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THE KING ISLAND SCHEELITE MINE, KING ISLAND, TASMANIA

I. Introduction

King Island is situated at the western end of Bass Strait. The scheelite deposits at Grassy were discovered by Mr.T.Farrell about 1913. The deposits were prospected and developed until 1916, and the King Island Scheelite Company N.L. was formed in February, 1917, to work them. The Company carried out active mining and treatment operations from the middle of 1917 until July, 1920 with the following results -

Year	Ore Treated (tons)	Concentrate Produced (tons)	Approx. Value of Concentrate (£)	Yield Concentrate (per cent)	Dividends (£)
1917	4937	69	12130	1.40	5,000
1918	21088	216	39352	1.02	10,000
1919	27832	199	43181	0.71	5,000
1920	13853	105	17903	0.76	5,000
Total	67710	589	112566	(Av.) 0.87	25,000

Operations ceased in 1920 owing to the fall which occurred in the price of tungsten ores after the war period.

In 1934, Mr.W.E.Hitchcock was considering the re-opening of the mine and an examination was made by Mr.P.B.Nye, Government Geologist of Tasmania. A drilling campaign was drawn up and was carried out during the latter half of the year. The drilling campaign was successful in proving the continuation of the lode system.

A new Company - King Island Scheelite N.L. was formed and commenced operations during 1938 and results of their operations to the 31st October, 1941 show -

Year Ended	Crude Ore Milled (tons)	Concentrate Produced (tons)	Approx. Value of Concentrate £	Yield of Concentrate (per cent)	Nett Profit (without depreciation & Income Tax Charges) £
31/10/38	5845	27	6092	0.46	1065
31/10/39	27670	168	38330	0.61	14680
31/10/40	35600	228	53484	0.64	24970
31/10/41	29190	204	44295	0.70	11191
	98305	627	142201	0.64	51906

In addition a tailings retreatment mill recovered -

	Tailings Retreated (tons)				
31/10/40	22390	35	7944	0.16	5724
31/10/41	18870	17	3741	0.09	1996
	41260	52	11685	0.12	7720

Hence the total production to 31st October, 1941, has been 166,015 tons crude ore for a yield of 1,268 tons scheelite concentrate. Assuming a concentrate grade of 70% tungsten oxide (WO_3), the recovery has been equivalent to 0.53% WO_3 for the tonnage mined.

The present production (based on 1941 figures) is 30,000 tons of ore per annum from which 200 tons of scheelite concentrate is obtained.

II. Geology

The following notes on the geological features of the deposits were included in Mr.P.B.Nye's report of 11/6/34 to the Director of Mines of Tasmania -

"Geology

The country rocks adjacent to the mine consist of quartzites and slates. The quartzites occur to the north and north-east, while the slates occur with the ore bodies and to the south thereof.

An aplite dyke and numerous small veins exist in the open cut and are intrusive into the slates etc. Aplite also occurs some 20 chains to the west, while loose pieces at the surface indicate other veins and dykes. It is reported that granite occurs to the south and the aplite is without doubt connected with the granitic intrusions.

The surface is largely covered by sand and is otherwise well soiled. Exposures are therefore few and most information as to rocks is obtainable from the mine workings. Gravels etc. are found at heights of 120' to 150' above sea level and represent either valley fillings or an old shore line.

The slates, etc. have a general E. - W. strike with a dip to the south, but the strikes and dips have a considerable range.

Economic Geology

It is difficult to detect scheelite in the ore by eye, although coarse patches can at times be seen in narrow quartz veins and it is visible occasionally in the garnet rock. The scheelite is readily proved by assay and this method and of course the mining, proved that it occurs mainly in the garnet rocks.

The garnet rock is for the most part coarse-grained, the crystals being up to ½" diameter and apparently free from gangue. In some of the finer-grained types, quartz is present between the garnet crystals. The ore in the treatment contained 66% of garnet, so that other gangue minerals (probably including some country rock) are present to the extent of at least 33% (allowing 1% scheelite).

