Mineral Sands Industry

Fact Book

This document is designed to provide information on the mineral sands sector and aspects of Iluka's operations for those considering an investment in the company. It should be read in combination with information contained on Iluka's website (Investors & Media section) which includes company statutory disclosures as well as briefing papers on various aspects of the industry. In some cases, this document utilises 2011 data to convey Iluka revenue by product or sales by region, for example. While not the most current data, it is used as it provides a more representative situation than in the case of 2012 data, when demand across both of Iluka's main product suites was low, reflecting mineral sands business cycle conditions, and which in some cases was not available at the time of preparation of this material

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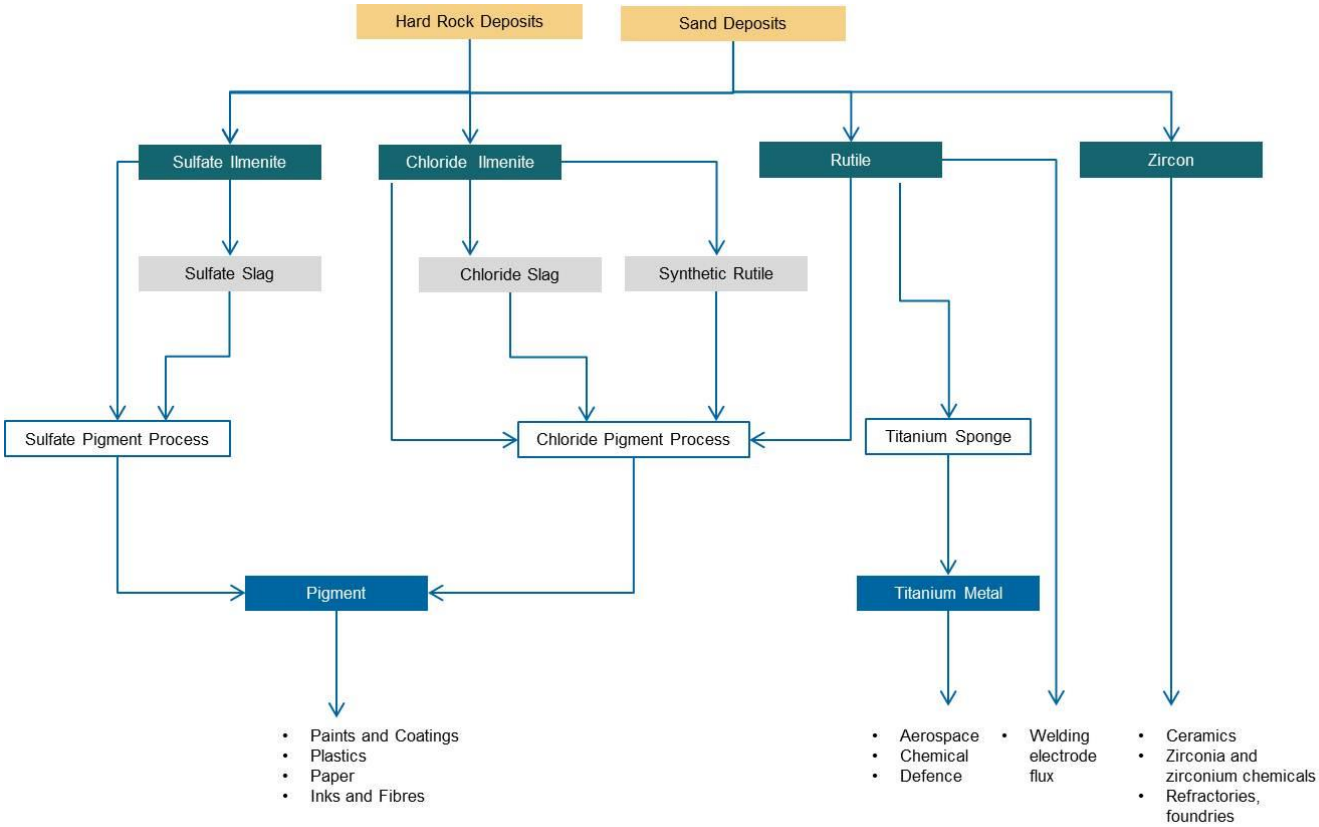
ILUKA

The Mineral Sands Industry - Overview



The mineral sands industry is involved in the mining and processing of zircon and titanium dioxide products (ilmenite, rutile and upgraded titanium dioxide products of synthetic rutile, slag and upgraded slag). The two product categories have different properties, prices and distinct end use markets.

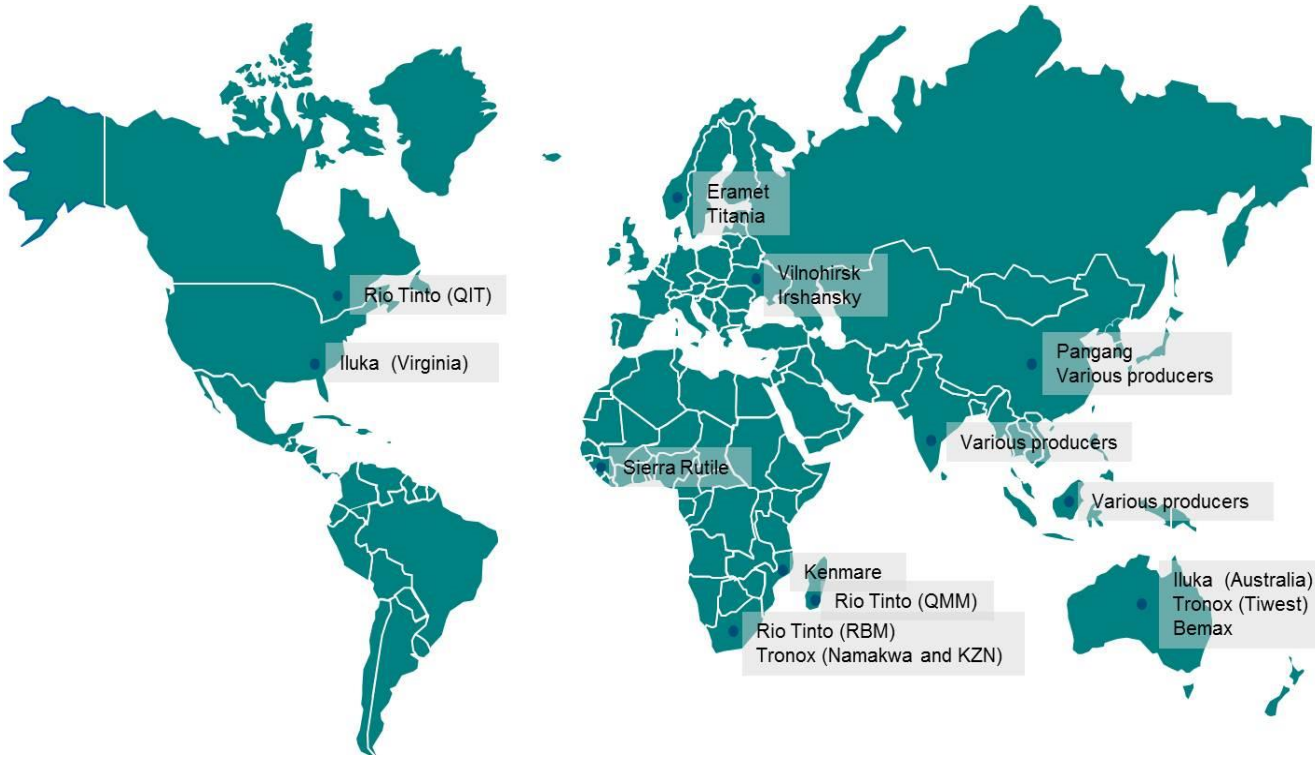
Mineral sands deposits typically contain both titanium dioxide mineral and, usually, a minor proportion of zircon. The relative weighting of each mineral (known as assemblage in an ore body) varies by deposit.

