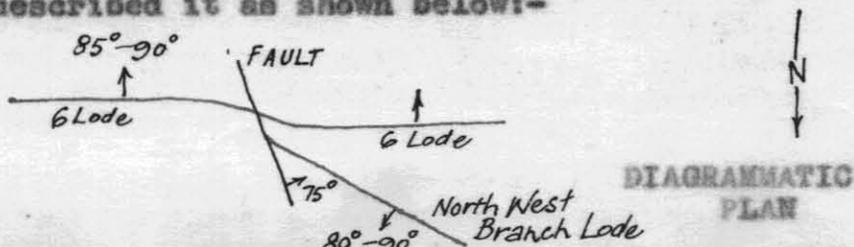
Some detailed mapping (including some stereographic projection work) has recently been done by Mr. K. Burns on the west drive 5 Lode 3 level. The results of this work are attached to this report as an appendix. Though the relationship between the main east-west 5 Lode and the north west trending 5 Lode were not established, the north west lode was thought to be later than some north south banded lodes.

It is possible that these north-south banded lodes are secretion veins, and not normal mineralisation type veins.

The North West Branch lode bears the same relation

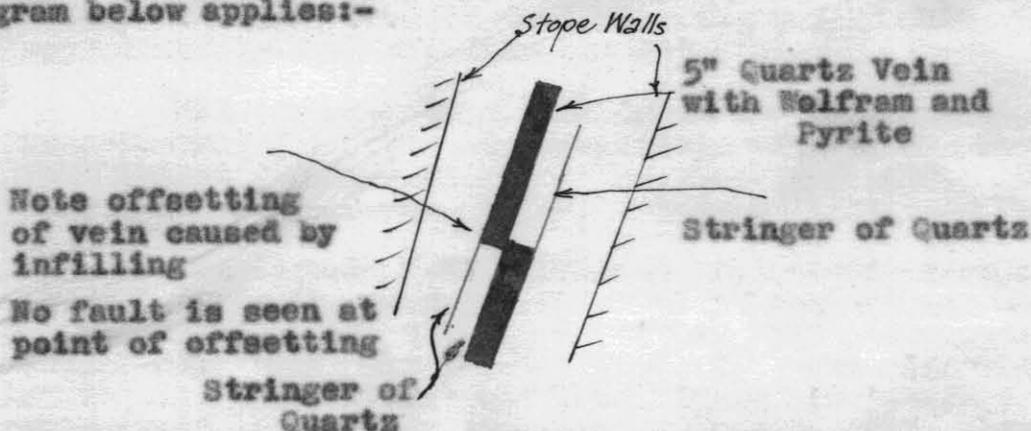
in trend to 6 Lode as the north west part of 5 Lode does to the main 5 Lode. This might be due to a similar origin and it is recommended that any future management seek the reason.

The "intersection" of the North West Branch Lode and 6 Lode was not seen due to lack of access, but the manager (pers. comm) described it as shown below:-



There is a possibility that the North West Branch Lode might continue on the southern side of 6 Lode, and this is worth checking by any future company.

Though signs of fissure filling are abundant, it is clearly shown from a point in 4 Lode West on 3 Level where the diagram below applies:-



Mine Working The Company now in liquidation has worked lodes developed by the earlier operators and in fact continue previously started stopes. Both Moina Tungsten Tin M.L. and the earlier companies had a stope width of 6 feet on average—a stope width that is excessive. This overwidth stoping and lack of sorting in the stopes must have materially contributed to the present closure of the mine.

It seems appropriate here to raise the point of a cut-off. In a regularly mineralised lode a cut-off grade is used to prevent uneconomic mining but at Moina with an irregular deposition, a cut-off grade is not useable. It is suggested that any future operators use some vein width as a cut-off. At Aberfoyle it is very conservatively placed at 10" vein width. On the basis of a 3' stope width, a cut-off of 6" would give a tolerable amount of dilution. Any future company would be well advised to use a cut-off of 6" at least on trial and raise or lower it as the operations suggest. Assuming a cut-off of 6", the author suggests that the lodes have been developed to their economic ore limits. This would necessitate development to try to find a parallel zone of "ore"-shoots. This is similar to the Aberfoyle Tin Mine. This zone of ore-shoots may not be the only zone and prospecting east and west for another is worthwhile. The ore limits seem to plunge westward in depth.

It is unfortunate that 5 Lode has not been cut on 3 Level other than in the main cross-cut for it has a good potential value, but due to lack of intersection does not enter in the ore reserves.

Reserves. An appendix on ore reserves is attached. At an estimated extractable grade of 0.21% Sn and 0.37% WO₃, the total probable ore is 42,400 tons while total possible ore is 34,600 tons (for definition of probable and possible ore see ore reserve appendix). The probable ore reserves are almost exclusively above the back of already started stopes.

From the grade of the reserves above, the in-situ value per ton is \$5.22 (with tin at \$7.5 per unit and tungstic oxide at \$10 per unit). The main criteria for profitable production is whether the total running costs could be less than \$5.22 per ton or not.

