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# **APPENDIX 5**

## **REVIEW OF ANCHOR MINE METALLURGICAL DATA**

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MEMORANDUM

TO: S. Gula DATE: 17th February 1994

AT: Mancala Pty Ltd

FROM: Nick Moony

SUBJECT: Review of Anchor Mine Metallurgical Data

c.c. W. Lannen

## Renison Ltd

A considerable volume of processing data has been sourced for this study on the Anchor Mine (Blue Tier) metallurgy. Renison Limited carried out a substantial drilling program in 1976-79. The drill core from this program was characterised in their metallurgical laboratories at Renison Bell by R.O.Devlin<sup>(1)</sup> in 1978-80 using heavy liquid analysis and superpanning. This work was to a high standard, but this was not fully acknowledged in later reports. The conclusions drawn were:

- Full liberation occurred at about 600 $\mu$ m.
- Recovery varied between 78% and 95% but averaged around 85%.
- Concentrate grades of 50%Sn to 60%Sn (wet) could be readily produced.
- The ore was reasonably soft probably having a Bond work index between 12 and 16 but this needed to be verified.
- The cassiterite in the north-east end of the mine was coarser.

In 1980 M. Millard(2) proposed the case for confirmatory work such as equipment selection, crushing and grinding requirements, more detailed heavy liquid analysis, confirmation of the single liberation pattern, i.e. preconcentration at coarse size, say coarser than 1.12mm, would seriously effect recovery.

The detailed equipment selection and processing work was carried out at the Department of Mines Laboratory in Launceston by G.Bryan(3) (1980-81) and Richards(4) undertook a detailed processing program at Mineral Deposits Ltd in 1982. Amdel(5) in conjunction with Renison characterised the different ore types using heavy liquid analysis. They confirmed that very high recoveries could be achieved on the Anchor ore. This work also verified that there was not a bimodal liberation pattern. Preconcentration at sizes coarser than 1.12mm might allow high concentrates to be produced but recovery would be badly affected. It seems recovery drops to about 50% when Anchor ore is crushed to 80% passing 3.65mm. In this respect Anchor is similar to Ardlethan and unlike Renison, Aberfoyle, Storys Creek, Cleveland, Bischoff porphyry etc..

All the samples used in this stage of the project were selected from each of the known geological zones. Considerable time and effort was spent in endeavouring to ensure they were as representative as possible. In 1983 Cross and Selby(6) wrote a comprehensive report, "The Metallurgical Treatment of Blue Tier Mineralisation". This report detailed and costed a flowsheet to treat 60tph at 0.27% and produce a wet concentrate that assayed between 50%Sn and 55%Sn. Recovery was expected to be 85%. The particulars are given below in Table One. In this project it was recognized that both capital and operating costs had to be kept to a minimum. The proposed flowsheet used spirals and took full advantage of the liberation characteristics that this ore possessed and brought this part of the project to a "ready to go" state. Today much of this document is still valid, except that now because of the very low tin prices, a higher feed grade is required and a cleaner concentrate may need to be produced. Consider that today the Renison mine now sells a concentrate that assays between 59% and 63%Sn. In 1983 they produced a concentrate assaying between 49% to 52%Sn. Cross and Selby opted for a low grade product because that is what they were familiar with.

**Table One**  
**Proposed Tin Concentrate**  
**Renison 1983**

<u>Element</u>	<u>Range</u>	<u>Average</u> <u>(Renison)</u>	<u>Actual (averaged)</u> <u>(Spectrum)</u>
Sn	50-55%	52.8%	60.3
Fe	1-6%	3.6%	2.4
S	1-3%	1.5%	0.7
As	<0.01%	0.01%	0.02
Cu	0.2-1.5%	0.60%	0.88
Pb	0.05-0.15%	0.10%	0.02
Zn	0.05-2.0%	1.1%	0.45
Ag	5-150g/pt	90g/pt	190g/pt
Mo	0.15-0.30%	0.2%	-
Bi	0.10-0.35%	0.2%	0.07
WO <sub>3</sub>	0.5-1.5%?	1.0%	(4.0)

Cross/Selby predictions proved true at the upper levels for all minerals except iron. Present knowledge, hindsight and experience suggests the following estimates given in Table 2.