Assemblage has a strong influence on the financial viability of a deposit, being primarily influenced not by the cash cost of production (as in many minerals) but by revenue to cash cost (or margin) characteristics.

Zircon
Zircon is an opaque, hard wearing, inert mineral. It is primarily used in the production of ceramic tiles. Other applications include use in refractories and foundry casting and a growing array of specialty applications as zirconia and zirconium chemicals, including in nuclear fuel rods, catalytic fuel converters and in water and air purification systems.

Titanium Dioxide
Titanium dioxide is mined as ilmenite or rutile (or other variants of titanium dioxide). Both are dark coloured minerals which, with processing, become white and opaque. It is primarily used as a whitening pigment in paints, plastics and paper. The raw minerals are also used in the manufacture of titanium metal and welding flux wire cord.

Global Mineral Sands Operations

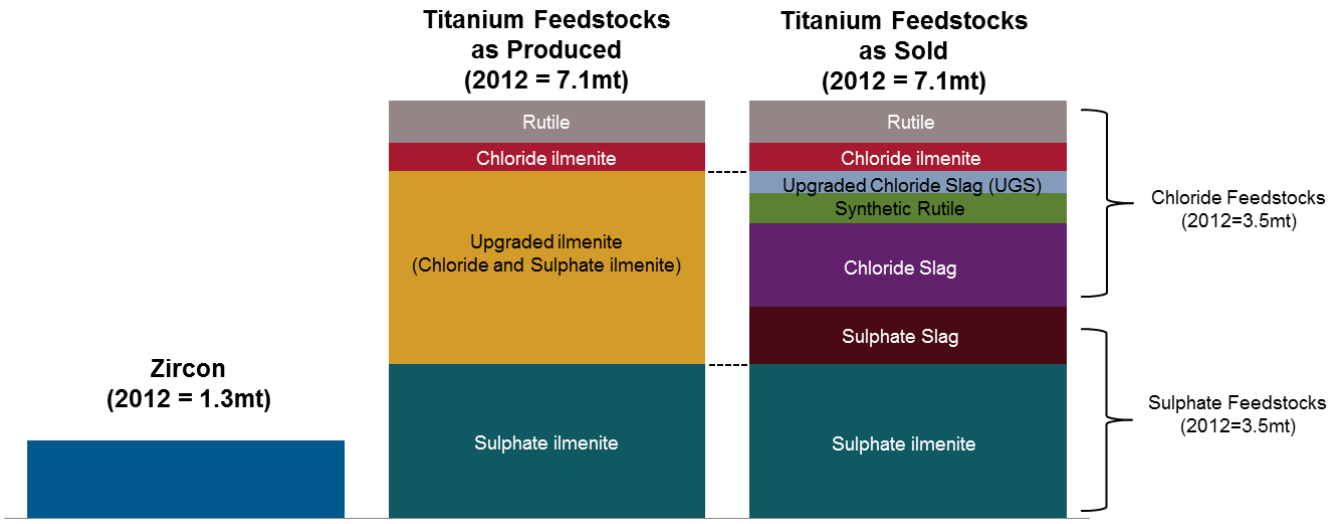


Operation (major owner for multiple operations)	Location	Deposit style, mining method	Ilmenite upgraded – slag or SR	Final products	2012 share of global production (%)[1]
Iluka Australia	Australia	Sand, dry mining	Yes – SR[2]	Zircon, rutile, SR	TiO2: 8% Zr: 22%
Iluka Virginia	US	Sand, dry mining	No	Chloride illmenite, zircon	TiO2: 2% Zr: 4%
RBM (Rio Tinto)	South Africa	Sand, dredge	Yes – slag	Zircon, chloride slag	TiO2: 11% Zr: 18%
QIT (Rio Tinto)	Canada	Hard rock, dry mining	Yes – slag	Sulphate slag, upgraded slag, chloride slag (from QMM ilmenite)	TiO2: 11% Zr: -
QMM (Rio Tinto)	Madagascar	Sand, dredge	Yes – slag at QIT	Zircon, chloride slag (from QIT)	TiO2: 4% Zr: 2%
Namakwa Sands (Tronox)	South Africa	Sand, dry mining	Yes – slag	Chloride slag, sulphate slag, zircon	TiO2: 3% Zr: 8%
KZN Sands (Tronox)	South Africa	Sand, hydraulic	Yes – slag	Chloride slag, sulphate slag, zircon	TiO2: 2% Zr: 1%
Tiwest (Tronox)	Australia	Sand, dredge	Yes – SR	Zircon, rutile, SR	TiO2: 3% Zr: 5%
Kenmare Resources	Mozambique	Sand, dredge	No	Chloride and sulphate ilmenite, zircon	TiO2: 4% Zr: 4%
Sierra Rutile	Sierra Leone	Sand, dredge and dry mining	No	Rutile, chloride ilmenite	TiO2: 1% Zr: -
Vilnohirsk and Irshansky (Ostchem)	Ukraine	Hard rock, dry mining	No	Sulphate and chloride ilmenite, rutile, zircon	TiO2: 5% Zr: 2%

[1] Data for all operations includes 100% of respective production.
[2] SR refers to synthetic rutile.

Source: Iluka and TZMI

Mineral Sands Market Characteristics



Source: Iluka and TZMI

Zircon

In 2012 around 1.3 million tonnes of zircon was produced globally.

In the majority of mineral sands deposits, zircon is produced in lower quantities than titanium dioxide. The historical average ratio between the two mined product streams is in the range 1:4 to 1:5.

Iluka's Jacinth-Ambrosia mine in South Australia is the exception with zircon accounting for approximately 50% of the assemblage of valuable heavy mineral.

Titanium Dioxide Feedstocks

In 2012 around 7.1 million tonnes of titanium dioxide (TiO_2) was produced. Of this, around 3.5 million tonnes, or 50%, was chloride titanium dioxide feedstocks and 3.5 million tonnes sulphate. Chloride feedstocks are generally used in chloride pigment plants and sulphate feedstocks are generally used in sulphate plants.

Titanium dioxide feedstocks are graded by their titanium dioxide content, which ranges from ~50% for sulphate ilmenite to ~95% for natural rutile.

Feedstocks are either sold as raw minerals (rutile and chloride or sulphate ilmenite) or as upgraded feedstocks. Upgrading involves chloride or sulphate ilmenite being heated in a kiln or furnace to remove impurities (mostly iron) and increase the TiO_2 content. Upgraded feedstocks are synthetic rutile, chloride and sulphate slag and upgraded slag.

