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DEVELOP
INNOVATE
EVOLVE

REPORT

NTUNGA SCOPING TESTWORK

DEVELOP
INNOVATE
EVOLVE

JOB NO:

25-2264

DESCRIPTION:

Ntunga Scoping Testwork

CLIENT:

Trinity Metals

DATE:

16/01/2025

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REPORT APPROVED BY: JAMES GAYDON
REV NO: 00

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Revision history

Revision issue	Date issue	Description
00	16/01/2025	Final

Executive Summary

GSL were contracted by Ronald Toledo from Trinity Metals to undertake initial scoping testing trials on a composite of drill cores representing a Run-Of-Mine (ROM) feed sample from the Musha-Ntunga deposit in Rwanda. The material represented material for a potential expansion of the operation focusing on the pegmatite component, which not only would offer potential tin products but also lithium. The testing was split into 5 phases:

1. Sample preparation and comminution testing
2. TOMRA ore-sorting trials
3. Gravity amenability testing
4. Flotation amenability testing
5. Further gravity amenability testing on ore sorter products

The aims of the study were to determine the following:

- Recovery indications and achievable grade of Sn through gravity separation
- Targeting a Li product with >6% Li_2O content (2.8% Li) through either gravity or flotation testing
- Determine the potential for primary ore sorting as an initial upgrading and mass rejection phase

Testing was carried out on both raw ore and ore sorted ore to determine the following conclusions:

- Head assay and AxS data resulted in a head grade of 0.73% Li, 0.07% Sn and 0.05% Ta with and even distribution through size fractions for Sn and Ta however with an increased deportment of Li in the coarser fractions.
- The mineralogy identified Cassiterite as the only Sn bearing mineral with Li associated with Spodumene (92.6%), Montebrasite (6.8%) and Tourmaline (0.7%). In terms of liberation Spodumene was liberated 50-70% at all fractions with Cassiterite locked above 300µm based on free parameter.
- Gravity separation trials on raw feed suggested that at a primary grind size of P_{80} 250µm a concentrate of 45%+ Sn and 2.5%+ Ta could be achieved at 65% and 30% recovery respectively.
- Mesh of grind flotation trials showed the initial flotation approach did not result in selectivity of Li bearing minerals at any size tested with low grades and recoveries achieved. Optimised conditions were suggested and agreed with client for the next phase.
- Flotation testing with the addition of NaOH washing, improved deslime and varied collectors did not yield increased selectivity of the Li bearing minerals through flotation, selectivity highlighted by a reduction in both Li grade and recovery through open circuit cleaning tests.
- Ore sorter separation when reconstituted with the residual -10mm material resulted in 29.5% mass rejection with 24.0% Li loss, 5.6% Sn loss and 9.0% Ta loss.
- Gravity testing on XRT product resulted in a 62.1% Sn recovery to 58% grade showing comparable performance to raw ore.
- Gravity testing on optical product resulted in highest Li grades with 1% Li grade achieved at recovery of 65.1%.
- Magnetic separation trials suggested that the Li bearing minerals were not magnetically amenable.

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Introduction

GSL were contracted by Ronald Toledo from Trinity Metals to undertake initial scoping testing trials on a composite of drill cores representing a ROM feed sample for the Musha-Ntunga deposit in Rwanda. The material represented material for a potential expansion to the operation focusing on the pegmatite component which not only would offer potential tin products but also lithium. The testing programme shown in Figure 1 was split into 5 phases:

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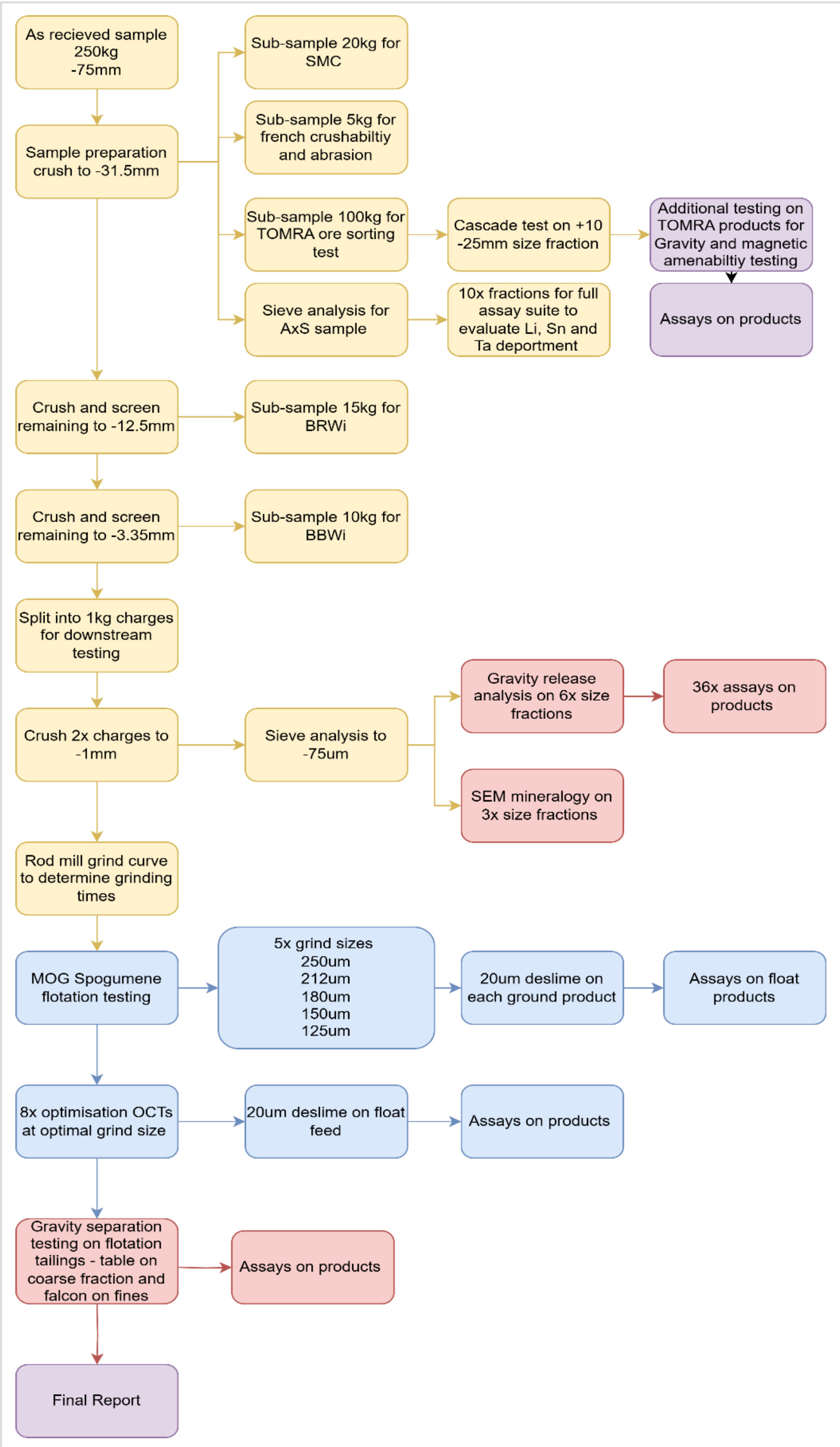

Figure 1 - Testing flowsheet

Methodology

Sample Preparation

The process undertaken for sample preparation was as follows:

- As received logged in with scaled images taken of each received sample
- Primary light crush over quarter core through jaw crusher
- Screen and jaw crush all material passing 31.5mm
- Screen -31.5mm at 10mm
- Sub-sample material from +10mm -31.5mm
    - 20kg for SMC test
    - 100kg for TOMRA ore sorting
    - 5kg for French crushability and abrasion
- Reconstitute -31.5mm +10mm material with -10mm to create a representative composite of feed material
- Cone crush and screen to -12.5mm rotary splitting 15kg for Bond Rod Work Index (BRWi)
- Cone crush and screen to -3.35mm rotary splitting 10kg for Bond Ball Work Index (BBWi)
- Split remaining sample into 1kg charges for rod mill grind calibration
- Cone and rolls crush 2x 1kg charges to -1mm screening into fractions for assay by size (AxS), mineralogy and gravity release analysis (GRA) analysis

Assay Suite

All assays carried out within the testing were undertaken by ALS Geochemistry. 2 suites were used (ME-ICP82b, ME-XRF15c) to cover the target elements, Sn, Fe, Nb, Ta, SiO_2 and Li. Figure 2 shows the assay limits and resolution.

