High grade titanium feedstocks supply under pressure

David McCoy
TZMI is a global, independent consulting and publishing company with offices in Australia, the US, Europe, Africa and China. The strength of TZMI’s consulting services stems from extensive practical experience in the mineral sands, titanium dioxide and coatings industries and from a comprehensive database, which has been built up over many years.

TZMI’s publications and data services support the consulting activities and ensure up-to-date, high quality and comprehensive data, analysis and information across the mineral sands, zircon and TiO₂ pigment industries.

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- Market assessments and industry analysis
- Due diligence
- Pre-feasibility studies incl. preliminary capital and operating cost estimation
- Competitive cost analysis and benchmarking
- Technical reviews and audits
- Resource assessments
- Physical separation test work
- Flowsheet development
- Customised data analysis and reporting
Today’s topics

- Overview of high grade feedstock supply & demand (focus on rutile, synthetic rutile and titanium slag)
- Where could new supply come from?
- What are the issues with these new projects?
- What is the impact to the metal supply chain?
## Chloride feedstock choices

<table>
<thead>
<tr>
<th></th>
<th>Chloride slag</th>
<th>Rutile</th>
<th>SR</th>
<th>UGS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Availability</strong></td>
<td>Wide – capex driven</td>
<td>Medium &amp; diminishing</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Occurrence</strong></td>
<td>beneficiated</td>
<td>Natural</td>
<td>beneficiated</td>
<td>beneficiated</td>
</tr>
<tr>
<td><strong>Ave producer margin</strong></td>
<td>Depends on ilmenite cost/ electricity/</td>
<td>High</td>
<td>Low</td>
<td>Low value add from sulfate slag</td>
</tr>
<tr>
<td><strong>TiO₂ content</strong></td>
<td>~86%</td>
<td>~95%</td>
<td>~90%</td>
<td>~95%</td>
</tr>
<tr>
<td><strong>Radioactivity</strong></td>
<td>None</td>
<td>varies</td>
<td>varies</td>
<td>none</td>
</tr>
<tr>
<td><strong>Particle size</strong></td>
<td>large</td>
<td>Deposit dependent</td>
<td>Medium (ilmenite dependent)</td>
<td>large</td>
</tr>
<tr>
<td><strong>Waste volume</strong></td>
<td>High</td>
<td>Low</td>
<td>medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Form</strong></td>
<td>Homogeneous solid</td>
<td>Homogeneous solid</td>
<td>Porous Solid (Sponge)</td>
<td>Homogeneous solid</td>
</tr>
<tr>
<td><strong>Beneficiation co-products</strong></td>
<td>Iron</td>
<td>none</td>
<td>minor</td>
<td>None (already had iron removed)</td>
</tr>
</tbody>
</table>
Major rutile producers

- **CIS Total (‘000 TiO2 units):**
  - 51 in 2017 vs 42 in 2018f

- **Asia Pacific (‘000 TiO2 units, excl. China):**
  - 20 in 2017 vs 29 in 2018f

- **China Total (‘000 TiO2 units):**
  - 36 in 2017 vs 42 in 2018f

- **South America Total (‘000 TiO2 units):**
  - 112 in 2017 vs 105 in 2018f

- **South Africa Total (‘000 TiO2 units):**
  - 2 in 2017 vs 1 in 2018e

- **Other Africa Total (‘000 TiO2 units):**
  - 256 in 2017 vs 237 in 2018e

- **Australia Total (‘000 TiO2 units):**
  - 250 in 2017 vs 149 in 2018e

*The bulk of the rutile output in China is produced from imported concentrates*
Major titanium slag producers