Iluka produces rutile, chloride ilmenite and synthetic rutile at its operations in Australia and the US.

Titanium Dioxide Content of Feedstocks

Form of titanium dioxide	TiO_2 %
Rutile	95-97
Synthetic rutile	88-95
Ilmenite - sulphate - chloride	 52-54 58-62
Slag - sulphate - chloride - upgraded	 80-85 85-90 95

Revenue to Cash Cost Ratio

For most commodities, unit cash cost is used to benchmark projects' relative economics. In this instance, the grade of valuable mineral, scale and mining method, and associated costs, are key factors influencing unit costs. In mineral sands, heavy mineral (HM) grade provides a good indication of the cost of mining - how much ore needs to be moved to capture heavy mineral.

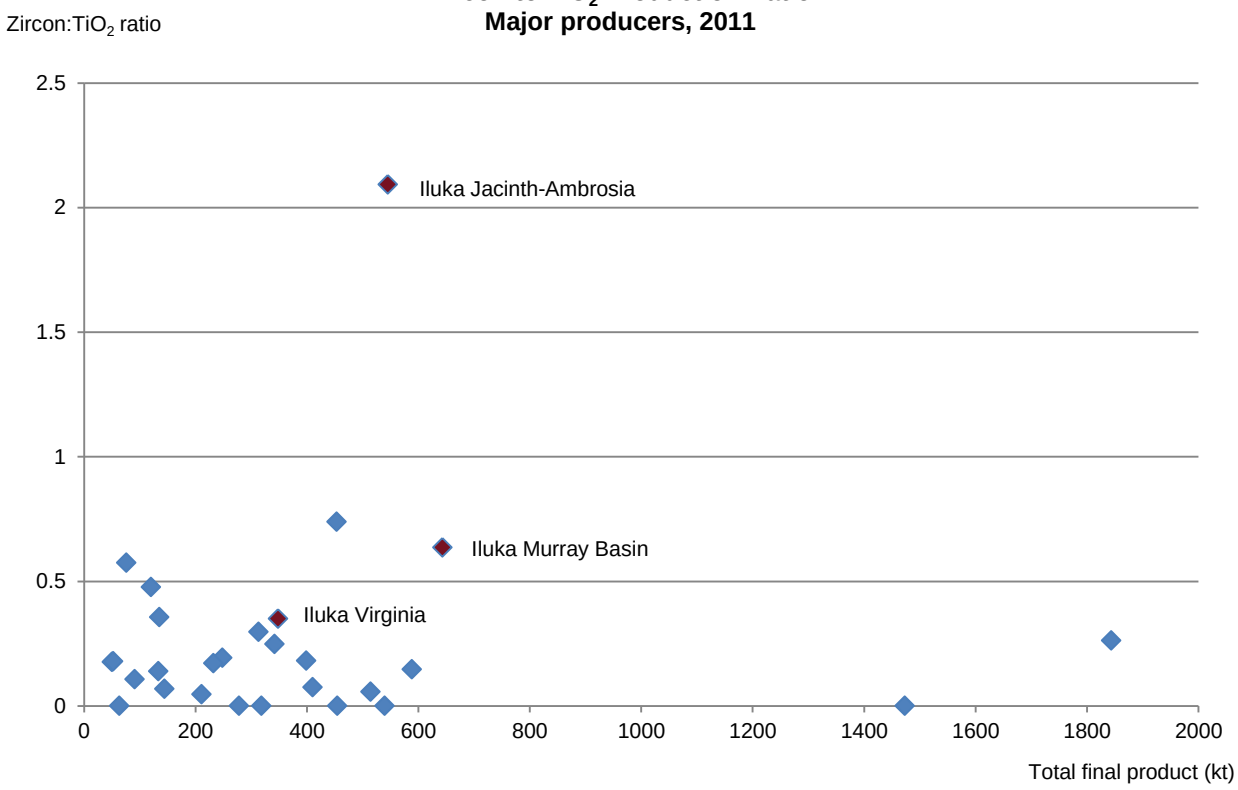
However, most mineral sands mines produce several product streams – predominantly ilmenite, with lesser quantities of the more valuable minerals of rutile and zircon. The weighting of each of these minerals (referred to as the assemblage of the deposit) varies significantly by deposit, but with ilmenite typically dominating the assemblage and zircon the minor constituent.

Consequently, the economics of mineral sands projects is influenced as much by assemblage – which shapes the revenue per tonne characteristics – as the deposit grade or cost of mining.

For this reason, the industry tends to use a margin curve or revenue: cash cost ratio curve to assess the relative attractiveness of mineral sands deposits and operations.

As indicated in the chart below, Iluka's Jacinth-Ambrosia operation has an unusually high zircon to titanium dioxide assemblage.

Zircon to TiO_2 Production Ratio
Major producers, 2011



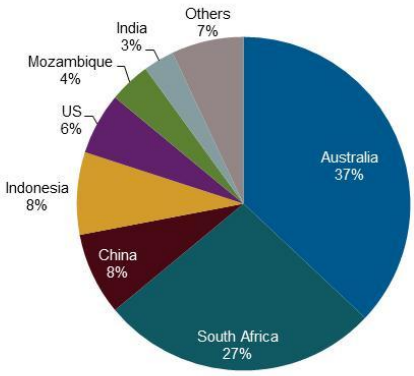
Note: 2011 used as an indicative year of production
Source: Iluka and TZMI

Zircon Production

Zircon Mining by Region

Zircon

(2012 - 1.3mt)



Source: Iluka

Australia is the world's largest zircon producing country, of which Iluka accounts for over two thirds of production.

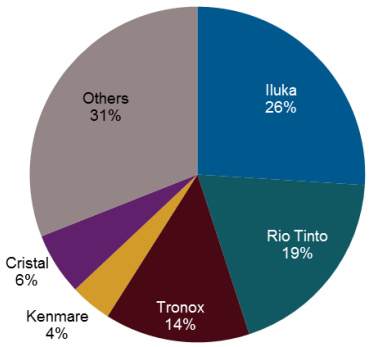
In China, only small amounts of zircon are produced from sand mines on Hainan Island. China's titanium mines on the mainland are hard rock deposits and contain no zircon.

Indonesian zircon production levels can vary significantly between years, influenced by market prices and government regulatory and taxation treatments (covering what is in large part an illegal activity). Zircon production is mainly from small artesian deposits, often mined primarily for gold.

Zircon Mining by Major Producer

Zircon

(2012- 1.3mt)



Source: Iluka

Iluka produces zircon from its Jacinth-Ambrosia, Murray Basin, Western Australia and Virginia mines.

Rio Tinto is majority shareholder of Richards Bay Minerals, South Africa.

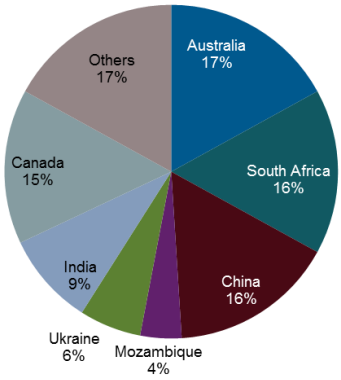
Tronox owns Namakwa and KZN mines in South Africa and Tiwest in Australia.