Method Code	Analyte	Unit	Lower Limit	Upper Limit
Li-OG63	Li	%	0.005	10.0
OA-GRA05x	LOI 1000	%	0.01	100

ME-ICP82b Analytes and Reporting Ranges							
Analyte	Units	Lower Limit	Upper Limit	Analyte	Units	Lower Limit	Upper Limit
Li	%	0.001	10				

ME-XRF15c Analytes and Reporting Ranges											
Analyte	Units	Lower Limit	Upper Limit	Analyte	Units	Lower Limit	Upper Limit	Analyte	Units	Lower Limit	Upper Limit
Fe	%	0.01	75	Nb	%	0.01	35	SiO2	%	0.01	100
Sn	%	0.01	79	Ta	%	0.01	41				

Figure 2 - ALS assay suites and analysis limits

Mineralogy

A sample was submitted to Petrolab (Redruth, UK) for detailed mineralogical investigation to characterise the bulk mineral deportment of the samples and particle liberation. The three samples were submitted and analysed as three size fractions: +300µm – 1000µm, +75µm -300µm, -75µm. Results for the parent samples were back calculated based on the proportional mass split across the fractions.

A polished block was prepared from each of the submitted sample/ fractions and carbon coated to a thickness of 10 nm. Each block was analysed using a ZEISS EVO MA 25 scanning electron microscope (SEM) fitted with one Bruker xFlash 6|60 x-ray detectors for energy-dispersive Xray spectroscopy (EDX) analysis. The Mineralogic Mining 1.6 software controlled the SEM and acquired morphology and X-ray data. A phase classification scheme was developed using the Mineralogic Mining software.

Ore Sorting Trials

Ore sorting amenability testing was conducted by TOMRA, Germany. Following a review of XRT images of the feed, it was decided to use a single stage of ore sorting to separate all the particles containing inclusions of higher atomic intensity, which would likely be Sn-Ta mineralization. The fraction without inclusions was reprocessed through the optical sorter with the aim of separating Li-bearing material from waste.

For the trial TOMRA's COM Tertiary XRT was used. An image of the feed material was taken at first. For the image capturing, a sample is exposed to high energy X-rays, and the resulting image is captured by the sensor. The X-ray sensor signal depends mainly on atomic density, but also on the thickness and density of the measured particle, and relays information about the internal composition of the particles which attenuates the initial X-ray radiation.

TOMRA´s image-processing software is then used to develop application-tailored sorting algorithms. Hereby, changes in the intensity of the X-rays passing through the samples are classified as either high atomic density or low atomic density. Note that, because the sorter is tailored to the material being tested, the terms high atomic density and low atomic density are used in a relative context. The different selected colour classes (coloured pixels) are then assessed as a percentage of the single rock area. This percentage is used as the parameter to determine and set the sorting cut.

There are two different image processing methods for the raw XRT images (Dual and Inclusions). For this application both methods have been used in combination and a special Multi Density Class Model was applied. Additionally, the option of sorting using colour technology was tested on the waste to evaluate the viability of separating lithium-containing material (spodumene) from pegmatite.

Comminution Tests

SMC

The SMC test is a simplified version of the JK Drop Weight test which provides the same basic ore comminution parameters but is used in situations where sample material is limited either in terms of size or quantity.

Testing was undertaken using 100 pieces of crushed rock which had been prepared as per the standard SMC test procedure.

The 100 particles were divided into five equal sets of 20 particles and then subjected to testing using the standard SMC test methodology which generates a correlation between energy input (kWh/t) and the percent of broken product passing a specified screen size.

The results of these tests are then used to determine the JK Drop Weight Index (DWI), which is a measure of the strength of the rock when broken under impact conditions and has the units of kWh/m^3.

French Crushability and Abrasion

The French Crushability and Abrasiveness test gives an abrasivity index and a crushability index that will rate the material in comparison with other materials. The French abrasion test is mainly used to estimate hammer wear life in impactor applications. However, the data has been shown to correlate well to the Bond CWi and Ai data and so can also be used during the sizing of crushers and to estimate mill media and liner wear rates. The crushability index is a measure of how easily the material breaks down. The test also includes the specific gravity or solid density of the material.

Bond Rod Work Index (BRWi)

Bond Rod Mill Work Index testing was undertaken to determining the energy required to grind each sample from a feed size distribution of 100% passing 12.5mm (F100) to a product size distribution of 100% passing 1.18mm (P100) using a standard laboratory Bond rod mill.

Bond Ball Work Index (BBWi)

Bond Ball Mill Work Index testing was undertaken to determining the energy required to grind each sample from a feed size distribution of 100% passing 3.35mm (F100) to a product size distribution of 100% passing 300 µm (P100) using a standard laboratory Bond ball mill.

Laboratory Rod Mill Grind Calibration

A grind calibration was performed on each of the received samples using material pre-crushed through 3.35mm.

The test involved milling 1 kg in a laboratory rod mill at 60 % w/w solids for increasing time periods and sieving the mill products to provide a size distribution of the material. The mill passing P_{80} was then plotted against the grind time to provide the grind curve.

The grind curve was referenced to provide grind times for the specific test particle P_{80} targets during the program.

Gravity Testing

Falcon Enhanced Gravity Separation

A Sepro Falcon LP40 was utilised for trials with a centrifugal separator. To achieve the targeted mass pull to concentrate two different tests were carried out. Test 1 used a 1kg three pass test targeting 3 concentrates equating to 6-10% mass pull on each pass and Test 2 used a 6kg three pass test targeting 3 concentrates equating to 1.25-1.5% mass pull each pass. For each test the following base parameters were adhered to:

- Feed size P_{80} 250µm

- 25% w/w feed solids
- 27 kg/h feed flowrate
- Fluidisation water 7.5Lpm
- 100 G-Force

All products were collected, filtered and dried and submitted for assay.

Mozley Superpanner Separation

A Mozley Superpanner was used for both Falcon cleaning stages and gravity release analysis (GRA). At each stage of operation throw, deck angle and fluidisation water were controlled based on visual indications of separation to maximise potential performance. The GRA testing was carried out at 6x size fractions.

- +600µm-1000µm
- +300µm -600µm
- +150µm -300µm
- +106µm -150µm
- +75µm -106µm
- -75µm

Falcon concentrate cleaning tests were undertaken with same methodology as GRA testing on a single sample. Products collected, filtered and dried and submitted for assay.

Holman Wilfley 800 Separation

Table separation trials were conducted using a Holman Wilfley 800 shaking table to provide a larger sample mass for better resolution and product availability for assay. The test generates 4 products and 1 tailings sample for analysis. The feed conditions for the testing were as follows:

- 3000g feed sample mass
- Feed size P_{80} 250µm
- 35 kg/h feed flowrate
- Deck angle and fluidisation water to visual optimal setpoints.

Products collected, filtered and dried and submitted for assay.

Magnetic Separation

A dry magnetic profile carried on an Eriez induced magnetic roll (IMR) separator. Material was passed across the roll repeatedly at each setpoint until no further mass was recovered to the magnetic fraction. The magnetic strengths used were:

- 3000G
- 5000G
- 8000G
- 10000G (1T)
- 12000G (1.2T)
- 15000G (1.5T

- 180000G (1.8T)

Products combined where necessary to ensure sufficient mass for chemical analysis.

Flotation

Flotation tests were carried out on a Denver D12 with chemistry monitoring throughout evaluating pulp chemistry for pH, mV, DO and temperature. Flotation tests were all conducted kinetically with split products taken of either rougher concentrates or final cleaner concentrates to provide better resolution of grade vs recovery profile across separation stages. 2 stages of flotation were carried out, the first investigating mesh of grind (MOG) and the second, optimisation tests. Two different sample preparation methods were followed:

MOG Sample Preparation:

- Using calculated grind time from grind calibration mill 2x 1kg samples to target P_{80}
- Wet screen milled product at 20µm for deslime stage
- Filter, dry and assay -20µm fraction for mass balance
- Riffle split 1kg charge for flotation test

Optimisation Sample Preparation

- Using calculated grinding time from grind calibration mill samples to target P_{80}. If required, reagents were added to mill.
- Carry out 2x displacement wash on the material to remove reagent
- Undertake a 20µm decantation using Stokes law
- Pour off supernatant through 45µm screen, recovering any lost coarse material
- Use settled material for flotation tests.

The following methodology was followed for rougher and cleaner flotation:

Rougher Flotation (Ro)

- Rougher tests carried out in 2.5L cell size
- pH, DO, mV and temperature recorded throughout test
- Split concentrates taken to determine kinetic change through test
- Filter and dry generated products
- Products submitted for assay

Cleaner Flotation (Open Circuit Testing, OCT)

- 1 kg deslimed feed charge
- pH, DO, mV and temperature recorded throughout test
- Rougher floats based on rougher optimisation tests
- Filter and dry generated products
- Products submitted for assay
- On completion, all collected samples sent for wet chemistry assay using ALS Suite 2 or 3 depending on expected Li grade

Results

The report provides a summary of the results achieved through the testing. Data sets have already been provided to the client.

Sample Receipt

5 bags of 50kg each were received for the testing, consisting of quarter core nominally 170-200mm in length. Sample were logged in with scaled images taken and samples confirmed with client before continuing with the testing. Table 1 and Figure 3 show the received material.

