



LOW IRON PETALITE and SPODUMENE CONCENTRATE MARKETS

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STUDIO

INTRODUCTION

Lithium is found in very low concentration in igneous rocks. The largest concentrations of lithium-containing minerals are found in granitic pegmatites. The most important of these minerals are spodumene (Li_2O , Al_2O_3 , 4SiO_2) and petalite (Li_2O , Al_2O_3 , 8SiO_2). Spodumene has a theoretical Li_2O content of 8.03%. Due to its high lithium content, spodumene is considered the most important lithium ore mineral. A typical run of mine ore can contain 1-2% Li_2O , while a typical spodumene concentrate suitable for lithium carbonate production contains 6-7% Li_2O (75% - 87% spodumene). Higher grade concentrates with 7.6% Li_2O and low iron content are used in ceramics and more demanding industries.

TECHNICAL-GRADE VS CHEMICAL-GRADE

There are a variety of lithium concentrates with differing levels of lithia, which are split into chemical-grade and technical-grade products.

Technical-grade lithium concentrates are sold into the glass and ceramic markets. Chemical-grade lithium concentrate is sold to processors for conversion into lithium chemicals.

Chemical Grade Lithium Concentrate

Chemical-grade lithium concentrate product range from 4%-6% Li_2O , where there is not firm iron, feldspar or other impurity ranges vs technical-grade concentrate. Chemical-grade lithium concentrate is sold directly to a number of major Chinese lithium chemical producers to be converted into lithium carbonate, lithium hydroxide and lithium metal.

Technical Grade Lithium Concentrates

Technical-grade lithium concentrates range in lithium content from 4.1% to 7.5% Li_2O but achieve additional specifications such as ultra-low levels of iron. Alkaline content for ceramics is also important with <1.0% combined K_2O and Na_2O requested by many end-users. Technical-grade lithium concentrates are commonly used in the manufacture of glass, ceramics, where discoloration from iron is a concern, and metallurgical powders.

LOW IRON LITHIUM CONCENTRATES

On 31st July 2019, Prospect Resources Ltd announced some of the results of a market analysis on petalite and low iron lithium concentrates undertaken by Benchmark Mineral Intelligence. The report indicates that globally, there are only two producers of low iron lithium concentrates (one being petalite concentrate and another being a spodumene concentrate producer) that meets the glass and ceramics market specifications.

Bikita Minerals Pvt Ltd

It is easy to conclude that the petalite producer is Bikita Minerals Pvt Ltd, a privately-owned company producing

petalite from its operation in Zimbabwe. The concentrates are sold through traders via South Africa to customers in Europe and China. In 2017, Bikita Minerals production totalled 5,300 tonnes Lithium Carbonate Equivalent (LCE) in petalite mineral concentrates. In 2018, Bikita's production was forecast to total 7,500 tonnes LCE.

Talison Lithium Ltd

The low iron spodumene producer is clearly Talison Lithium Pty Ltd (51% Tianqi Lithium, 49% Albermarle). Talison Lithium sells its technical-grade lithium concentrates directly and indirectly to customers in many different countries within Continental Europe and, among others, China, Japan, the United States of America and Mexico. Marketing of Talison Lithium's technical-grade lithium concentrates is carried out by exclusive distribution agents in each of the major geographical sales areas, who provide local storage and logistics support, as well as commercial, administrative and technical services.



Source: Talison Lithium

Prospect Resources Ltd

Beyond the two operations mentioned above, the Arcadia project developed by Prospect Resources Ltd is the only lithium hard rock project that can produce low iron lithium concentrate in the form of spodumene and petalite products as the majority of minerals projects currently in production or being evaluated are targeting solely the chemical market due to the high iron content of their mineral deposits, rendering them unsuitable for most technical applications.

Product	Tonnes	Li_2O	Fe_2O_3	Ratio
Pilgangoora Mar Q shipment (AJM)	14,770	5.9%	1.50%	3.9
Pilgangoora Jun Q shipment (PLS)	43,214	6.0%	1.20%	5.0
Mt Cattlin Jun Q production (GXY)	56,460	6.0%+	1.20%	5.0
Bald Hill Jun Q production (A40)	38,717	6.2%	0.50%	12.4
Arcadia SC6.5 sample (PSC)	n/a	6.5%	0.33%	19.7
Arcadia SC6.1 sample (PSC)	n/a	6.1%	0.33%	18.5
Arcadia PC4.2 sample (PSC)	n/a	4.2%	0.08%	51.5

Source: company announcements.