Titanium Dioxide Production

Titanium Dioxide Mining by Region

Titanium Feedstocks

(2012 - 7.1mt)



Source: Iluka

Globally, approximately 50% of all feedstock produced is chloride grade and approximately 50% sulphate grade.

Australia produces mainly chloride feedstocks from small, high grade mineral sands deposits.

South Africa predominantly produces sulphate ilmenite which is upgraded to chloride slag. The mines are typically low grade with ilmenite dominant assemblage. Ilmenite is also produced in other African countries, including Madagascar (Rio Tinto) and Mozambique (Kenmare)

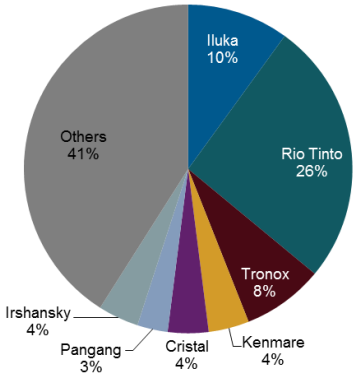
Rio Tinto's QIT operations (Quebec, Canada) produce sulphate slag and upgraded slag from its Canadian mine but also upgrade chloride ilmenite to chloride slag from Rio Tinto's QMM mine at Fort Dauphin, Madagascar.

China mines mainly sulphate ilmenite from hard rock deposits which is sold directly or upgraded to sulphate slag.

Titanium Dioxide Mining by Major Producer

Titanium Feedstock

(2012- 7.1mt)



Source: Iluka

The four largest producers account for around 50% of titanium feedstock production.

Rio Tinto is the world's largest titanium producer with production from Richards Bay Minerals (South Africa), QIT (Canada) and QMM (Madagascar).

Iluka is the second largest producer with operations in Australia and the US (Virginia).

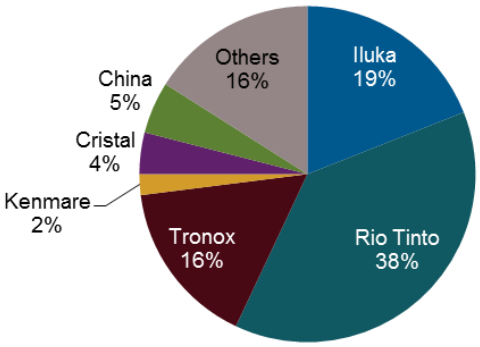
The industry has a large number of smaller producers.

Chloride Titanium Dioxide Production

Chloride titanium feedstocks accounted for around 50% of all titanium dioxide produced in 2012.

Chloride Titanium Feedstock

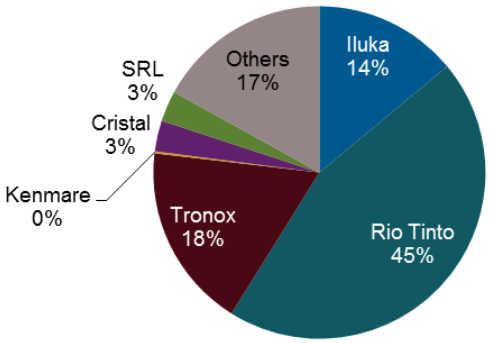
(2012- 3.5mt)



Source: Iluka

Chloride feedstocks include chloride ilmenite, chloride slag, natural rutile and synthetic rutile.

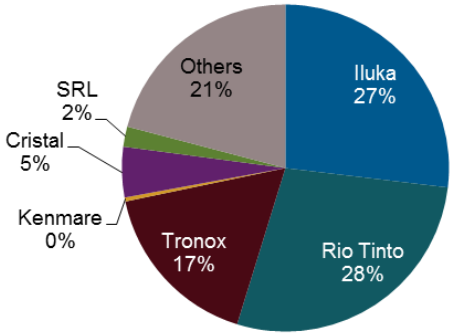
High Grade (>80%TiO2) Chloride Titanium Feedstock
(2012 - 3.0mt)



Source: Iluka

The three largest producers account for almost 80% of the high grade chloride market. Rio Tinto is the world's largest producer of high grade titanium with chloride and upgraded slag from its operations in South Africa and Canada.

Very High Grade (>90%TiO2) Chloride Titanium Feedstock
(2012 – 1.6mt)



Source: Iluka

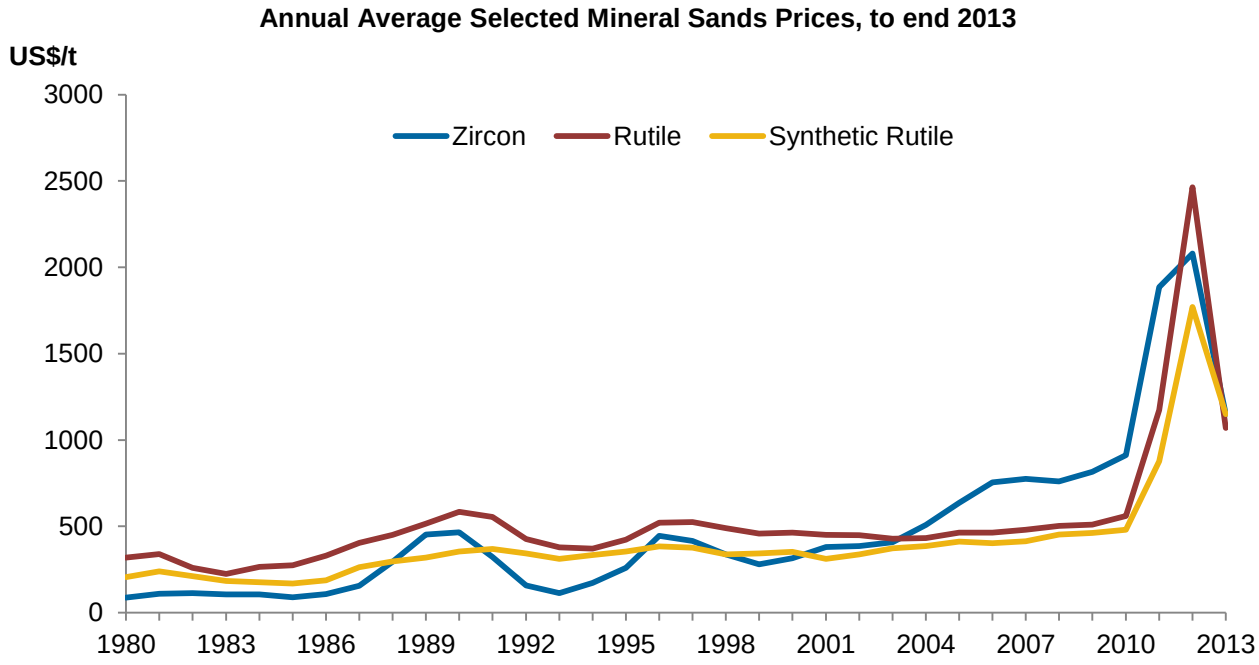
Very high grade feedstocks (defined here as above 90%) include rutile, synthetic rutile and upgraded slag. Iluka is the world's largest rutile producer and has capacity to produce approximately two-thirds of synthetic rutile supply.

Most chloride pigment plants typically use a blend of high to very high grade feedstocks. Such feedstocks serve to increase the average titanium content of the blend. Pigment plants feedstocks blends are discussed in more detail on page 16.