Table 1 - As received samples

JOB NUMBER	SAMPLE SERIAL	DESCRIPTION	NAME	Mass (kg)
25-2264	1000	As Received	Bag #1	50
25-2264	1001	As Received	Bag #2	50
25-2264	1002	As Received	Bag #3	50
25-2264	1003	As Received	Bag #4	50
25-2264	1004	As Received	Bag #5	50

Figure 3 - Scaled images of received quarter core

Feed Characterisation

Head Assay and Assay by Size (AxS)

Table 2 shows the head assay for the sample. Sn grade is 0.07% with Ta at 0.05%, the Li grade is 0.73% equating to 1.57% Li_2O.As would be expected the main gangue material is SiO2 at 70.9%. It should be notedthe Fe levels as a potential inhibitor to spodumene flotation is at 0.53%.

Table 2 - Sample head assay

Head Assay						
Li %	Li2O %	Fe %	Nb %	SiO2 %	Sn %	Ta %
0.73	1.57	0.53	0.01	70.90	0.07	0.05

10 size fractions were submitted for AxS analysis carried out on 100% passing 1mm material:

- +850µm
- +600 -850µm
- +425 – 600µm
- +300 – 425µm
- +212 – 300µm
- +150 – 212µm
- +106 – 150µm
- +90 – 106µm
- +75µm
- -75µm

It can be seen in Figure 4 that in terms of Sn and Ta the elemental deportment is equivalent to the mass with consistent grade at each of the size fractions. The Li grade can be seen to be higher in the coarser fractions with 1.1% Li in the +850µm fraction and 0.41% Li in the -75µm but due to the mass yields the deportment, as with the Sn and Ta is generally linear.

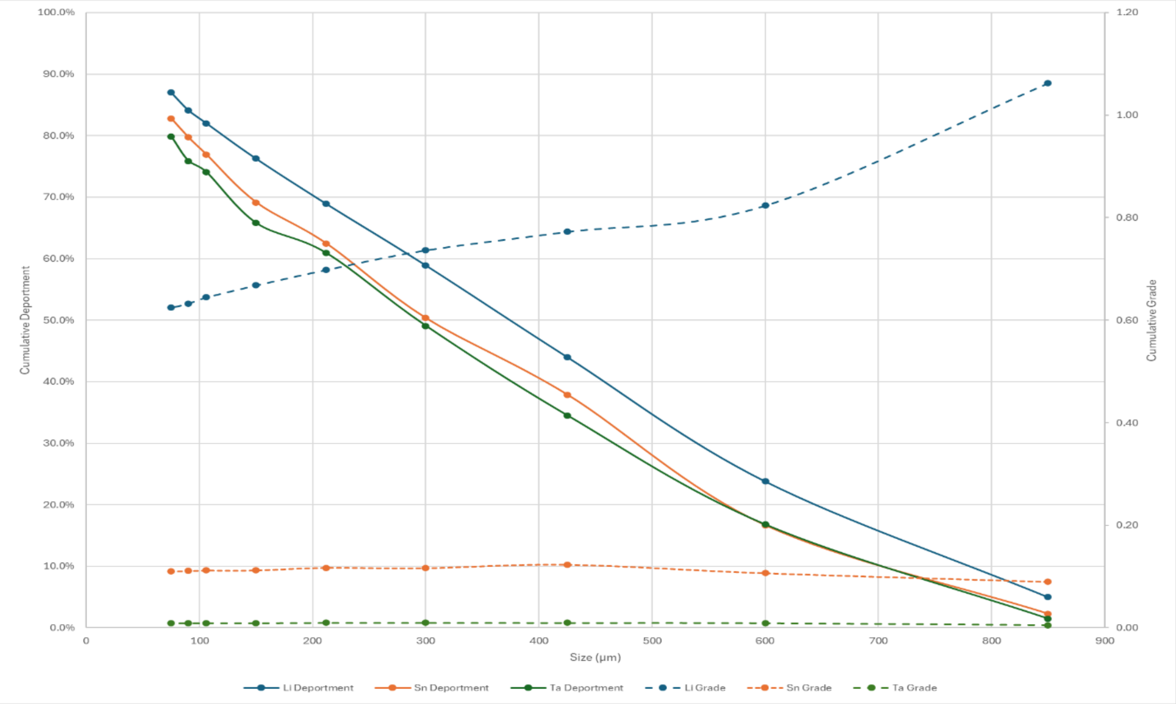

Figure 4 - Cumulative deportment and cumulative grade vs size

Mineralogy

Bulk Modal Deportment

The full mineralogical report provided by Petrolab has been supplied to the client with the below summary covering aspects that aided processing decisions.

Figure 5 shows the mineralogical deportment for the 3 tested size fractions and a reconstituted feed based on the mass splits. The Li bearing minerals highlighted were Spodumene and Montebrasite i.e. a lithium aluminosilicate and a lithium phosphate. The Sn bearing mineral was exclusively identified as cassiterite with Ta specific minerals not identified or detected with ion probe.

With regards to the Sn mineralisation there is a contradiction to the AxS with notably higher reported cassiterite in the +300µm and +75µm fractions compared to the -75µm fractions whereas the AxS showed linear grading of Sn across all size fractions. Further to this with 0.3% cassiterite identified, at an assumed 78% Sn grade, the expected head grade mineralogically is a lot higher than both the head assay and AxS.

The Li bearing minerals aligned with aspects of the AxS showing a preferential deportment to the coarser fractions with combined Montebrasite and Spodumene deportment of 14.3% in the +300µm fraction, 16.9% in the +75µm fraction and 8.9% in the -75µm fraction. With the higher grade of Li in Montebrasite (4.8% to 3.7% in Spodumene) it would therefore be expected that highest Li grades seen would be in the -300 +75µm fractions. However, as with Sn, there is a disconnect in AxS to mineralogical deportment.

It should also be noted that the Muscovite mica is at 9.5% deportment within the reconstituted feed and it is likely to be recovered with Spodumene in flotation unless a mica removal flotation stage is undertaken prior to Spodumene flotation to achieve a target grade of Li.

With the differences observed between the analyses, it is recommended that for future programmes more detailed mineralogical investigations and assays in triplicate be carried out to minimise chance of low correlation.

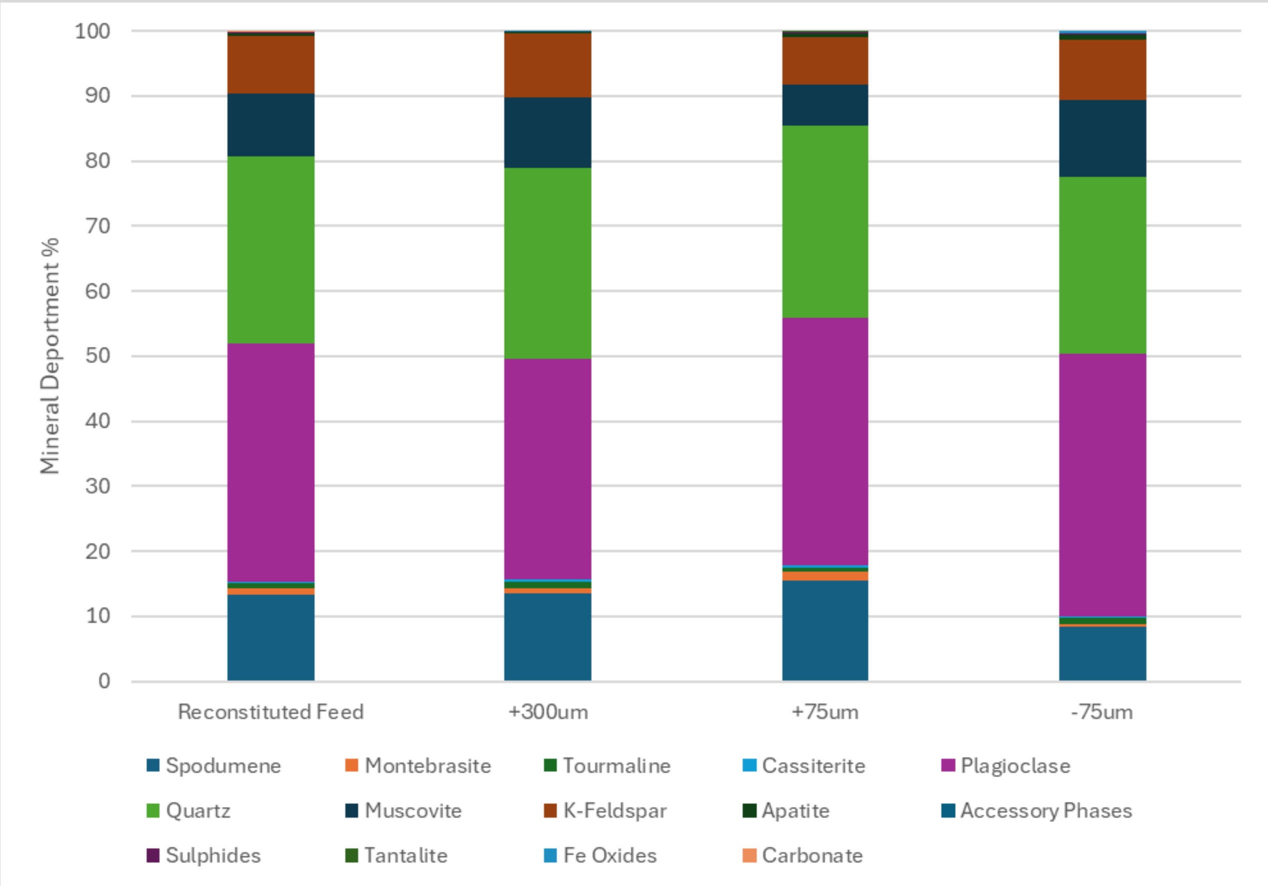

Figure 5 - Mineralogical deportment

Elemental Deportment

Table 3 shows the assay deportment as determined by ion probe for Sn and Li. The Sn can be seen to be 100% associated with cassiterite. The Li for feed is 6.8% associated with Montebrasite and 92.6% with Spodumene. Correlating with the deportment then highest percentage of Li associated with Montebrasite is in the +75 -300µm size fraction.