Associated with the garnet rock, there are bands of fine-grained garnetiferous rocks of which were found by L.L.Waterhouse to be pyroxene-garnet rocks.

The aplite is also reported to contain scheelite, but this was not investigated.

Waterhouse reported the presence of quartz, epidote, calcite, pyroxene, and actinolite in the ore and quartz, albite, sericite, chlorite, biotite and magnetite in the country rocks.

The garnet ore-bodies are associated with, and occur as bands in, a series of slaty and shaly rocks. They appear to be conformable in strike and dip with these rocks and therefore apparently represent replacements of certain beds. The mine reports refer to limestone in some of the underground workings and it is not impossible that the ores are replacements of limestone beds although no limestone beds were observed during the recent examination. However garnet bodies can be formed by alteration of shale as well as of limestone, and so the ore bodies may have been formed by alteration of such rocks. Further it is certain that the iron content of the garnets was introduced by the mineralising solutions and so also may have been the calcium content, so that a local source of calcium is not necessary for the formation of the garnet (andradite).

The ore bodies occur in a mineralised zone about 400 feet wide. The zone is bounded on the north by quartzites, the boundary corresponding generally with the northern edge of the Northern open-cut. The actual junction is probably a faulted one and it appears to have a strike of 315°. It was probably cut in the old Nos.1, 2 and 3 adits and had a similar strike but the dip ranged from vertical to 60° to the south-west.

The zone has a general E.-W. strike in agreement with the slates etc. existing in it. The southern boundary is not so well-defined, but dark quartzites and slates occur to the south of the most southern ore-body. There is no evidence of any fault at this boundary, but the rocks appear to conformably overlie the mineralised zone. The extension of the ore-bodies at depth should be found beneath those slates and quartzites.

The principal extension will be found to the west of the open-cuts in the region partly tested by the prospecting shafts.

The mineralising solutions responsible for the formation of the ore-bodies undoubtedly represent the final differentiates from the granite magma. The aplite dykes and veins were also derived from the granite but at a slightly earlier stage. It is probable that the presence of aplite dykes and veins will serve as a general indication for places (outside the open-cuts) favourable for prospecting".

The mining operations since 1934 have exposed fresh faces and the lodes and geological structure are now more readily observable. Time did not permit of more than a hurried inspection of the workings.

The manager refers to five lodes and these were seen in the open working faces. The lodes appear to be interbedded and they dip to the south at moderate angles. In places, ore occurs across a width of 50 feet, but such is not the true width.

The geological structures are well developed and could readily be mapped. This appears to be urgently required as the lodes are faulted and folded and we feel sure that accurate mapping of structures would soon elucidate the structural control of the ore deposition. It would also serve as the basis for future drilling campaigns and determine the possible limits of the ore deposition, which should be known to prevent further buildings etc. being erected on the hanging wall of the low dipping lodes.

III. Mining Operations

At the time of our visit - 13th April, 1942 - the deposit was being worked by an open benching system of mining on five benches -

45', 90', 120', 140' and 170' contours. On the top bench - 170' contour - the overburden of wind-blown beach sand and country rock was being removed by a mechanical shovel which delivered to motor lorries; the waste being dumped on the footwall side of the lode system on the hill slope. A Fordson tractor loader with ¼ c.yd. bucket is used for loading waste rock on the other benches.

The ore is mined by horizontal holes bored at the working contour level and the blasted rock is hand shovelled into trucks. The scheelite content - which really only means the free scheelite grains - is determined by hand panning of grab samples.

The ore is hand-trucked from 45 and 90 feet contour benches and delivered by motor lorry from the higher benches to the mill ore bin.

The mine manager estimates that the ore reserves are 50,000 tons proved ore above 90' contour, 25,000 tons probable ore above 90' contour, 100,000 tons possible ore below 90' contour, but he is confident that there is 10 years of ore available at the present rate of extraction of 30,000 tons per annum.