**Table 2**  
**Predicted Concentrates**  
**Anchor Mine**

<u>Element</u>	<u>Probable (wet)</u>	<u>Probable (dry)</u>	<u>Possible (dry)</u> <u>Super Conc.</u>
Sn	60-64%	66-70%	70-72%
Fe	2-5%	1.5-2.0%	0.5-1.0%
S	0.2-1.0%	0.2-0.60%	0.10-0.20%
As	0.02%	0.02%	0.01%
Cu	0.15-0.80%	0.10-0.70%	0.10-0.20%
Pb	0.02-0.05%	0.01-0.05%	0.01-0.05%
Zn	0.10-0.60%	0.10-0.60%	0.05-0.20%
Ag	-	-	-
Mo	-	-	-
Bi	0.05-0.08%	0.05-0.10%	0.02-0.05%
WO <sub>3</sub>	2.0-7.0%	0.40-0.80%	0.20-0.40%
Recovery	85-88%	84-86%	82-85%

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The higher than expected tungsten content suggests that wolfram might be produced as an easy by-product. While at current prices it will not make a great profit, it should pay for operating the dry mill and allow for the production of a cleaner super tin concentrate(12). Consider the following hypothesis:

**Table 3**  
**Anchor Mill**  
**Metallurgical Balance**  
**Tin and Tungsten**

<u>Product</u>	t.p.y.	Sn%	WO <sub>3</sub> %	Sn% Dist.	WO <sub>3</sub> % Dist
Final Tin Conc.	860	72.0	0.5	82.5	4.0
Final Tungsten Conc.	100	0.5	70.0	0.5	70.0
Combined Tailings	<u>149.040</u>	<u>0.08</u>	<u>0.02</u>	<u>17.0</u>	<u>26.0</u>
Mill Feed	150,000	0.50	0.10	100.0	100.0

**Table 4**  
**Metallurgical Balance**  
**Tin and Tungsten**  
**Dry Mill**

<u>Product</u>	t.p.y.	Sn%	WO <sub>3</sub> %	Sn % Dist	WO <sub>3</sub> % Dist
Final Tin Conc.	860	72.0	0.5	96.0	6.0
Final Tungsten Conc.	100	0.5	70.0	0.8	91.0
Bulk Sulphide Conc.	350	1.0	0.3	0.5	1.5
Middlings Return	<u>300</u>	<u>6.0</u>	<u>0.6</u>	<u>2.7</u>	<u>3.5</u>
Gravity Conc.	1,610	40.0	4.8	100.0	100.0

In considering the above it must be taken into account that nobody has attempted to produce a tungsten concentrate and the results are based on Rossarden(7) performance before the Storys Creek mill shutdown. Also, the final tin concentrate should be checked for Nb and Ta. The bulk sulphide concentrate analysis is given below in Table 5.

**Table 5**  
**Sulphide Bulk Concentrate Assay**

	<u>Range</u>	<u>Average</u>
Sn%	0.5-2.5	1.0
Cu%	10-30	20.0
Zn%	20-35	30.0
Ag g/pt	2000-3000	2500.0
Mo%	0.3-1.5	0.8
Bi%	0.5-2.0	1.0
Sb%	0.1-1.0	0.3?
Fe%	5-15	8.0
Au g/pt	0.1-1.0	0.6

It would seem from the low annual tonnage and the nature of the product that only an ISF smelter would treat this concentrate. The realised value will be low and shipping difficult so, therefore, it should be stockpiled for the present.

#### Mines Department

In 1987-1989 Spectrum Resources requested the Department of Mines, Tasmania, L. Rhodes (8) (R.888) to carry out a full scale metallurgical study from first principles. It is a little sad that the Renison reports were not reviewed because it must have been assumed by Mr Rhodes that the ore was similar to Aberfoyle or Storys Creek and Anchor could be preconcentrated at coarse sizes. The complete project was carried out on crushed ore at 100% passing 6mm. As expected results were poor. The report concluded that if Spectrum Resources wished to achieve tin recovery they had to grind the ore to 500 $\mu$ m after jigging. Rhodes did produce some very high grade concentrates but did not check on wolfram production or assay for minor elements in the concentrates. Spectrum Resources requested Rhodes to check out rubidium recovery but he did not find an easy method to upgrade low grade concentrates (0.5%-1.0% Rb). In 1962 the Mines Department (R.412)(9) carried out a brief superpanning on two ore samples from Anchor, both of which achieved 95% recovery but they can only be considered sighter tests. R.901(11) and R.908(10) were also found but due to filing problems at the Department only those reports that I already know about could be sourced.