Table 3 - Li and Sn assay deportment

Mineral	Reconstructed Feed	+300um	+75um	-75um
Li Bearing	Li	Li	Li	Li
Spodumene	92.6%	95.8%	88.8%	93.3%
Montebrasite	6.8%	3.4%	10.8%	5.7%
Tourmaline	0.7%	0.8%	0.4%	1.0%
Sn Bearing	Sn	Sn	Sn	Sn
Cassiterite	100.0%	100.0%	100.0%	100.0%

Liberation

Figure 6 shows the liberation with regards to free perimeter for Li bearing minerals at each size fraction. With regards to spodumene, as the main Li bearing mineral, based on deportment at +75 -300µm and -75µm liberation is equivalent with 68% free or liberated at +75 -300µm and 72% free or liberated at -75µm. The +300µm fraction resulted in 53% free or liberated suggesting a primary grind size of 300µm or lower would maximise upgrading to the required target.

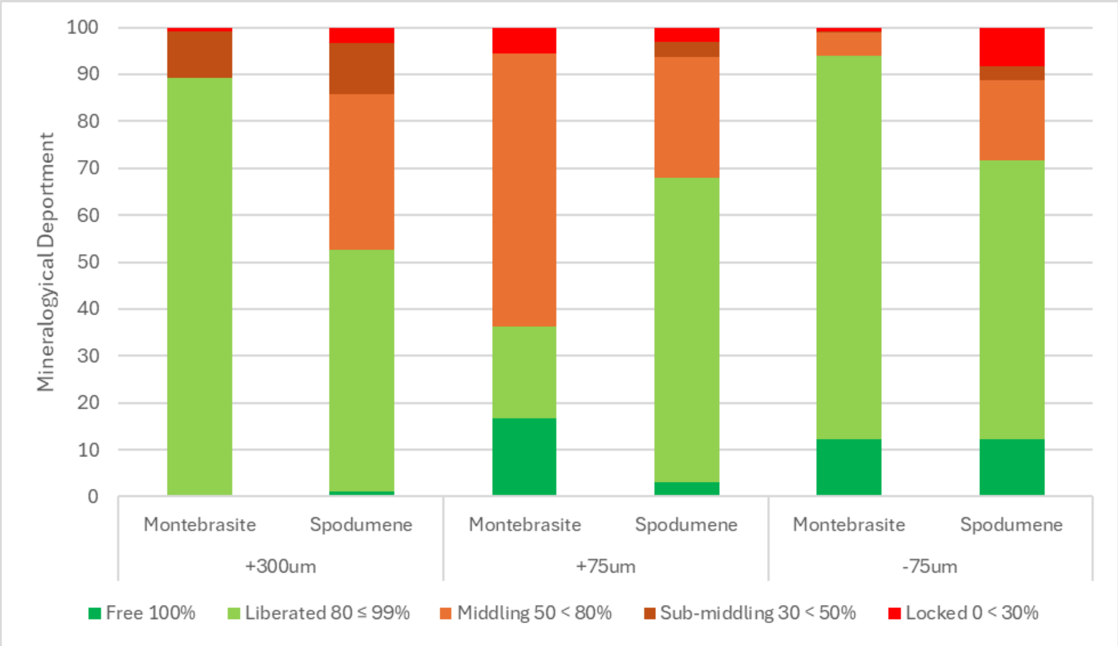

Figure 6 - Li bearing mineral liberation

The cassiterite liberation based on free perimeter (Figure 7) also suggests a grind size of sub 300µm primary grind with 100% of the +300µm either sub-middling or locked. This improves to 94% liberated at +75 -300µm with the finest fraction reporting 77.3% free.

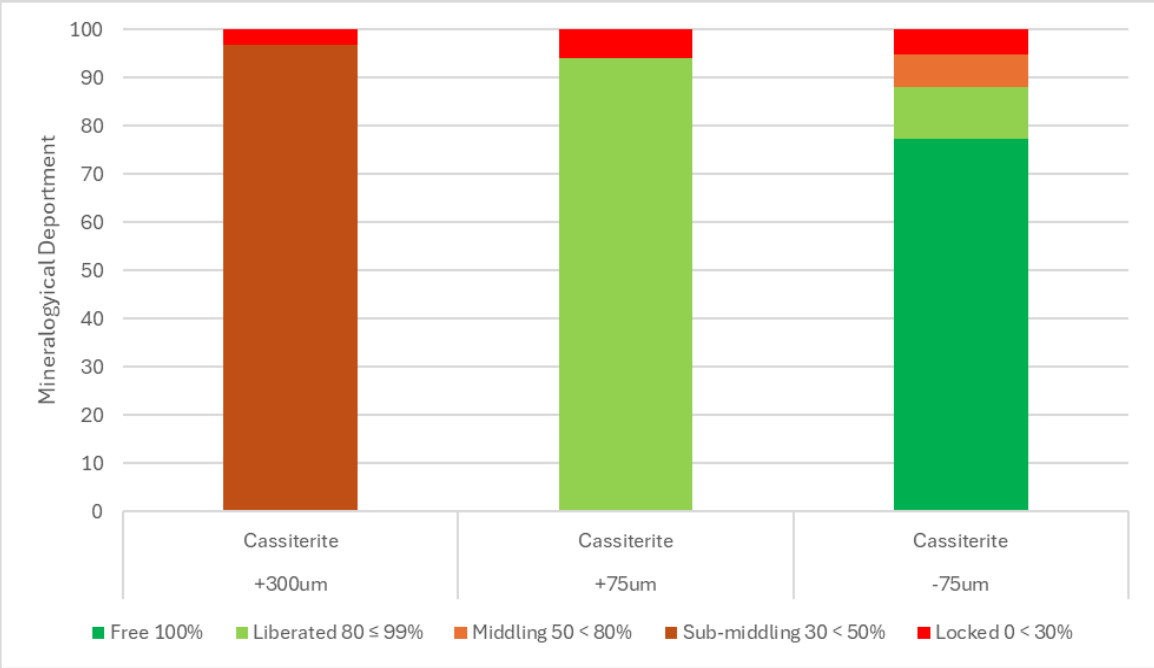

Figure 7 - Sn bearing mineral liberation

As received Ore Amenability Testing

The main testwork programme was carried out on as received ore sample, i.e. had not been through any pre-concentration phases. The testing was split into 3 sections:

- Comminution
- Gravity
- Flotation

Comminution Testing

Table 4 summarises the comminution results of the as-received ore sample. The material can be seen to require high energy for both crushing and milling with very difficult crush work index and high kWh/t requirements for all milling stages. Comminution testing on samples post ore sorting should be carried out as a decrease would be expected with the rejection of SiO_2.

Table 4 - Comminution data summary

Test	Result	Units	
BRWi	17.1	kWh/t	
BBWi	13.19	kWh/t	
SMC	5.35	DWi	kWh/m3
	33		%
	15.8	Mia	kWh/t
	11.2	MiH	kWh/t
	5.8	Mic	kWh/t
	51.67	Axb	
	8.92	SCSE	kWh/t
French Crush and Abrasion	51%	Very Difficuilt (CR)	
	1180	Medium Abrasive	

Gravity Release Analysis

GRA was carried out on a 7 discrete size fractions from -75µm to -1000 +600µm of the prepared as-received sample. The GRA is an un-optimised initial evaluation of the material to understand particle liberation and indicate potential grade and recovery.

Figure 8 shows the grade vs recovery for each of the 7 size fractions with regards to Sn. All tests, except for +150µm resulted in a 45-80x upgrade ratio for concentrate 1. The 150µm test showed a higher mass pull to concentrate 1 of 9.6% compared to 0.8-2% for the other tests. With the increased mass pull in the 150 µm, the fraction achieved comparative recovery to other tested fractions but the same level of upgrading was not seen.