- **Western Europe (‘000 TiO₂ units):** 157 in 2017 vs. 173 in 2018f
- **CIS (‘000 TiO₂ units):** 41 in 2017 vs. 41 in 2018f
- **China (‘000 TiO₂ units):** 458 in 2017 vs. 500 in 2018f
- **CIS (‘000 TiO₂ units):** 41 in 2017 vs. 41 in 2018f
- **North America (‘000 TiO₂ units):** 690 in 2017 vs. 625 in 2018f
- **Middle East (‘000 TiO₂ units):** 0t in 2017 vs. 25 in 2018f
- **Vietnam (‘000 TiO₂ units):** 16 in 2017 vs. 18 in 2018f
- **South Africa (‘000 TiO₂ units):** 896 in 2017 vs. 788 in 2018f
- **China (‘000 TiO₂ units):** 458 in 2017 vs. 500 in 2018f
- **CIS (‘000 TiO₂ units):** 41 in 2017 vs. 41 in 2018f
- **North America (‘000 TiO₂ units):** 690 in 2017 vs. 625 in 2018f
- **Middle East (‘000 TiO₂ units):** 0t in 2017 vs. 25 in 2018f
- **Vietnam (‘000 TiO₂ units):** 16 in 2017 vs. 18 in 2018f
- **South Africa (‘000 TiO₂ units):** 896 in 2017 vs. 788 in 2018f
Major synthetic rutile producers

India (‘000 TiO2 units):
101 in 2017 vs. 105 in 2018f

China (‘000 TiO2 units):
46 in 2017 vs. 54 in 2018f

Australia (‘000 TiO2 units):
420 in 2017 vs. 374 in 2018f
Global rutile supply and indicative outlook to 2022 (current mines)

- Total demand
- Others
- China
- Kenya Sierra
- CIS
- Australia
- India
- US
- Leone
- South Africa

Note: Supply profile only reflects existing operations
Rutile feedstock supply/demand outlook to 2022

- The global rutile market is experiencing extremely tight market conditions, with a deficit position of 104,000 TiO$_2$ units forecast for 2018.
- Near term rutile demand has been moderated to reflect the declining supply availability.
- The demand projection for rutile assumes no blend change at the pigment plants from 2020 as all individual high-grade feedstock product will essentially be in deficit.
- TZMI has made provisions for greater chloride slag supply during the next few years, on the basis that there is some latent capacity in the supply chain that can be re-commissioned to meet chloride feedstock demand growth.
Major events in last 2 years

- Lomon Billions starts captive SR and Slag plants in China to feed its chloride TiO₂ expansion.

- CYMG Xinli – cash flow issues, operations suspended most of 2018


- White Mountain – Dec 2016 was issued with notice of default on certain loans. Feb 2017 files to delist and directors resign.

- Tronox announced to customers no external rutile sales – closing on Cristal?

- Mengda Titanium (slag producer in Inner Mongolia), has applied for a capacity expansion to 300,000tpa. Five furnaces will be built. Construction is complete at the first furnace and it was commissioned in June 2018 with current capacity of 60,000 to 70,000tpa.
Major events in last 2 years

- Rio Tinto Sorel Canada
  - April 2018 a worker killed. Plant closed for investigation
  - Sept 2018 Force Majeure declared. Slag plant unlikely to be up again until 2018?

- The furnace at RTFT that was taken down in July has resumed operation. Currently running 7 furnaces.

- TiZir slag production was impacted by the pre-reduction kiln experienced a gearbox failure. Titanium slag output down by 33% in Q1 2018.

- Eramet made a takeover bid for MDL (JV partner in TiZir) this was completed in July 2018.

- Rio Tinto RSA
  - Jan 2018 roaster failure declares force majeure
  - April 2018 local unrest shuts operations and invokes force majeure.
  - July 2018 security contractor killed, operations suspended again.
Technology is difficult: Case study – Cristal Jazan

- **Oct 2011** – LOI with Outotec (Finland) to build 500,000 tpa TiO₂ slag facility in Saudi Arabia

- **Jun 2012** - announced EPC €350 million operational in 2014

- **Nov 2013** – announced furnace 1 commissioning in May 2014 and furnace 2 in June 2014.

- **Mar 2015** – fire at the facility.

- **Jul 2015** – announced delay in commercial production to 2H 2016 (technical issues)

- **Nov 2015** – announced expects plant to be operational Q3 2016

- **April 2016** – announced expects plant to be operational 1H 2017.