No systematic plans or cross-sections are kept. It is stated that a boring campaign completed last year proved that the lode formations continue for at least 400 feet west of the present workings. The boring results have not been correlated with lode exposures in the working faces, and this should be included in the urgently needed geological mapping of the property.

The mining is carried out on one shift only and the overburden removal above the 170 ft. contour is carried on for 10 to 12 hours per day. The mine production could be increased at least five fold by working three shifts. This would necessitate increased development work and rate of overburden removal, but given manpower and little additional equipment this can easily be achieved. The present air compressor can cope with double the present tonnage, which as before mentioned is obtained on one shift only. Such work would be urgent because working at a five fold rate would mean the mining of 150,000 tons of ore per annum and the total reserves quoted above amount to only 175,000 tons.

The andradite garnet (lime-iron silicate) which is the chief gangue mineral is separated from the scheelite concentrate by magnetic separation. It is quite possible that the garnet is sufficiently magnetic to enable the employment of the magnetic method of geophysical survey to trace the extension of the lodes. Samples have been requested from the Company by Mr.P.B.Nye in order that their magnetic permeability may be determined.

IV. Milling Practice

A flowsheet of the mill is attached. The plant is operating three shifts over 132 hours per week and is at present handling a maximum of 5.5 tons per hour or about 750 tons per week. The plant is poorly designed and cannot be regarded as efficient. Hand-panning of the blasted ore in the bench faces shows that there is much 'free' scheelite i.e. loose scheelite freed from the gangue, in the mill feed; yet there is no attempt to separate this freed mineral from the ore before any of the crushing processes. The use of the ultra violet lamp may assist in grade determination and gangue rejection.

The ore is irregularly hand-shovelled from the bin to the jaw crusher, and the crushing operations in the jaw crusher and coarse rolls must 'slime' much of the already freed scheelite.

The aim in the milling of scheelite ores should be to prevent 'sliming' but in this plant there is no attempt to do so. The present bottlenecks in the plant are the elevators and the Huntington mills. The capacity of the elevators can be greatly increased by punching holes in the bottom of the buckets and increasing the height of the bucket lips. The Huntington mills are a poor job and not suitable for this work. The Fahrenwald Sizer is not operating as a sizer but the first two spigots are bulked and diverted to the primary jigs.

The jigs do a very good job, but the table concentration is hampered by inefficient classification. The gangue consists largely of andradite garnet, and the larger garnets crowd towards the concentrating end of the tables preventing the recovery of the fine scheelite, which is ultimately lost.

In July, 1941, Mr.J.G.Hart of the Council for Scientific and Industrial Research, at the invitation of the Company, carried out an unofficial investigation of the milling process and his tests showed the following mesh recoveries of scheelite.

Sizing	% WO_3 Lost	Recovered
-60	12.0	88.0
-80	11.8	88.2
-100	16.2	83.8
-150	20.5	79.5
-200	30.0	70.0
-200	75.15	24.85

The overall mill recovery was 55% of the WO_3 content of the crude ore. Of the total loss of 45% of the scheelite, 35% occurs in the minus 200 mesh scheelite - in other words 78% of the total loss is due to minus 200 mesh scheelite.

The origin of most of the minus 200 mesh scheelite is in the overgrinding in the Huntington mills and in the failure to remove the already 'free' scheelite grains from the ore before each crushing stage. The rolls are operated with a spacing of about ¼" between roll faces, which means that they are performing very little useful work and that much scheelite is diverted to the Huntington mills where it is invariably slimed. The hand feeding of the jaw crusher, or in other words, the plant (as there is no bin between the crusher and the remainder of the plant) results in very inefficient work. During the change of shifts over a period of at least ½ hour there is little or no feeding, and water rushes through the plant flushing out the Huntington mills and destroying the 'setting' of the concentrating machines. It is also reasonable to assume that during the night shift the feeding would be very intermittent with resulting variations in crushing and grinding and efficiency of the jigs and tables.