The results achieved in the GRA do not correspond with the degree of liberation observed in the mineralogical analysis with regards to Sn. The -1000 +600µm fraction resulted in 84.1% recovery to a 1.8% Sn product with -150 +75µm achieving 90.9% recovery to a 0.9% Sn product. This would suggest that a separation at a coarser size with spirals would be preferable for the material followed cleaning with shaking tables (with a potential regrind if higher grades are required).

The -75µm highlights the potential losses of fines in the gravity circuit with 64.9% recovery to a 1.4% product showing much higher losses to tailings.

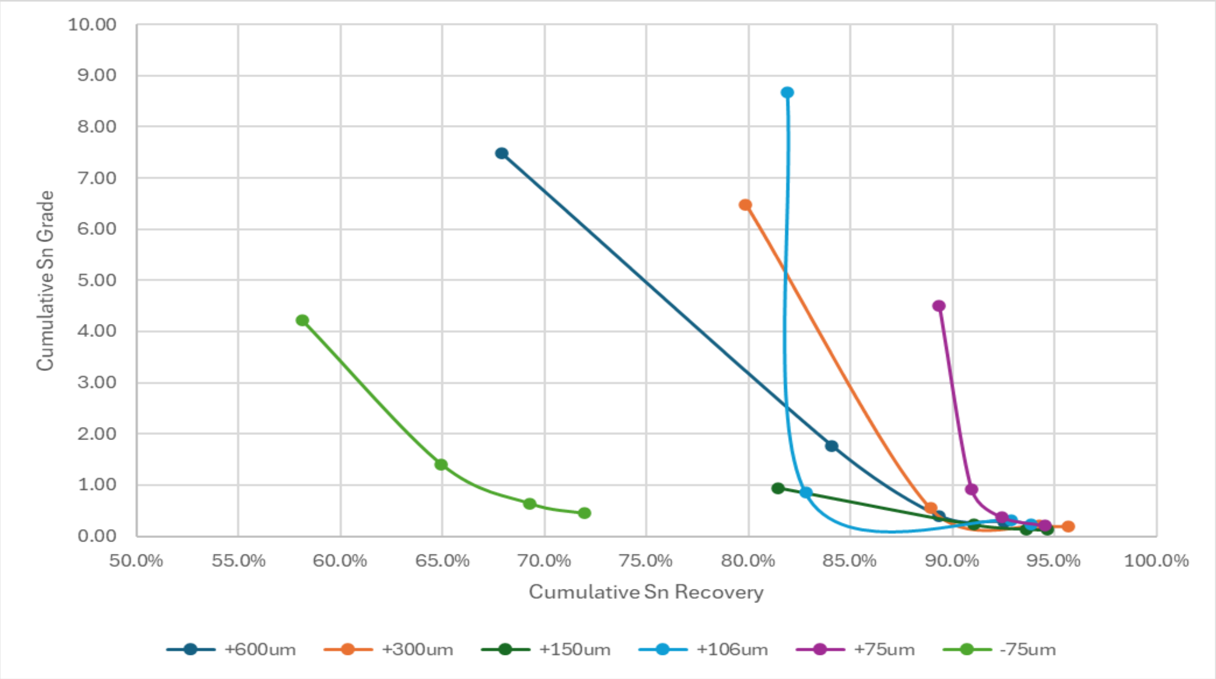

Figure 8 - GRA Sn performance at each size fraction

The Ta performance (Figure 9) showed similar trends to the Sn with regards to upgrading ratios at the different size fractions, however, the overall recovery is reduced with the best performance achieved at +75 -106µm with a 0.4% Ta grade with 35.5% recovery. What was seen is better gravity performance compared to the coarser fractions for the fines with the -75µm fraction achieving 0.5% Ta to a 34.2% recovery.

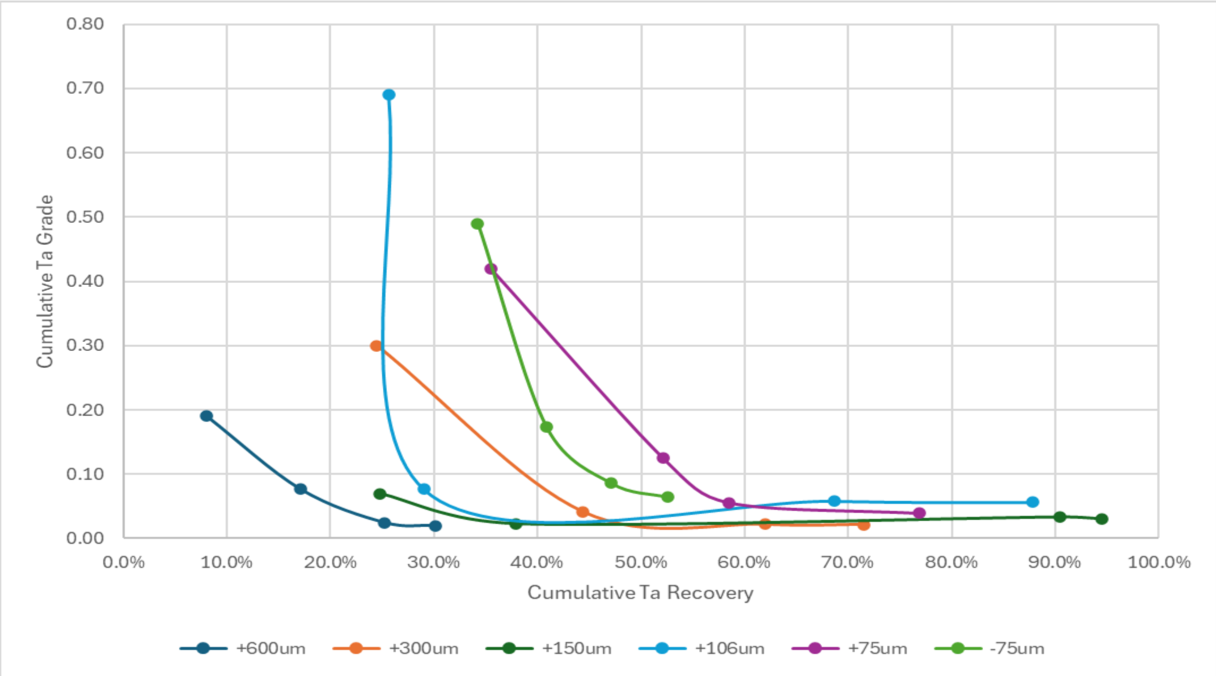

Figure 9 - GRA Ta performance at each size fraction

Flotation tailings gravity separation trials

Testing for 2 stage gravity separation was carried out on flotation tailings as per the flowsheet (Figure 1), however, based on the head grade to the testing it can be assumed that equivalent performance would be achieved from raw feed although further testing would be required to confirm this. As flotation tailings were used the F_{80} for testing was 250µm.

Figure 10 shows the grade vs recovery for Sn and Ta across the two separation methods with split concentrates on the table cleaning stage. Primary separation phase in a Falcon LP40 resulted in a 7% mass pull to concentrate from a 1kg feed charge mass. Stage recovery of Sn to Falcon concentrate of 76.2% to a grade of 1.23% with an 11x upgrading. The Ta recovery was lower at 37.9% with 6x upgrading to 0.08%.

The Table cleaning stage saw small reductions in recovery with Sn recovery reducing to 64.8% with a further upgrading to 46.7% Sn at 0.2% mass yield. The Ta saw good upgrading too with a 2.77% grade achieved at 29.2% overall recovery. The table cleaning stage therefore applied a further upgrading of 38x and 34x for Sn and Ta respectfully from the Falcon primary concentrate.

It would be recommended to undertake further evaluation of the Falcon tailings to understand the losses by AxS as well evaluating whether regrinds aid the grade of the Sn, Ta concentrate to a higher saleable concentrate.