- **May 2018** – Tasnee signed an option agreement to sell a 90% stake in the titanium smelter. Option agreement follows a technical services agreement between the parties, which will see Tronox provide technical assistance to AMIC to facilitate the startup of the smelter.
Nominal historical prices

US$/tonne FOB

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Likely new projects - rutile
West Balranald: Iluka Resources

- Balranald and Nepean are two rutile-rich mineral sands deposits in the northern Murray Basin, New South Wales.
- Iluka said work on the unconventional mining development at Balranald continued in 2017. Work on testing an improved mining head to assess suitability is under way.
- Should the testing of the mining unit prove successful, a decision will then be made on whether to proceed with a final field trial in 2018.
- Mine life is approximately eight years for the conventional development.
- The deposit also contains considerable quantity of ilmenite and zircon. Production commencement is anticipated to be post 2020 at the earliest.
Located to the northwest of its Gangama deposit, Iluka’s Sembehun deposits have a total estimated resource of 3.7 million tonnes of rutile.

The Sembehun deposits are situated 20-30km northwest of the existing Sierra Rutile operations. Iluka plans to develop a new 1,000tph mine at these deposits.

A pre-feasibility engineering study is under way and environmental baseline studies are planned to commence in Q3 2017.

The development of the Sembehun deposit is subject to market conditions.

The mine also has small quantities of chloride ilmenite.

The output from this mine will be a replacement for Lanti Dry and Gangama, rather than an addition to Iluka Sierra Leone’s output.
Atlas Campaspe: Cristal Mining

- The project is located approximately 80km north of Balranald in New South Wales.
- A DFS has been completed and the NSW Planning and Environment Department has approved the development. Federal approvals are still required.
- The project has a mine life of 20 years and the primary product is rutile.
- Construction was meant to start in 2017 but an investment decision has now been delayed due to the proposed acquisition of Cristal by Tronox.
- This project is seen as replacement for Cristal Snapper and Ginkgo operations once these reach the end of mine life in 2020.
In 2006, Nordic acquired nine mineral claims for the Engebø rutile deposit from Conoco Phillips Investment Norway.

In 2013, Nordic undertook further drilling on the deposit to upgrade the project’s resources. The preliminary mine plan is a 10 to 15-year open-pit operation followed by 35 years of underground mining.

Approval was given for the industrial area plan and discharge permit in April 2015. This was the major obstacle to project development.

The PFS was completed in October 2017 with an estimated initial investment of US$207 million for a 1.5 million tpa operation.

Following a testwork program in 1H 2017, the company will now develop the Engebø project as a dual operation with rutile and garnet production.

First production is anticipated in 2021.
Impacts on the metal sector
Feedstock demand for sponge outlook to 2022

Feedstock demand for titanium sponge end use resumed the upward trends since 2016 and is expected to reach 449,000 tonnes in 2018, up 7.4% year-on-year. The rising trend is expected to continue during the forecast period, at 5.3% CAGR.

TZMI believes that the strong demand from aerospace and new-energy automobiles will support demand growth for titanium sponge in the foreseeable few years.
Demand for feedstock into metal end-use is expected to increase, at 4.0% CAGR through to 2022.

Chloride slag accounts for the majority of the feed blend, with rutile accounting for the balance. Chloride ilmenite is included as part of chloride slag as the ilmenite is only an intermediate feedstock. It is all used for slag production which ultimately feeds the sponge plant.

Chloride fines are starting to be used.
Feedstock into Japanese sponge production

Considerable production increase in 2018 anticipated, up 21% year-on-year.

Unlike the CIS, demand for feedstock for sponge end-use in Japan is dominated by UGS, with the balance comprising chloride slag, rutile and SR.

- Rutile from Kenya, RBM and Sierra Leone
- SR mainly from India
What does this mean to the metal industry

- Cost pressure on sponge producer using high grade feedstocks in the next 1-3 years?
- Metal supply chains that require ‘back to source’ certification might have less leverage on future prices.
- Usage of scrap in melted products to stay high if rutile supply is limited
- Sponge producers will be competing for feedstocks against a growing global chloride TiO₂ sector.
Thank you

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