Considerable improvement in milling results would result from, -

1. installation of washer or wet screen ahead of primary crusher to eliminate 'free' scheelite from the mined ore.

2. installation of jaw crusher ahead of mill bin with automatic feeder from mill bin to the coarse rolls.

3. operation of both coarse and fine rolls in closed circuit with screens and rolls to be operated with roll faces much closer.

4. alterations to elevator buckets permitting increase in elevator capacity.

5. attention and efficient operation of the Fahrenwald Sizer to yield properly sized products for coarse jig, fine jig and, at least, three different sized products for table concentration.

It is doubtful whether any additional grinding would be necessary if the fine rolls are operated at full efficiency. If additional grinding is necessary, the installation of the 5'x4' Marcy mill at present on the mine could be considered.

The aim of the company is to increase the present output of 600 tons of ore per week (present mill capacity is given as 700 to 800 tons of ore per week) to 1400 tons per week and duplication of the present mill has been considered. The Company has proposed two possibilities ..

1. The erection of a mill on a site where provision could be made for a two unit mill (one unit to be erected as soon as possible, and the other at some later date).

2. The erection of practically a new mill adjacent to the tailings retreatment mill so that with the additional crushing section etc. the present concentrating tables could be used with a little re-arrangement.

The proposed new site was inspected but it may well be in a dangerous position on the hanging wall of the lode and should not be considered until the area has been properly geologically surveyed. The second possibility could be utilised but it is felt that the mine has such outstanding possibilities of greatly increased production that the present milling process should be thoroughly investigated before a decision is reached. At the same time the absolute limit of the present plant should be determined as we feel sure that its capacity can be considerably increased by close attention and alterations.

It is our suggestion that the Council for Scientific and Industrial Research permit Mr.J.G.Hart and assistants to investigate the present milling practice and at the same time carry out experimental metallurgical tests on the job which would aid in the evolution of a flowsheet for the new mill. This commission has been discussed with Mr.Hart who is most anxious to carry out the work, and we would be pleased to give direction and assistance in the investigation and design of the new plant. The investigation should require not more than four weeks and a minimum of two weeks.

Flotation testing of the ore has resulted in promising results in a fresh water circuit but the presence of calcium and/or magnesium salts in the Grassy River water, or dissolved from the ore upsets the flotation. The mine and mill are situated on the sea coast and there may be difficulty in obtaining a sufficient supply of fresh water for flotation purposes. This phase can be studied by Mr.Hart and further tests should be conducted with the flotation concentration of scheelite.

At the present time the mill tailings assaying at least 0.3% WO_3 are laundered to the sea. At the present price of 125/- Aust. per ton WO_3 these are valued at 37/6 per ton, and it is recommended that they should be stacked on account of their contained values which may be recoverable in the future. Very little work has been done anywhere on the concentration of scheelite ores and it is a national waste to send the tailings to the sea. The mill dominates a large area wherein the tailings can be delivered by gravity for some time.

V. Power Plant

At present the mill and compressor is driven by -

1 - 100H.P. 4 cylinder horizontal Crossley oil engine driving the Crushing section and 35KW D.C. generator.

1 - 45 H.P. 2 cylinder horizontal Crossley oil engine driving the table section and duplicate generator.

1 - 35 H.P. single cylinder Ruston - Hornsby oil engine driving the air compressor.

Aggregate H.P. is 180 but it is insufficient to permit the installation of the 5' x 4' Marcy mill with 50 H.P. motor now on the job, but not installed.

The Company has reported that two complete generating sets each comprising -

Ruston Hornsby 4 cylinder vertical engine, 120 H.P. direct coupled to Crompton 76 KW, 400 volt, 50 cycle, 3 phase, 330 r.p.m. alternator

are lying idle at the Glaxo works, Pt.Fairy, Victoria and would be suitable for the increased tonnage programme. The purchase of these engines would result in four different types of engines necessitating a large number of spares.