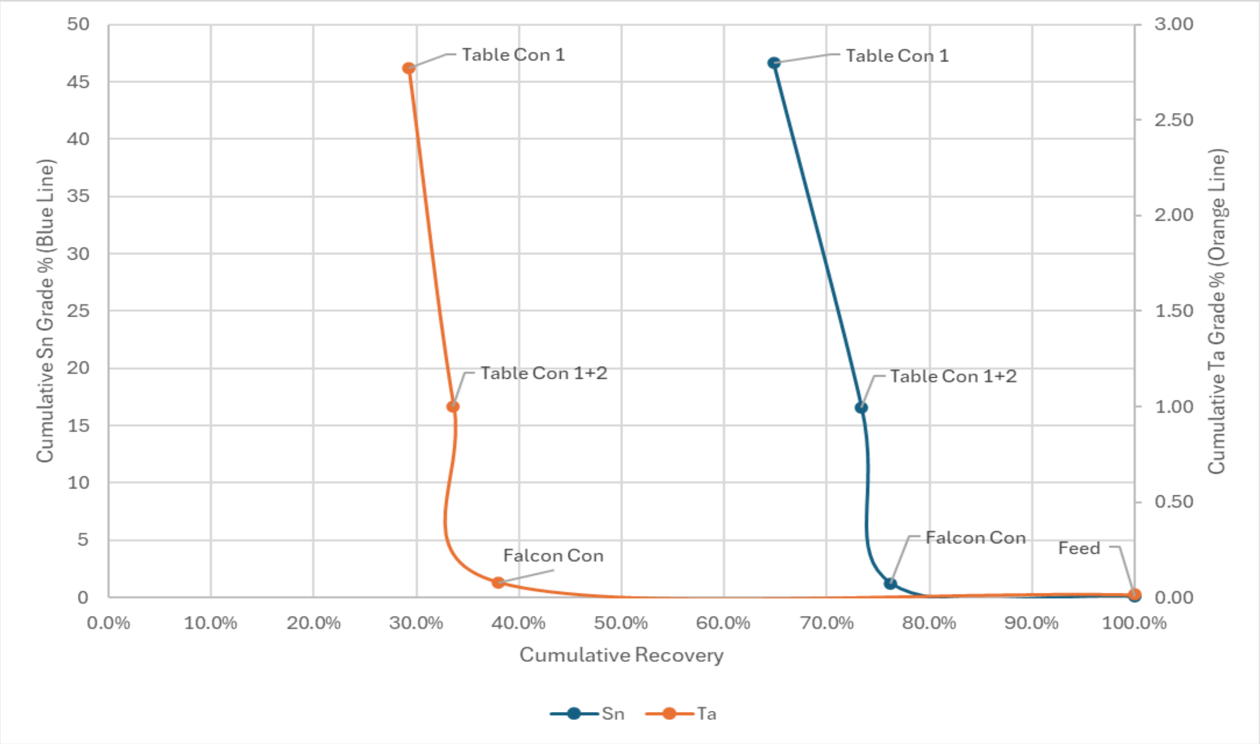

Figure 10 – 2 stage gravity separation trials (Sn primary Y axis, Ta secondary Y axis)

Flotation

Mesh of Grind (MOG) Flotation Trials

For the MOG flotation trials an initial base flotation reagent scheme was used with the aim to show comparative performance at decreasing primary grind size for particle liberation indication. The full flotation conditions including pulp chemistry are listed in the data file, however, the base conditions followed were:

- High solids conditioning (50% solids w/w) prior to flotation for 5 minutes with addition of 150 g/t Na_2SiO_3 to aid dispersion and depression of silicates
- Flotation undertaken at 33% solids w/w
- 4 split concentrates with total of 8.5 minutes residence time
- 3 collector addition points into high shear conditioning and 2 further conditioning stages.
- 300 g/t Sodium Oleate collector addition, added as 250g/t conditioner 1, 50g/t conditioner 2 and 50 g/t conditioner 3

Prior to flotation the feed was ground to the required P_{80} grind size and the ground product screened at 20µm. Table 5 shows the resultant mass and Li loss through the screened deslime stage. The losses increase, as expected, with reducing P_{80} particle size however it can be seen that the Li loss is lower than the mass loss showing deportment of Li within the -20µm fraction is lower than in the coarser fractions.

Table 5 - MOG deslime losses

Grind size (µm)	-20µm Mass Loss	-20µm Li Loss
250	10.3%	7.6%
212	11.9%	9.2%
180	12.8%	10.5%
150	15.9%	12.7%
125	18.3%	14.6%

Figure 11 shows the grade vs recovery the 5 MOG tests undertaken. With an average flotation head grade of 0.65% Li it can be seen that all grind sizes with the baseline reagent scheme showed no noticeable selectively of Li bearing minerals. The highest mass pull achieved was at P_{80} 125µm however the mass pull and Li recovery were equivalent at 14% therefore no selectivity achieved.

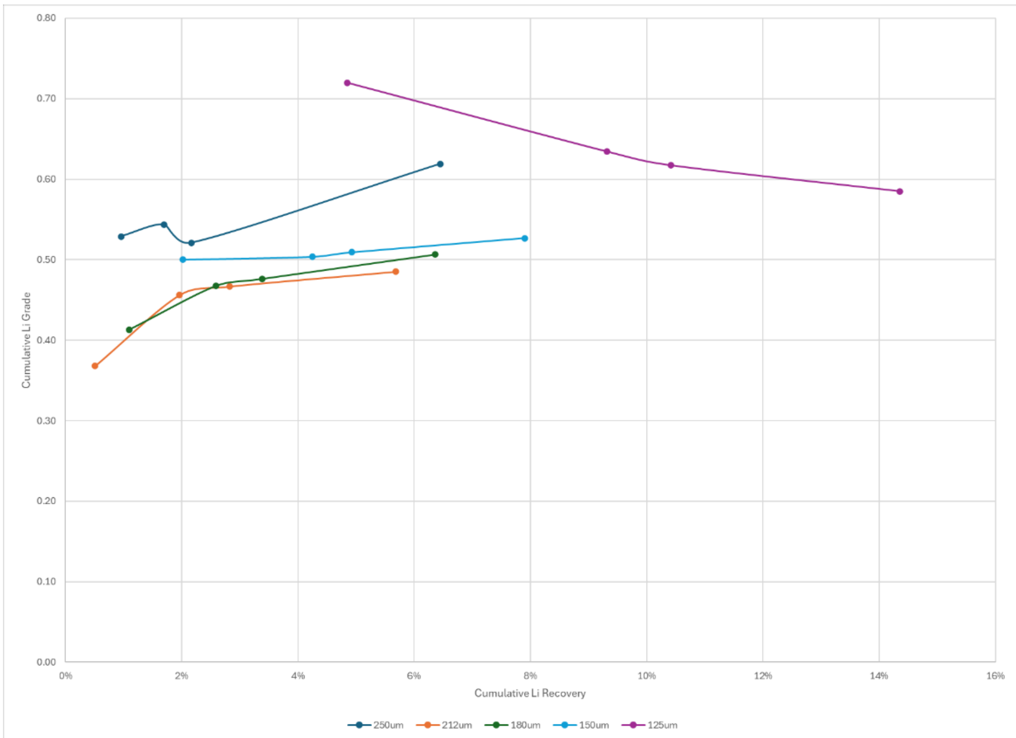

Figure 11 - MOG grade vs recovery

Optimisation Flotation

Following the results of the MOG testing it was agreed with the client to undertake NaOH washing of the material during the milling process with an aim to remove any potential Fe staining that may be present on the Spodumene surface that could potentially limit the effectiveness of separation by flotation. In addition to the washing stage, a refined deslime method to reduce mass/Li loss was suggested utilising decantation with the resultant deslime material subjected to flotation with a number of collectors.

8 rougher tests were carried out with 2 open circuit tests (OCTs) with 3 stages of cleaning on the rougher concentrate. As assays were submitted after flotation was completed decisions on conditions for OCT

testing were based on mass yield and visual indications of performance. Table 6 lists the conditions for the 8 rougher tests and 2 OCTs carried out. Products and tailings from all OCTs and Ro FT6 to FT12 were submitted for assay but based on FT13 visual performance and mass yield it was decided that the products would not be submitted for assay.

Table 6 - Optimisation flotation conditions

Test	NaOH Wash (g/t)	Deslime	Collector Rougher		Cleaner Stages
			Name	g/t	
Ro FT6	500	Decant 20µm	Sodium Oleate	600	n/a
Ro FT7	1000	Decant 20µm	Sodium Oleate	600	n/a
Ro FT8	1500	Decant 20µm	Sodium Oleate	600	n/a
Ro FT9	1000	No Deslime	Sodium Oleate	600	n/a
Ro FT10	1000	Decant 20µm	Armeen C	600	n/a
Ro FT11	1000	Decant 20µm	Armeen T	600	n/a
Ro FT12	1000	Decant 20µm	Flotigam 7100	600	n/a
Ro FT13	1000	Decant 20µm	Flotigam 5944	600	n/a
OCT FT1	1000	Decant 20µm	Armeen C	600	3
OCT FT2	1000	Decant 20µm	Sodium Oleate	600	3

Figure 12 shows the grade vs recovery for Ro FT6 to Ro FT12 with regards to Li. With an average head grade of 0.6% Li with the more refined approach, no selectivity was achieved for Li bearing minerals in any of the flotation tests. The highest recoveries were seen for Ro FT12 with Flotigam 7100 and Ro FT10 with Armeen C however the increased recovery was proportional to a higher mass pull which would be expected to be related to the nature of amine-based collectors.

As the OCT conditions were based on mass pull the two tests taken forward for further evaluation were Ro FT12 with reduced kinetics to achieve a mass pull of 30% and Ro FT7.