## Tailings

It is now reasonably estimated that there is at least 130,000 tonnes of tailings at 0.18%Sn in the main tailings dam. There is a possibility that there could be another 10,000 tonnes at 0.35-0.65% in a small dam near the mill. Metallurgical investigations carried out by R.M.S.Watsford(13) and B.H.Choo(14) both confirm that 50% to 60% of the tin can be recovered by spirals and tables to 60%Sn concentrate. These tailings can be easily combined with ore in any proportion. Both Watsford and Choo readily demonstrated that tailings should not be rejected above 425 $\mu$ m. The present tailings are about 50% passing 425 $\mu$ m. Table 9 estimates the concentrate grade that would be produced if tailings were treated alone.

## Summary

The ore at Anchor Mine will yield recoveries ranging from 78% to 95% but should average 85% after the circuit has been recommissioned and any tailings rejected are ground to 100% passing 500 $\mu$ m. Feed grade should range 0.44%-0.56%Sn at concentrate grades of 60% to 64%Sn but these may be dirty and incur penalties. Tin concentrates as high as 72% can be produced but definitive knowledge on such products was not found. It is possible that tungsten concentrates can also be obtained. To allow maximum tin and tungsten concentrates to be produced, a progressive grinding circuit is suggested. Say a primary crush of 80% passing 2.8mm and a regrinding circuit producing a spiral feed at 80% passing 425 $\mu$ m. An estimate of previous operations is given below in Table 7. In Table 8 the tin lost in tailing is added to the Esker estimate. Full details on the proposed flowsheet and method for producing clear concentrates will be given elsewhere(16) except to say the mineralogy of Anchor ore indicates, and the technology exists, for reducing copper and other contaminates.

**Table 7**  
**Estimated Anchor Mine Production 1990-1992**

<u>Product</u>	<u>Esker Estimate</u>			<u>Mine Records</u>		
	<u>Tonnes</u>	<u>Sn%</u>	<u>Sn% Dist</u>	<u>Tonnes</u>	<u>Sn%</u>	<u>Sn% Dist</u>
Ore mined	134,631	0.51	100.0	170,000	0.44	100.0
Conc. sold	741	60.33	65.0	741	60.33	59.0
Tailings	133,890	0.18	35.0	169,259	0.18	41.0

**Table 8**  
**Previous Operations**  
**Possible Production**

<u>Product</u>	<u>Tonnes</u>	<u>Sn%</u>	<u>Sn%Dist</u>
Ore Mined	134,631	0.5	100.0 *
Conc. sold	741	60.33	65.0
"Tailings"Conc.	228	60.00	20.0
Final Tailings	133,662	0.08	15.0

**Table 9**  
**Tailings Only Concentrate**

	<u>Probable (wet)</u>	<u>Possible (dry)*</u>
Sn	60%	66%
Fe	3%	1%
S	0.4%	0.2%
As	0.02%	0.02%
Cu	0.5%	0.3%
Pb	0.05%	0.02%
Zn	0.40%	0.40%
Mo	-	-
Bi	0.15%	0.10%
WO <sub>3</sub>	3.0%	1.0%

\* The fineness of the concentrate would preclude the efficient use of the H.T. roll separator.



## References

- (1) R.O. Devlin - Metallurgical Progress Reports - August 1978-December 1979
- (2) M.Millard - 1980 - Review of Previous Work - Proposed Scope for Future Metallurgical Testing
- (3) G. Bryan - File notes and progress reports 1980-1981 - Department of Mines Reports R.801 and R.811.
- (4) R.G. Richards - Mineral Reports No.018.5/1 - Pilot Scale Metallurgical Testwork for the Gravity Concentration of Tin Ore from the Blue Tier Deposit
- (5) Amdel - Sink Float Tests Reports GS 1853/83 - GS 2073/83 on BT No.2, BT 3B and BT 3A - August-November, 1982
- (6) W.Selby/S.Cross - The Metallurgical Treatment of Blue Tier Mineralisation
- (7) Summary of Rossarden Operations - September, 1969
- (8) L. Rhodes - R.888 - Tin Recovery Tests on drill core from the Blue Tier - Progress Report 24/9/88
- (9) Anon - R.412 - 1962
- (10) L.Rhodes - R.908 - Reduction of Copper Content in tin concentrate from Anchor Mine - 1/6/90
- (11) P. James - R.901 - Anchor Mine visit 11/10/89  
R.901 - Anchor Mine Visit 12/ 7/89
- (12) H.W. Fander - CMS Report 82/4/19 - Blue Tier Mineralogy
- (13) R.M.S.Watsford - Heavy Liquid Separation of Stored Tailings
- (14) B.H.Choo - Memo to S. Gula - November 1993
- (15) R.M.S.Watsford - Metallurgical Survey of Treatment Plant Operations Blue Tier
- (16) N.Moony - Memo to W.Lannan/S.Gula, July 1993