In following the veins in depth the quartz vein width seem to have decreased. As a general rule, the metal content of a quartz vein is proportional to vein-width. The rate of decrease of grade does not seem to have been very abrupt, but never-the-less present at Moina. In September, 1918, the grade was quoted to be 1.66% of combined concentrates (cassiterite, wolfram and bismuthinite) while in Williams (1957) a calculated grade from the production for 1906-1918 is given as 1.73% combined concentrates. While from assay results available the present grade is approximately 0.8% combined concentrates.

The average vein width used for calculation of reserves was 7½". This is consistent with widths recorded from latest development, and though earlier sources quote large widths, narrowing of the veins has definitely occurred.

One diamond drill hole was drilled by Moina Tungsten Tin N.L. from the eastern end of the 3 Level 6 Lode drive. It was drilled on a bearing of 30° for 320' (see appended drill log). This intersected three (3) lodes with widths of 18", 12" and 24" respectively. These are possibly extensions in depth of the veins in Godwins Adit, though for this to be true the dip of the veins would need to be flatter than at the surface. This drill hole went beyond the anticipated position of the Godwin's adit lodes by 100'.

A test of 1 and 5 lodes in depth is suggested with 5 Lode having the best potential. This is covered in the suggested diamond drilling later in this report.

Grade The extractable grade of 0.21% Sn and 0.37% WO₃ used in the calculation of the ore reserves and value per ton, was achieved by the averaging of a large number of recent run of mine ore assay results, and is thought to be a reasonably true figure. For comparison see the tables below:-

Run of Mine Ore Grade

Mine	Aberfoyle Tin (1955)	Storey's Creek (1955)	Renison Bell (1953)	King Is. Scheelite (1953)	Moina
% Sn	0.83	0.16	0.7% to 1.0%		0.21%
% WO ₃	0.46	1.35	-	0.5%	0.37%

In the section on reserves, it was stated that there has been a decline in the grade at Moina, but this is not abnormal and has been noted at Aberfoyle Tin (See Edwards 1957).

Development and Exploration. Any new company would be well advised to do the following work, listed here in order of priority:-

- (1) Sink another level.

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- (2) Drive east and west on 6 Lode (or North West Branch Lode on the west) to the economic limits.
- (3) From the end the 6 Lode drives, and from the shaft, cross-cut to intersect 5, 4 and 2 Lodes.
- (4) If the lodes were still continuing strongly on 4 Level sink another level and repeat items 1 to 3.

For efficient mining, without having excessively high stopes, it is suggested that the future level interval be about 110'.

Diamond Drill holes that could be usefully drilled are set out below in order of priority. These holes should be drilled at least AX size.

Collar Position	Bearing	Inclination	Length	Reason.
3/L North End Main cross-cut	315°	Horizontal	400'	Prospect for lodes found in the drill hole by Moina Tungsten Tin (Godwin's Adit Lodes?).
3/L End of 6 Lode East Drive.	135°	Horizontal	450'	Prospecting for 5 Lode and any other mineralisation.
3/L. Main cross-cut South End.	135°	Horizontal	250'	Prospecting for 1 Lode and any other mineralisation.

Driving westward on 3 level to test for another zone of ore shoots is recommended. It would be best to follow a lode even if very narrow. Drilling north and south from this drive should be considered.

Prospects. Of the surface prospects, exploration of the lodes from Godwin's Adit would be covered by the first drill listed above. Cross-cutting and driving on the lodes might be warranted after drilling.

An alluvial lead exists above the western workings of the mine. Little is known definitely about the size and position of this lead, though it is indicated on the surface plan of Blake (1955). "Deep lead" mining might enable profitable working if the deposits warranted it. Testing of the lead by churn drilling would be a necessary step prior to any planning.

Conclusions:- The final decision as to whether the Moina mine could operate profitably is purely an economic problem. However overwidth mining by Moina Tungsten Tin N.L. must have been detrimental to efficient operations.

Any future company should examine the possibility of working some other tin/wolfram deposits in this district in conjunction with the Moina mine. Mines Department records show some deposits (especially some wolfram deposits in the Upper Forth Valley) that might be payable deposits.

The present reserves though not very large might be increased by exploration as outlined herein.

No increase in grade could be anticipated in mining deeper.

References: Several publications exist referring to the Moina mine. Some listed below only indirectly refer to Moina, but have been used to compile this report.

(a) Departmental publications:-

- 1919 Reid, A.M. The Mining Fields of Moina, Mt. Claude and Lorinna. (Geological Survey Bulletin No.29).
- 1938 Nye, P.B. and Blake F. The Geology and Mineral Resources of Tasmania (Geological Survey Bulletin No.44)
- 1943 An unpublished report by Keid, H.G.W. Report on the Moina Mineral Field.
- 1955 Blake, F. A report presented in the Dept. of Mines Annual Report. The Shepherd & Murphy Mine, Moina.