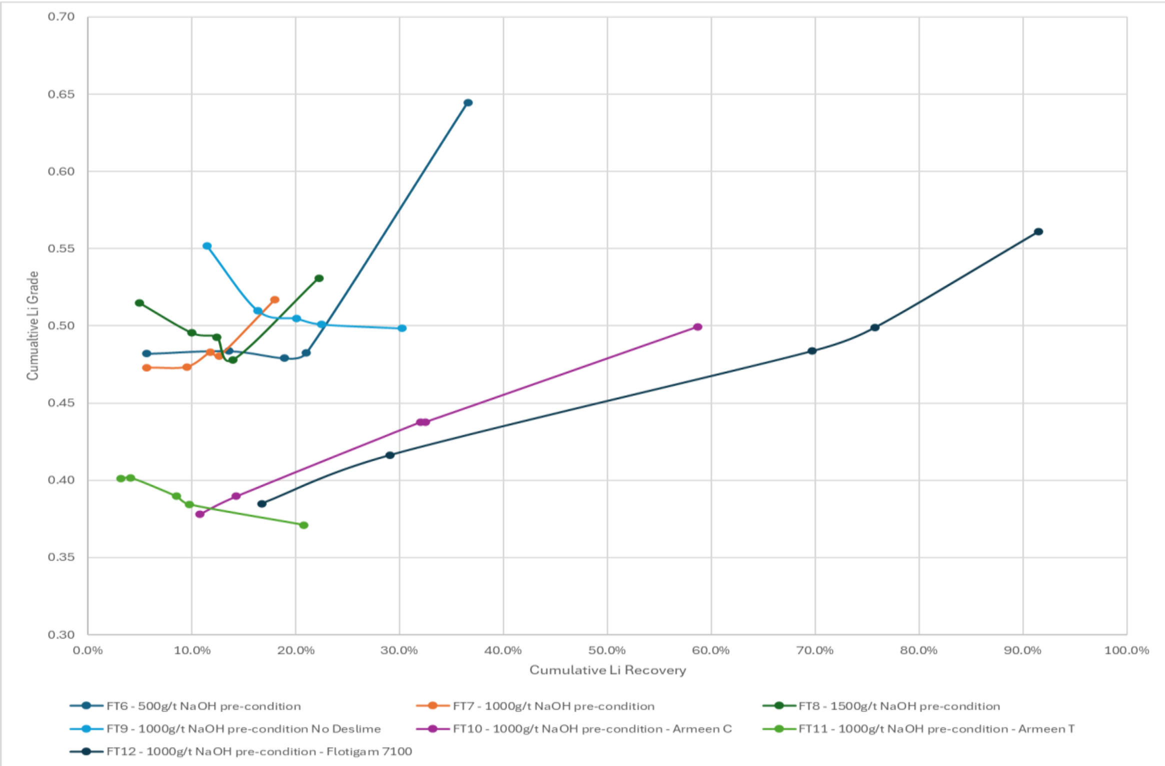

Figure 12 - Rougher grade vs recovery

The OCT results are shown in Figure 12 as with the rougher performance selectivity and upgrading was not achieved through the cleaning stages with both grade and recovery reducing at each additional stage for both collector types.

The results have shown a revised approach would be required to attempt flotation for the Li bearing minerals as initial standard reagent scheme did not yield required upgrading.

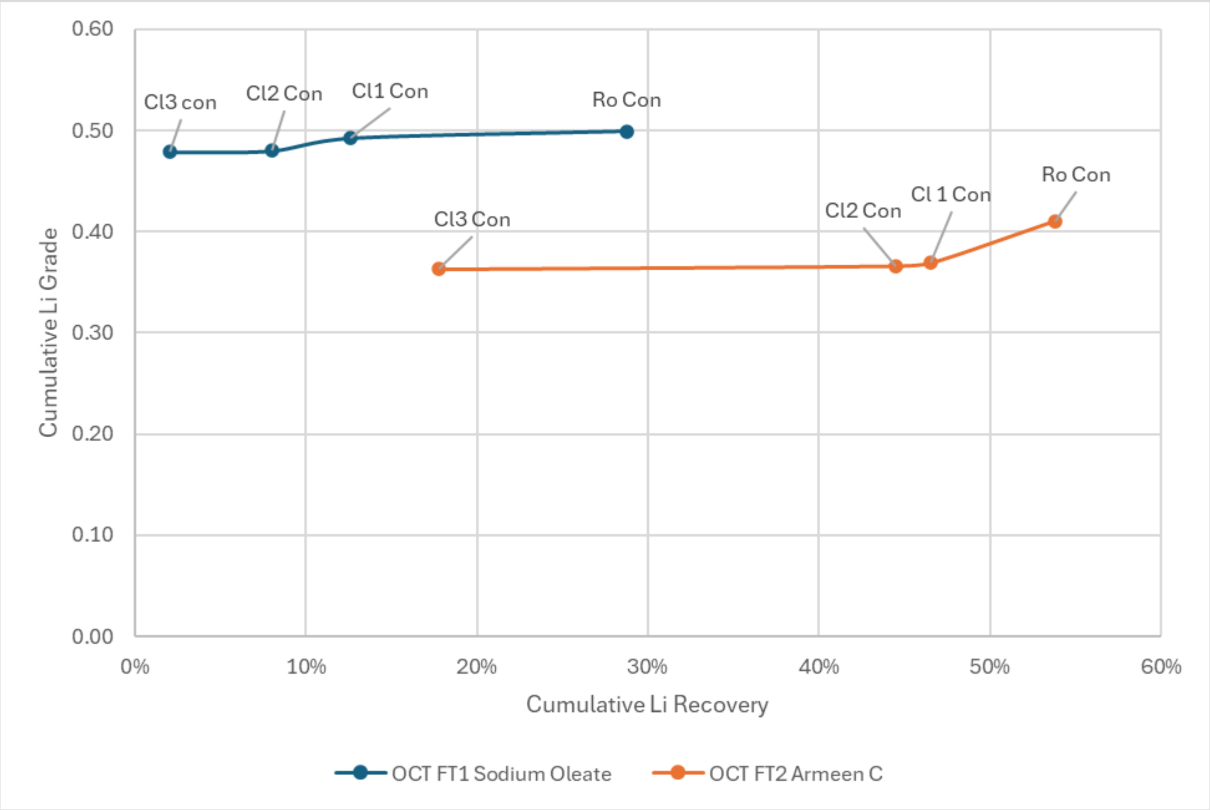

Figure 13 - OCT grade vs recovery

Ore Sorter Testing Amenability

The original scope of testing allocated testing for XRT and optical ore sorting to evaluate the potential separation that could be achieved through cascade testing. Following the initial mass and pXRF analysis results of the products discussions were held with the client where additional testing was agreed to be undertaken. For the XRT products gravity testing was carried out and for the optical sorted products gravity and magnetic separation testing was carried out.

TOMRA performance

Table 7 shows the grade and recovery for the two ore sorter products and waste for the TOMRA separation on the +10 -31.5mm size fraction. Stream based mass rejection was 46.5% with 16.6% mas yield to XRT and a further 37.0% mass yield to optical sorted products.

The XRT accepts recovered 83.5% of the Sn with a 5x upgrading to 0.51% Sn with a further 40.6% of Ta and 14.9% of the Li. The optical sorter accepts were less selective with 48.2% of the Li recovered at a 1.3x upgrading. Overall the two sorter streams resulted in:

- 90.8% Sn recovery at 0.17% Sn grade
- 63.1% Li recovery at 0.7% Li grade
- 69.0% Ta recovery at 0.01% Ta grade

Table 7 - TOMRA ore sorter results

Stream	Mass %)	Grade (%)				Recovery			
		Li	SiO2	Sn	Ta	Li	SiO2	Sn	Ta
XRT Accepts	16.6%	0.59	71.3	0.51	0.01	14.9%	16.1%	83.5%	40.6%
Optical sorter Accepts	37.0%	0.86	73.7	0.02	0.01	48.2%	37.1%	7.3%	37.0%
Waste	46.5%	0.52	73.9	0.02	0.00	36.9%	46.8%	9.2%	22.4%
Back Calculated Head Grade		0.66	73.4	0.10	0.01	-	-	-	-

Table 8 shows the results when reconstituted with the -10mm material. Due to the relative mass split of 36.6%, the -10mm alters the overall mass yield to products as well as the grade and recovery. The recalculated mass rejection equates to 29.5%, with Li loss reducing to 24.0%, Sn to 5.6% and Ta to 9.0%. With the Li Loss of 24.0% it would still be suggested to undertake optimisation of optical separation or evaluate whether finer fraction DMS results in more promising pre-concentration.

Table 8 - Recombined product balance

Final Product	Mass	Grade (%)				Recovery			
		Li	SiO2	Sn	Ta	Li	SiO2	Sn	Ta
XRT and -10mm	21.8%	0.60	72.4	0.30	0.01	20.5%	21.5%	63.3%	40.6%
Optical and -10mm	48.7%	0.73	73.5	0.07	0.01	55.5%	48.8%	31.1%	37.0%
Waste	29.5%	0.52	73.9	0.02	0.01	24.0%	29.7%	5.6%	9.0%
Back Calculated Head Grade		0.64	73.4	0.10	0.01				

XRT Accepts Gravity Testing

The 2-stage gravity methodology previously used was adhered to with the feed mass increased to 6kg with an aim to increase the grade of the resulting Falcon gravity concentrate. Further to this scavenger stages were conducted to give a rougher, scavenger 1 and scavenger 2 as products as well as tailings for better resolution on performance.