Such feedstocks are also favoured in the welding and titanium sponge markets.

Rutile-rich deposits are relatively uncommon. Capital costs and access to cheap power (in the case of upgraded slag) place an impediment on the increase in new ilmenite upgrading capacity.

Mineral Sands Prices



Source: Iluka and TZMI

The above chart reflects historical pricing trends for Iluka's main products. Mineral sands products have traditionally been sold on the basis of Long Term Contracts (LTC). This resulted in an extended period of relative price stability and only modest price growth.

Constrained pricing in the context of declining grade and/or assemblage and increasing costs, were major contributors to the historically poor returns in the feedstock industry. Low returns acted as a disincentive for new investment, with the industry still largely reliant on mining provinces which have been in existence for many years. Iluka was the first of the major titanium dioxide producers to come off so-called "legacy contacts" at the end of 2010 and consequently had the opportunity, under the prevailing market conditions, to increase its rutile and synthetic rutile prices.

The majority of Iluka's product is now sold via contracts negotiated quarterly or half yearly. There is also a growing role for small volume "spot" sales.

There are neither prevailing benchmarks nor readily sourced representative traded prices for mineral sands products. In Iluka's case the vast majority of its sales are direct; the company does not make use of middle men or agents to any significant extent.

For latest pricing commentary, please refer to Iluka's 2013 Full Year Results presentation material.

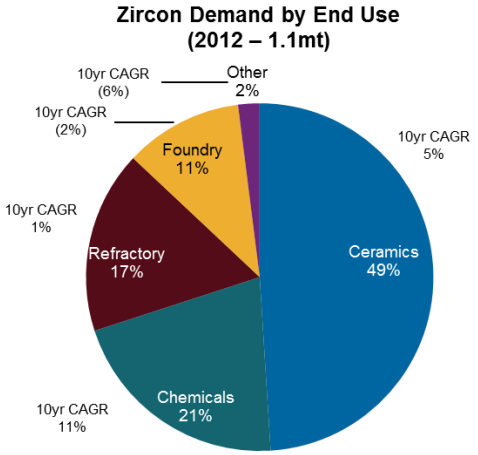
Selected Annual Weighted Average Mineral Sands Prices
US$ / tonne

	2009	2010	2011	2012	2013
Rutile	510	560	1,170	2,400	1,069
Synthetic rutile (SR)	460	480	870	1,700	1,150
Zircon	815	910	1,880	2,080	1,150

Source: Iluka

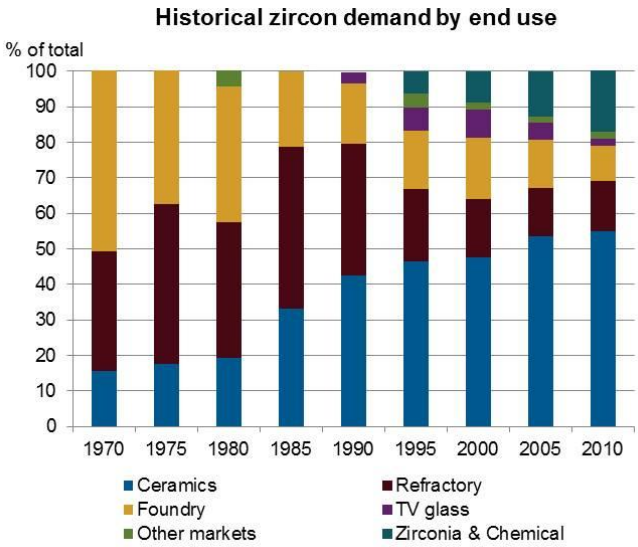
Zircon Demand

The ceramics sector is the largest end user of zircon, accounting for around 50% of demand. Approximately 90% of ceramics demand is related to tile manufacturers, 9% to the production of other ceramics (sanitary ware, other bathroom fittings etc) and 1% to tableware.



Source: TZMI

Demand from the chemicals sector is the fastest growing with annual average growth of over 10%. The sector caters to an increasingly diverse array of end applications, utilising zircon's unique properties. These include catalytic converters, nuclear fuel rods, electronics and pressure and oxygen sensors (discussed in more detail on page 13).



Source: Iluka,TZMI and Roskill

Zircon use in the refractories and foundries sectors has been relatively flat in recent years due to technology improvements.

Growth drivers for zircon demand include urbanization, construction and industrial production.

Zircon Applications and Attributes

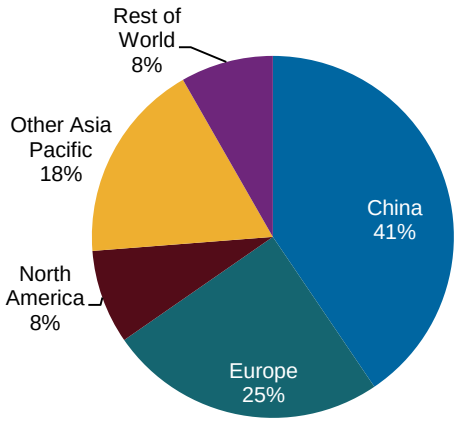
CERAMICS Floor and wall tiles | Sanitary ware | Table ware	**Opacity (whiteness)** – high refractive index **Hard wearing** – water, heat, chemical and wear resistant
REFRACTORY & FOUNDRY Steel and glass production | Casting of manufacturing parts, including engines	**Temperature stability** – low thermal expansion, high thermal conductivity, high melting point **Non-wetability** – resistant to molten metals
ZIRCONIUM METAL Nuclear reactor cores and rods | Heat exchangers | Superalloys	**Low thermal neutron absorption –** increases nuclear reactor efficiency **Inert -** corrosion resistant
ZIRCONIA & ZIRCONIUM BASED CHEMICALS Refractories | Pigments | Abrasives | Electronics | Catalysts | Fibre optics | Purification systems	**Range of unique properties** – thermal stability, oxygen conductivity and dielectric and piezoelectric properties

Zircon Demand

Zircon demand is heavily influenced by tile production and consumption.

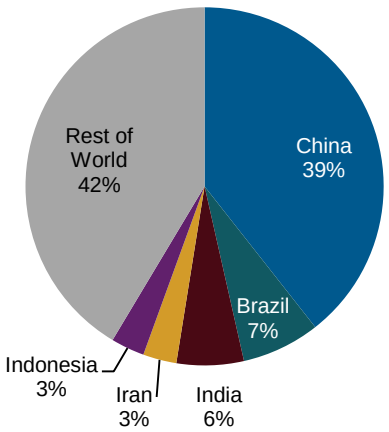
Europe has traditionally been the largest tile producing region with tiles predominantly made in Spain and Italy. However, recently China has surpassed Europe, producing in the range of 6 to 8.7 billion square metres of tiles per year.