(b) Outside publications:-

- 1953 Edwards, A.B. Geology of Australian Ore Deposits Volume 1. Proceedings of the Fifth Empire Mining & Metallurgical Congress. An A.I.M.M. publication.
- 1956 Edwards, A.B. Baker, G. and Callow, K.J. Metamorphism and Metasomatism at the King Island Scheelite Mine Journ. of the Geol. Soc. of Aust. Vol. 3, p55.
- 1957 Edwards, A.B. and Lyon, R.J.P. Mineralisation at the Aberfoyle Tin Mine, Rossarden, Tasmania. A.I.M.M. Proceedings No.181 March 1957.
- 1957 Williams, K.L. Mineragraphic Report No.681 Tin Tungsten Ore from the Shepherd and Murphy Mine, Moina. (a C.S.I.R.O. Mineragraphic Section publication).

ORE RESERVES.

Assumptions (1) A "cut off" of 6" quartz.
(2) A stoping width of 3 feet.
(3) The sorting out of 12½% of the broken mullock that is to be left in the stope.
(4) An average vein width of 7½" in all lodes
(5) A tonnage/volume factor of 13 cubic feet per ton for unbroken ore.
(6) The use of 10 foot deep floor pillars below all levels in all lodes.
(7) A uniform grade of 1.12% Sn and 1.94% WO₃ in the quartz vein stuff in all lodes. From this and items 2, 3 and 4, the extractable grade (allowing only 80% extraction) in the broken ore would be 0.21% Sn and 0.37% WO₃. With prices of tin at £7.5 per unit and Wolfram at £10 per unit. The in situ value per ton of ore is £5.22. To work at a profit complete running costs would have to be less than this figure of £5.22 per ton.

CLASSIFICATION:- Normal classifications of ore reserves are valueless in this circumstance so that probable and possible ore classifications are used. Probable ore is ore between tentative ore limits and opened on two levels. Possible ore is that below the floor of 3 level and continuing downward for say 110 feet (to the next possible level).

PROBABLE ORE:- 2 Lode. No reserves are considered above 4 Creek Drive level due to lack of information regarding ore limits and lack of access.

Above 1/L and below 4 Creek Drive floor pillar Tonnage = 9,100
" 3/L " " 1/L " " " Tonnage = 12,000

4 Lode. Due to completeness of mining no ore reserves are deemed to exist above 1/L.

Above 3/L and below 1/L floor pillar Tonnage = 13,000

6 Lode. No ore reserves are deemed to exist above 1/L due to completeness of mining.

Above 2/L and below 1/L floor pillar Tonnage = 1400
" 3/L " " 2/L " " " Tonnage = 1000

North West Branch Lode. Due to inaccessibility and partial collapse of workings no ore reserves are considered above 1/L.

Above 2/L and below 1/L floor pillar Tonnage = 1700
" 3/L " " 2/L " " " Tonnage = 4200

5 Lode. Due to lack of development between one and three levels, and completeness of mining above 4 Creek Drive no ore reserves are calculable in 5 lode.

POSSIBLE ORE (see definition of usage here).

2 Lode	Tonnage	=	9600
4 Lode	Tonnage	=	10800
6 Lode	Tonnage	=	14200
North West Branch	Tonnage	=	10000
5 Lode	Tonnage	=	Nil

<u>TOTAL</u>	<u>PROBABLE</u>	<u>POSSIBLE</u>
2 Lode	21,100	9600
4 Lode	13,000	10800
6 Lode	2,400	14200
North West Branch	5,900	10000
5 Lode.	-	-
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Total	42,400 Tons.	34,600 Tons.
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Log of Diamond Drill hole drilled from the
 6 Lode East Drive 3/L on bearing of 30° for 320' horizontally.

From	To	Length Recovered	Geological Classification	Remarks.
0'	30'	0-35' = 35' 35-30' = 20'	Tubicolar Series quartzites without any definite bedding.	Some patches of quartz.
30'	31'6"	1'6"	Lode showing altered Mica a gray sulphide (bismuthinite) a purple mineral (covelite?) and chalcopyrite.	Lode
31'6"	100'	7'	Tubicolar Series quartzites without any definite bedding.	
100'	115'	15'	Tubicolar Series quartzites Core/bedding angle = 70°	
115'	120'	3'	Tubicolar Series quartzites	
120'	121'	1'	Lode showing alteration mica.	Lode
121'	145'	15'	Tubicolar Series quartzites - no bedding visible.	
145'	147'	2'	Lode with pyrite, wolfram mica and chloritic alteration products Vughs with quartz crystals present.	Lode
147'	255'	55'	Tubicolar Series quartzites with disseminated pyrite - some altered to limonite Bismuthinite present? Chalcopyrite present?	
255'	280'	9'	Skarn Rock	Quartzite/ Skarn Contact at 255'
280'	320'	-	Not seen! not in box at Moina! Most probably Skarn. 320' End of Hole.	