Figure 14 shows the grade vs recovery with regards to Sn and Ta for the gravity separation tests. The Falcon rougher and scavenger 1 were taken forward as a combined concentrate for table cleaning test where a combined 7.99% Sn grade was achieved at 67.8% recovery to a mass pull of 2.2%. Following a cleaner test on a Mozley Superpanner a final product of 58% Sn was achieved at a recovery of 62.1% to a mass pull of 0.3%. The stream-based recovery for the cleaning stage was 91.6% with a further 7.3x upgrading from the Falcon concentrate feed with controlled losses.

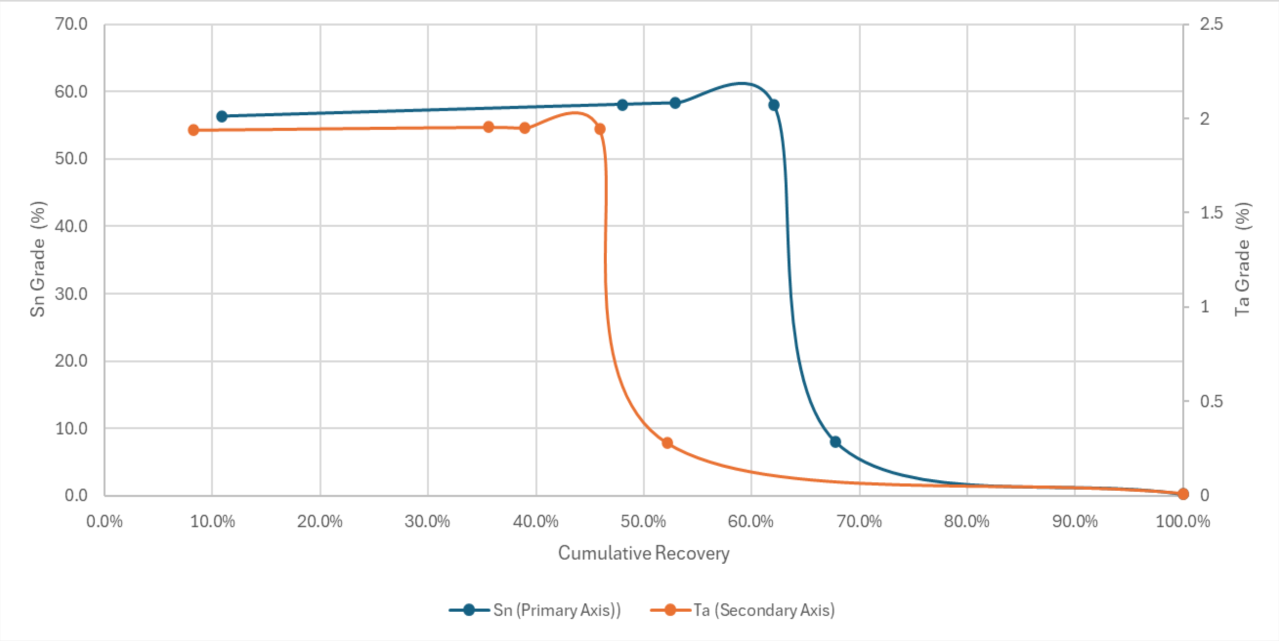

Figure 14 - Gravity grade vs recovery for XRT accepts

Optical Sorter Accepts Gravity and Magnetic Testing

The gravity separation tests, as with the GRA analysis on whole feed, provided the best recovery and grade for Li bearing minerals for separation. The data (Table 9) shows a 1% Li grade product was achieved (2.56% Li_2O) to a recovery of 65.1%.

Table 9 - HW800 gravity separation results

Stream	Mass (g)	Mass Stream (%)	Grade %				Recovery			
			Li	SiO2	Sn	Ta	Li	SiO2	Sn	Ta
Con 1	119.95	4%	1.361	72.1	0.35	0.03	7.4%	3.7%	25.7%	10.9%
Con 2	503.89	17%	1.399	76.5	0.17	0.02	31.8%	16.7%	52.4%	30.6%
Mids 1	839.9	28%	0.685	82.4	0.01	0.005	25.9%	30.0%	5.1%	12.8%
Mids 2	880.48	30%	0.527	75.6	0.01	0.01	20.9%	28.8%	5.4%	26.7%
Tails	624.8	21%	0.497	76.5	0.03	0.01	14.0%	20.7%	11.5%	19.0%
Back Calc Head Grade			0.75	77.72	0.06	0.01				

Table 10 shows an initial magnetic profile of the material conducted dry. The testing undertaken up to 1.6T (16000G) would show that the Li bearing minerals are not amenable to magnetic separation with a total mass pull of 3.3% equating to 3.7% total recovery and equivalent Li grade in magnetics and non-magnetics.

Table 10 - IMR separation results

Stream	Mass (g)	Mass Stream (%)	Grade %				Recovery			
			Li	SiO2	Sn	Ta	Li	SiO2	Sn	Ta
1.6T Mags	22.4	0.8%	1.061	64.3	0.21	0.06	1.1%	0.7%	2.6%	0.9%
1.2T Mags	32.2	1.1%	0.856	64.9	0.17	0.07	1.3%	1.0%	3.0%	1.5%
0.9T Mags	38.8	1.4%	0.753	65.7	0.13	0.11	1.4%	1.2%	2.8%	2.9%
Non-Mags	2774.9	96.7%	0.748	74.8	0.06	0.05	96.3%	97.2%	91.6%	94.6%
Back Calc Head Grade			0.75	74.48	0.06	0.05				

Conclusion and Recommendations

The aim of the testing was to undertake beneficiation testing a sample of Pegmatite from the Ntunga deposit in Rwanda. Th testing would provide an initial evaluation into whether a Sn/Ta and Li product could be produced through gravity and flotation testing. In addition to this evaluate whether ore sorting via XRT and optical could sufficiently upgrade material prior to processing.

Testing was carried out on both raw ore and ore sorted ore to determine the following conclusions:

- Head assay and AxS data resulted in a head grade of 0.73% Li, 0.07% Sn and 0.05% Ta with and even distribution through size fractions for Sn and Ta however with an increased deportment of Li in the coarser fractions.
- The mineralogy identified Cassiterite as the only Sn bearing mineral with Li associated with Spodumene (92.6%), Montebrasite (6.8%) and Tourmaline (0.7%). In terms of liberation Spodumene was liberated 50-70% at all fractions with Cassiterite locked above 300µm based on free parameter.
- Gravity separation trials on raw feed suggested that at a primary grind size of P_{80} 250µm a concentrate of 45%+ Sn and 2.5%+ Ta could be achieved at 65% and 30% recovery respectively.
- Mesh of grind flotation trials showed the initial flotation approach did not result in selectivity of Li bearing minerals at any size tested with low grades and recoveries achieved. Optimised conditions were suggested and agreed with client for the next phase.
- Flotation testing with the addition of NaOH washing, improved deslime and varied collectors did not yield increased selectivity of the Li bearing minerals through flotation, selectivity highlighted by a reduction in both Li grade and recovery through open circuit cleaning tests.
- Ore sorter separation when reconstituted with the residual -10mm material resulted in 29.5% mass rejection with 24.0% Li loss, 5.6% Sn loss and 9.0% Ta loss.
- Gravity testing on XRT product resulted in a 62.1% Sn recovery to 58% grade showing comparable performance to raw ore.
- Gravity testing on optical product resulted in highest Li grades with 1% Li grade achieved at recovery of 65.1%.
- Magnetic separation trials suggested that the Li bearing minerals were not magnetically amenable.

With the tests and results that were undertaken a gravity beneficiation process flowsheet would likely be best suited for the material with the potential for further optimised testing into flotation and ore sorting to potentially supplement the products produced.

1. ROM feed material through primary crushing and milling plant to nominally -1mm.
2. Primary gravity separation at -1mm through spiral separation.
3. Regrind of spiral concentrate to P_{80} 150-250µm.
4. Table separation and table cleaning producing Sn/Ta stream and Li stream.
5. Centrifugal gravity separation on fines recombined with cleaner streams Sn/Ta cleaner streams.
6. Either optimised flotation on Li stream or hydrometrical testing for $LiCO_3$ generation

Recommendations

On completion of the project the following recommendations would be suggested to better understand the process and final products possible.

- Utilizing performance from initial cascade test undertake further optimised ore sorter separation tests on different size fractions and changed settings with the main aim of improving the Li optical sorting stage limiting losses.
- Incorporate spiral and larger scale table separation testing to evaluate mass flowrates and potential stage upgrading for both Sn/Ta streams and Li streams
- Undertake additional flotation trials to evaluate whether a more complex chemistry approach can produce a selective float.
- Undertake sulfuric roasting trials with Li concentrate to determine extraction rates achievable to produce a final $LiCO_3$ product.

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