Zircon Demand by Region (2011 – 1.4mt)



Source: Iluka

Tile Use by Country (2012 – 10.9 billion sqm)



Source: Ceramic World Review

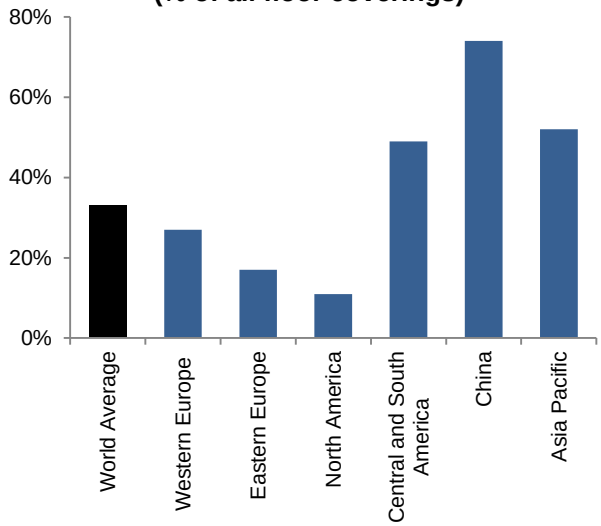
A preference for tiles is influenced by several factors.

- Culture - some regions, particularly in the Middle East, have a strong historical preference for tile use.
- Climate – tile usage is more prevalent in warmer regions, for sanitary and cleaning purposes.
- Personal or society-based taste.
- Cost – certain varieties of tiles are less expensive or more readily available relative to other floor coverings (e.g. timber or carpet).

Many developing countries are large tile users. China in particular has shown a strong preference for tiles with an estimated 75% of all floor coverings being tiles.

Central and South America and other parts of the Asia Pacific also use a large proportion of tiles.

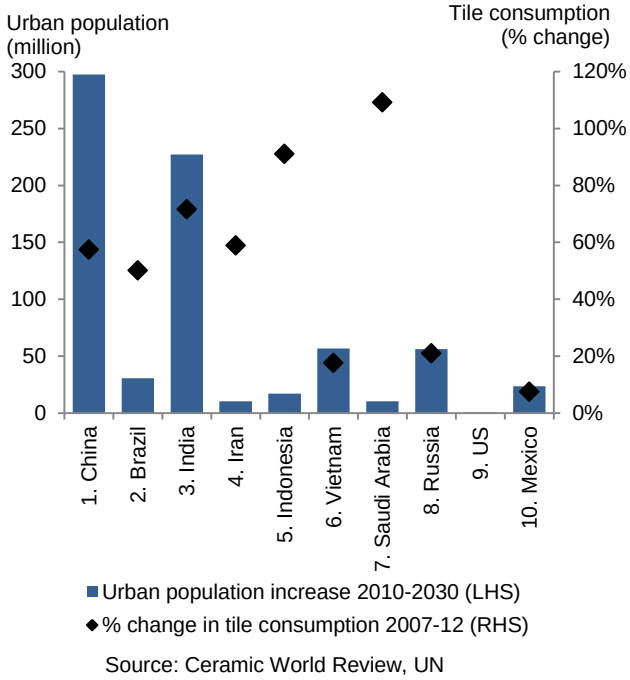
Tile use (% of all floor coverings)



Source: Ceramic World Review

Urbanisation is expected to be a key driver of tile, and hence, zircon demand. Higher urban living standards are linked to increased use of floor coverings in general, of which tiles are expected to form a large proportion.

Top Ten Tile Consumers in 2011 and Urbanisation



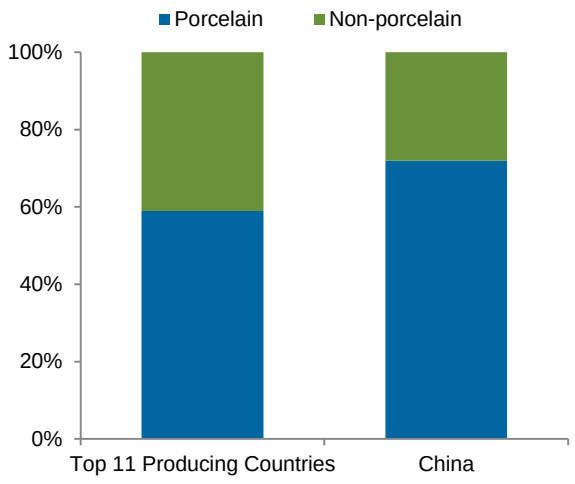
Source: Ceramic World Review, UN

For additional information refer to Iluka Briefing Paper – China Zircon Demand, December 2011.

Tile Properties and Zircon Content

There are two main categories of tiles – porcelain and non-porcelain. Non-porcelain tiles include clay and other stone based tiles. Globally, it is estimated that 60% of tiles produced are porcelain, similarly in China around 70% of tiles produced are porcelain.

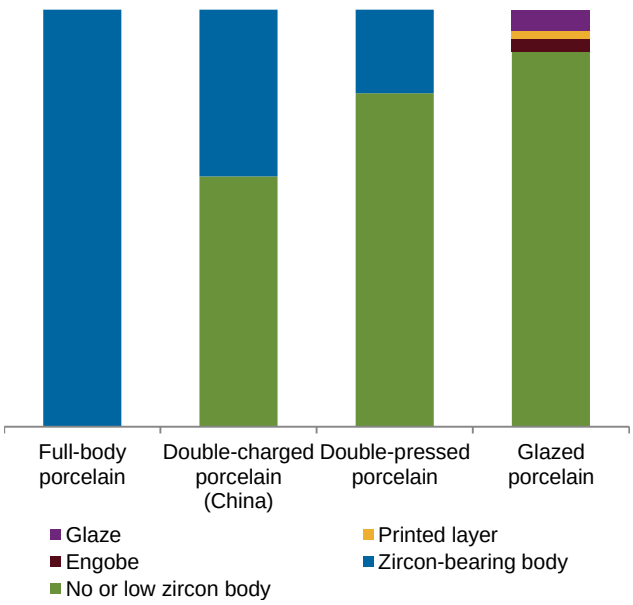
Types of Tiles Produced



Source: Asian Ceramics

Porcelain tiles have the highest weighting of zircon. There is also large variation in the amount of zircon used per tile within the range of porcelain tiles.

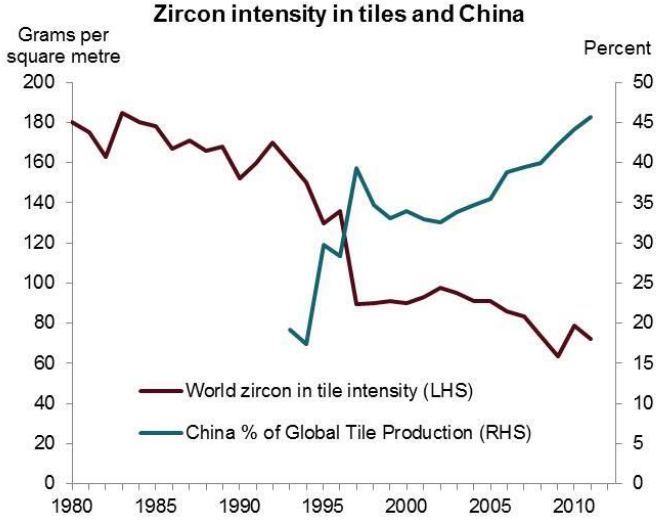
Zircon Containing Layers of Tiles



Source: Iluka

Technological improvements, increased adoption of more efficient manufacturing practices and shifts in the types of tiles made has reduced the amount of zircon used per tile over time.