VI. General

We are of the opinion that the prospects of the mine justify the consideration of a much larger output, and a bolder policy of mine development than proposed by the directors. The urgent need of tungsten for war purposes is the major consideration, but this mine should be able to compete with other mines in the world in any post war reductions in tungsten prices.

The geological, mining and milling investigations would be completed within one month; and, if favourable reports are forthcoming, we would advocate the installation of two large central power units sufficient to cope with the recommended tonnage possibilities of the mine.

This enlarged scheme of development would necessitate early consideration of a new town site with reasonable living facilities. At present the houses are built very close to the mine and in a very exposed position.

VII. Recommendations

1. We consider that the King Island Scheelite mine possesses distinct promise for the development of large tonnages of ore and is worthy of a much larger tonnage increase than proposed by the Company.

2. The geological structures are well developed and apparent, and the area and the mineralised zone should be geologically mapped in detail. This investigation of the geology and the ore possibilities could advantageously be undertaken by an officer of the Tasmanian Geological Survey working in collaboration with Mr.P.B.Nye, Assistant Geological Adviser, because of the latter's knowledge of the deposits.

3. Providing the tests by the Geological Branch of the Department of Supply and Development of the magnetic permeability of the garnet-bearing ore give encouraging results it is recommended that that Branch give consideration to the carrying out of a magnetic geophysical survey over the area and that such survey should be followed by a drilling campaign.

4. The present mining practice appears to be well managed but should be reconsidered following the results of the geological and drilling investigations.

5. The Council for Scientific and Industrial Research be asked to make available the services of Mr.J.G.Hart to thoroughly investigate the present milling practice and carry out tests to obtain information for the proposed new mill design. This work to be done in collaboration with Mr.M.Mawby.

6. The company be asked to stack their present tailings which are at present allowed to run to the sea.

7. No immediate action be taken to increase production pending reports on Recommendations (2). (4), and (5) - which could be completed within one month.

8. Arrangements be made for companies, whose major source of revenue is from tungsten, to deduct capital redemption, costs of new plant and development from profits before any taxation is assessed, and to be allowed a special taxation concession for increased production.

9. Manpower must be made available. Present labour force at 11/4/42 was 55 including manager and staff, whereas 70 are the normal requirements for the tonnage (about 750 tons of ore per week). Attached is the statement of employed and required labour to maintain present production.

10. Consideration to be given to a new town site and general housing and living facilities should the scheme of production be accepted.

We have spoken to Mr.A.R.Bruhn, legal manager of the company about the increased production of the mine and he stated that the amount of £15,245 previously sought from the Commonwealth Government would not be required in view of the recent gazetted rise in the price of tungsten. He feels confident that the Board of Directors would give every consideration to the enlarged scheme of development outlined in our recommendations.

M. A. Mawby
Member, Minerals Committee

P. B. Nye
Assistant Geological Adviser

2nd May, 1942.

Appendix

KING ISLAND SCHEELITE N.L. LABOUR STATEMENT

Men required to maintain present production -

	Labour force at 11/4/42	Normal requirements
OFFICE		
Manager	1	1
Accountant	1	1
Typist	1	1
Store Clerk	1	1
MILLING		
Mill Foreman	1	1
Metallurgist	1	1
" Assistant	-	1
Electrician	1	1
Fitter	1	1
Fitter's Assistant	1	1
Mill Carpenter	1	1
Shift Boss	3	3
Engine Driver	3	3
Greaser	3	3
Magnetic Separator Attendants	2	3
Crusher Feeder	4	6
Floor Hand	3	3
QUARRYING		
Quarry Foreman	1	1
Blacksmith	1	1
" Striker	-	1
Machine Man	5	6
Shovel Driver	2	2
Lorry Driver	5	5
Ore Shoveller	8	8
Labourer	5	10
SURFACE		
Carpenter	1	1
Changehouse Attendant	1	1
Watchman	2	2
	55	70

KING ISLAND SCHEELITE CO.

MILL FLOW SHEET

DATE:-13-4-42

Prepared by M. Mawby (Zinc Corp Ltd)