The table above indicates some of the specifications achieved by the new Australian producers, Alita Resources Ltd (A40, receivers appointed), Altura Mining Ltd (AJM), Galaxy Resources (GXY) and Pilbara Minerals Ltd (PLS) versus

some of the samples of spodumene concentrate (SC) and petalite concentrate (PC) achieved in preliminary testing at the Arcadia project, operated by Prospect Resources (PSC). The ratio $\text{Li}_2\text{O}/\text{Fe}_2\text{O}_3$ is 4 to 10 times higher with Arcadia products compared to Pilgangoora products.

Prospect's average annual concentrate production is expected to be approximately 212,000 tonnes of 6% spodumene, 216,000 tonnes of 4% petalite, and 188,000 pounds of tantalum pentoxide. This will place Prospect Resources as the largest petalite producer in the world and a significant producer of spodumene.



Source: Prospect Resources, Arcadia Lithium Project site and Petalite samples

EFFECT OF IMPURITIES

The chemical process taking place in Chinese converters can be summarised as follows. The α -spodumene (unreactive to sulphuric acid) is converted to β -spodumene by heating the concentrate in a rotary kiln at $1,000^\circ\text{C}$ to make the lithium in the spodumene amenable to react with acid and get it into solution as a sulphate, which is then purified prior to the manufacture of lithium carbonate or lithium hydroxide.

The presence of other minerals in the concentrate can have two key impacts on the conversion process. The first effect is that greater is the amount of impurities, the more difficult it is to produce battery grade lithium carbonate or other chemicals.

The second impact is that iron containing minerals such as feldspar, phosphate minerals and micas can melt at low temperature and form clinker (lumps) in the kiln. Those lumps are a headache for converters in the operation of their plant as well as lowering the amount of lithium that can be extracted in the subsequent acid leach.

ARCADIA'S COMPETITIVE ADVANTAGE

The low levels of iron and alkali impurities in Prospect's spodumene concentrate is highly desirable in the conversion process, due to a reduction of clinker formation during roasting. These product specifications make Prospect's low iron spodumene a premium lithia source for chemical conversion. In addition to enhancing roasting performance, the low iron and low impurities in Prospect's concentrates help mitigate reagent consumption and waste during the production of lithium chemicals such as battery grade lithium carbonate and lithium hydroxide.

Low iron lithium concentrates can also be achieved through petalite as its crystalline structure is more easily separated

from mica in the concentration process and therefore lowers the alkali and iron content of the final product.

In glass and ceramics production, lithium is used as a flux to reduce the melting temperature, thus reducing energy consumption in glassmaking by about 5% while also reducing flaws in the finished product. Glass and ceramics makers have a choice of lithium containing products to use with lithium carbonate, spodumene and petalite all widely used, and each with slightly different value in use properties. Low iron concentrates are popular as an additive for the fabrication of white and clear glazes, as they melt without delivering a noticeable tint.

While almost all lithium carbonate can be used in glass and ceramics, as a refined product with relatively few impurities, it is not the favoured product as it requires additional purchases of alumina and silica which are already contained in both low iron petalite and low iron spodumene substitutes.

For ceramics especially there is demand for additional low iron petalite as a substitute to other materials. It is likely that market share can be taken from the tonnes of lithium carbonate currently consumed in glass and ceramics.

PREMIUM PRICING

Product quality and rarity attracts premium pricing despite overall price weakness for lithium products.

Benchmark Mineral Intelligence confirmed that in May and June 2019 low iron petalite concentrates sales in China ranged between US\$1,300 and US\$1,400 per tonne, well above the US\$749/dmt average selling price recorded for the June quarter at the Bald Hill mine or the US\$600/dmt (CIF China) realised by Altura Mining at Pilgangoora.

IMPACT ON ARCADIA ECONOMICS

The range of prices for low iron petalite concentrates compares also very favourably to the US\$457/t FOB price assumption for petalite concentrate used by Prospect Resources Ltd in the DFS results announced in November 2018. Considering that the petalite concentrate production represents more than half of Arcadia's scheduled production, the impact of the overall economics of the project is quite significant.

In parallel, the low iron spodumene concentrate also produced by Arcadia could potentially attract premium pricing as a sweetener or blending material for Australian chemical-grade concentrates having difficulties in maintaining quality specifications in the long term, particularly the level of iron content.

REFERENCES

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