Zircon intensity in tiles and China



Source: Ceramic World Review and TZMI

Many China tile manufacturers have modernised tile production facilities over the last two years and now use 'double charging' technology that has, when applied, typically reduce\d zircon usage per tile. This technology has been employed in Europe for at least a decade.

Iluka has conducted extensive testing and research into the Chinese tile industry and believes the process of double charging is now complete.

Potential substitutes or partial substitutes for zircon in ceramics include white clays, kaolin and feldspar. However, these minerals do not have all the properties of zircon, thereby limiting their use and efficacy.

For additional information refer to Iluka Briefing Paper – Modernisation, Thrifting and Substitution in the Manufacture of Tiles, December 2012 and Iluka Briefing Paper – Social Housing in China, September 2011.

Zircon Chemicals

The zircon chemicals sector has grown strongly in recent years. This is mainly due to the versatility of zircon in this sector, making it applicable to a large array of end uses. In many cases zircon's function is highly specialised and few materials can provide the properties required.

Zircon in the chemicals sector is used to produce two intermediate products: a fused zirconia and a zirconium chemical, with half of the latter then used to produce chemical zirconia.

Several end uses, including ceramic pigments and steel and glass refractories, are specialty applications of zircon relating to the ceramics and refractories sectors more broadly, with growth expected to match.

Another large end use, and one of the strongest growing, is catalytic converters for automotive and industrial exhaust systems. These reduce the emissions from the engine by catalysed chemical reactions.

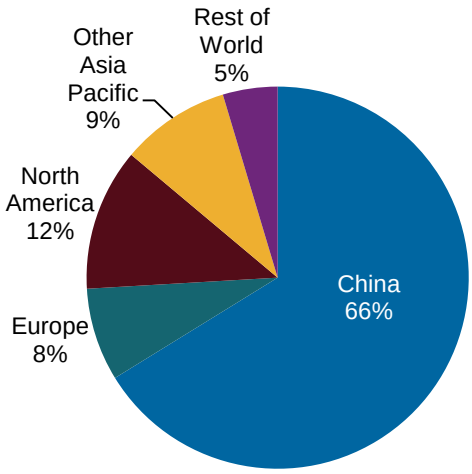
Other uses include:

- Pigment and paper coatings
- Zirconium metal (nuclear)
- Antiperspirants
- Paint dryers
- Glass and cubic zirconia
- Optical fibre ferrules
- Dielectrics (in motherboards and capacitors)
- Piezoelectric devices (e.g. pressure sensors)
- Oxygen sensors
- Electronics
- Fuel cells

Growth of the sector is linked to increased usage of electronics and communications, energy efficiency and emission controls.

Regionally, zircon chemicals demand is dominated by China. China's large, low cost manufacturing base provides it with a comparative advantage in the production of fused zirconia and zirconium chemicals.

Zircon Use in Chemicals (2012 – 220kt)



Source: TZMI

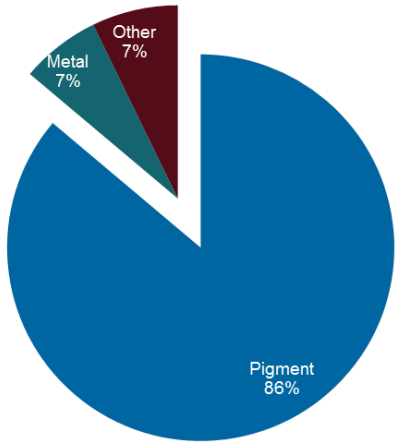
Titanium Dioxide Feedstock Demand

Titanium pigment is by far the largest end use of titanium feedstocks, accounting for around 90% of demand. Average annual growth of this segment has been broadly in line with GDP, at around 4% per annum over the last ten years.

Metal and other end uses, while smaller, have experienced stronger growth at around 12% per annum. Titanium metal uses include aeronautics (body and engine parts), defence applications, biomedical and sporting goods.

The 'other' market segment comprises titanium use in welding rods.

Titanium Feedstocks (2012 – 6.5mt)



Source: TZMI

Titanium Dioxide Applications and Attributes

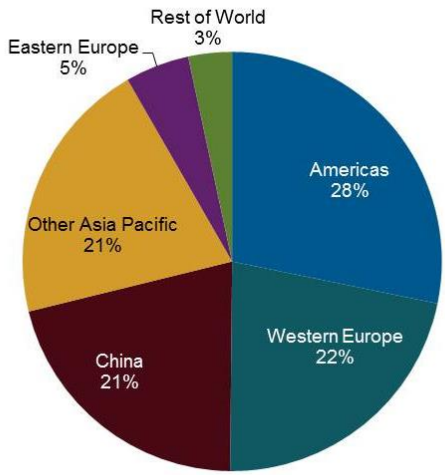
PIGMENT	
Paints & coatings | Plastics | Paper | Inks	**Opacity (whiteness)** – high refractive index **UV protection** – prevents fading, peeling and cracking **Non-toxic –** safe for use in cosmetics and pharmaceuticals
TITANIUM METAL	
Aircraft engines and frames | Military applications | Chemical & desalination plant components | Medical & sporting equipment	**High strength to weight ratio –** fuel efficiency benefits in aviation **Corrosion resistant** – resistant to chemicals, sea water and other elements
WELDING FLUX CORD WIRE	
Ship building | Fabrication | Steel construction	**Slag formation –** shapes, holds and protects weld from atmospheric conditions

Titanium Pigment Production

Global Pigment Capacity

Global pigment capacity (chloride and sulphate) was estimated at 6.4 million tonnes in 2011. Around 21% of this was in China.

Pigment Regional Capacity (2011 – 6.4mt pigment)



Source: TZMI

Titanium pigment, like titanium feedstocks, is classified as sulphate or chloride, with the split being approximately 50:50. Generally, chloride plants are fed with chloride feedstocks and sulphate plants with sulphate feedstocks.

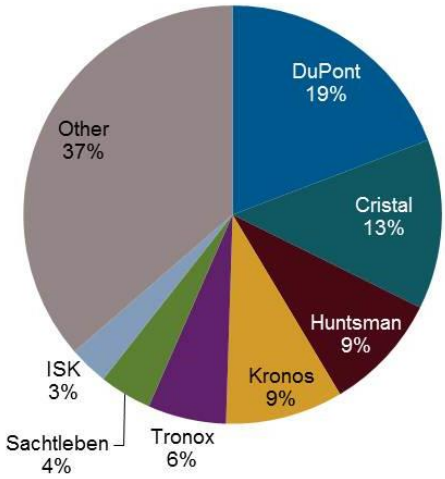
There has been significant growth in sulphate capacity, predominantly in China. More accessible sulphate pigment technology and lower capital costs in China have contributed to investment in new plants. Around half of all sulphate pigment produced using sulphate technology is now from China. However China's central government policy, as reflected in the 12th Five Year Plan, is to encourage the adoption of chloride pigment technology.

Most other regions produce pigment using a mix of both chloride and sulphate technology.

Major Pigment Producers

Five major producers account for over half of global production. Outside the top seven producers, the industry is relatively fragmented, especially Chinese pigment production.

Pigment Major Producers (2011 – 5.6mt pigment)



Source: TZMI

Some characteristics of the major pigment producers are outlined below.

- DuPont is the world's largest producer and produces pigment at plants in the US and Taiwan.
- Cristal, Tronox and DuPont have varying degrees of vertical integration, all owning mineral sands mines.
- Huntsman and Kronos are European based producers with sulphate and chloride plants; and
- ISK is a Japan based producer.

Pigment Plant Capacity Utilisation

Pigment plant capacity utilisation (or yield), as with pigment demand broadly, is linked to industrial production and GDP trends. Capacity utilisation fell significantly during 2009 and 2012 as the effects of the global economic crisis reduced demand for pigment, and pigment inventories increased to higher than typical levels..

In an effort to reduce pigment production, pigment plants lower capacity utilisation by reducing operating time (through measures such as maintenance and shutdown periods) and by changing the average titanium content of feedstocks. The latter entails lower titanium dioxide feedstock blends (for example, more chloride slag and less synthetic rutile or rutile) to maintain plant utilisation and throughput but with lower levels of pigment produced.

In the second half of 2012 and into 2013, a reduction in pigment demand and higher than usual inventory levels, resulted in reduced plant capacity utilisation levels, often in the level of 65 – 75%, compared with typical operating levels of high 80% to low 90%. In addition to switching to lower grade feedstocks during this period, the continued availability of cheaper and lower grade legacy contract material, acted as a further disincentive to the use of higher grade feedstocks, including rutile and synthetic rutile.

In periods of more usual demand for pigment, and associated higher plant capacity utilisation, rutile and synthetic rutile are typically an important component of feedstock blends to optimise plant efficiencies and output.

Pigment production and feedstock grade

Titanium feedstock grades are important for pigment producers (which account for around 90% of titanium demand) as they affect the amount of pigment produced. The higher the grade of titanium feedstock going into the plant, the more pigment produced (and less waste).

Chloride pigment plants predominantly use a blend of different feedstocks with different titanium dioxide grades. Most chloride pigment plants are orientated to higher grade feedstocks - rutile, synthetic rutile and chloride slag. Chloride ilmenite is typically a minor part of the feedstock blend. The plants are large and sophisticated, where operational efficiency is highly dependent on specifications of feedstock blends.

Rutile and synthetic rutile, having the highest titanium grade, form an important part of the feed component as they increase the average grade going into the plant, thus increasing output and decreasing waste.

Titanium Pigment Applications

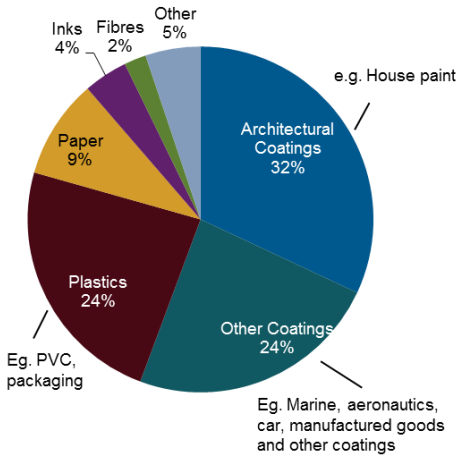
Titanium pigment is used in a large array of end uses, including paints, plastics and paper.

Approximately 80% of end applications can use either chloride or sulphate pigment.

Some of the applications that need chloride pigment specifically are specialty heat treated coatings, including automotive paint and some industrial coatings, while fibres and cosmetic applications need sulphate pigment.

Specific growth drivers for each end market segment are listed below. Broadly, pigment demand is linked to GDP per capita (discussed on next page).

Pigment End Use
(2012 – 4.8mt pigment)



Source: TZMI

Pigment Applications and Growth Drivers

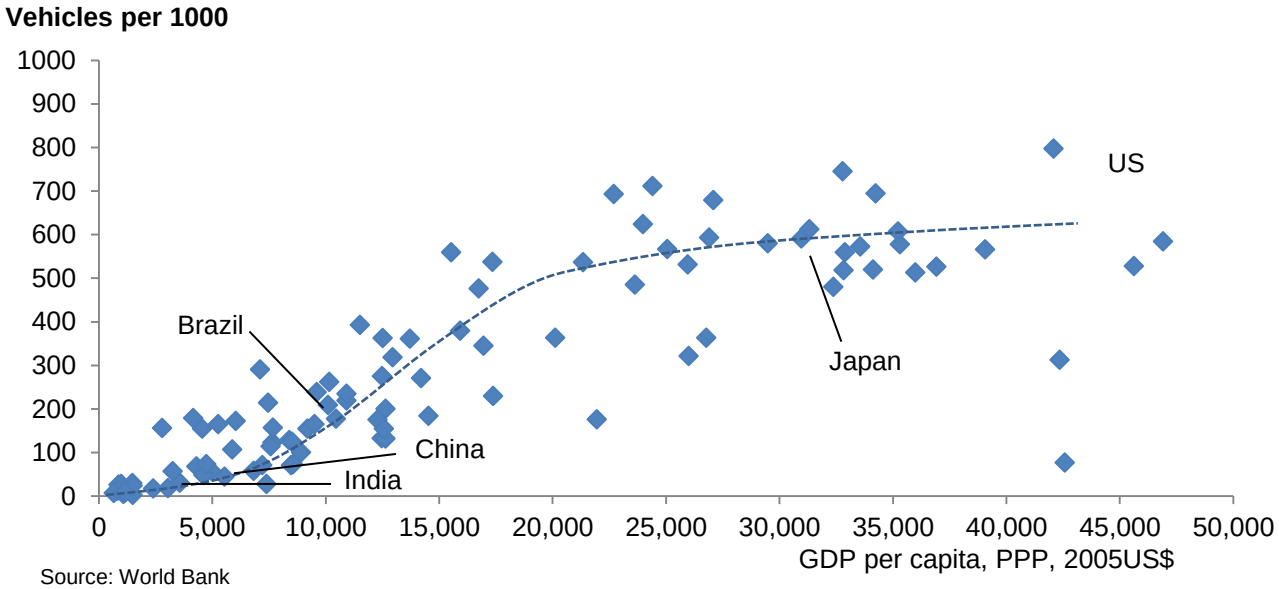
Pigment segment	Application	Growth drivers
Architectural coatings	Residential and commercial paint	New home starts Construction activity DIY spending
Other coatings	Marine Aeronautical Appliances Automotive	International trade Air traffic and travel Industrial production Discretionary spending Car sales
Plastics	Packaging Piping Window frames Appliances Automotive	Discretionary spending Construction Car sales
Paper	Stationery Packaging Laminates	Advertising Construction
Inks	Printing Packaging	Consumption spending
Fibres	Carpets Synthetic fibres	Construction Durable goods spending
Other	Cosmetics Food Pharmaceuticals	Disposable income Consumption

Regional Titanium Pigment Demand

Pigment per Capita and GDP per Capita

Due to the "quality of life" nature of many end use applications, pigment demand is linked to living standards, or GDP per capita. Pigment per capita, or pigment intensity of use, as with many commodities and consumer based goods, increases with GDP per capita, following an S-curve pattern. This can be seen in the case of motor vehicles below. That is, intensity of use increases gradually until a certain income level is reached (take-off point), followed by a period of accelerated growth before a saturation point is reached.

Motor Vehicles Per Capita, 2010/11



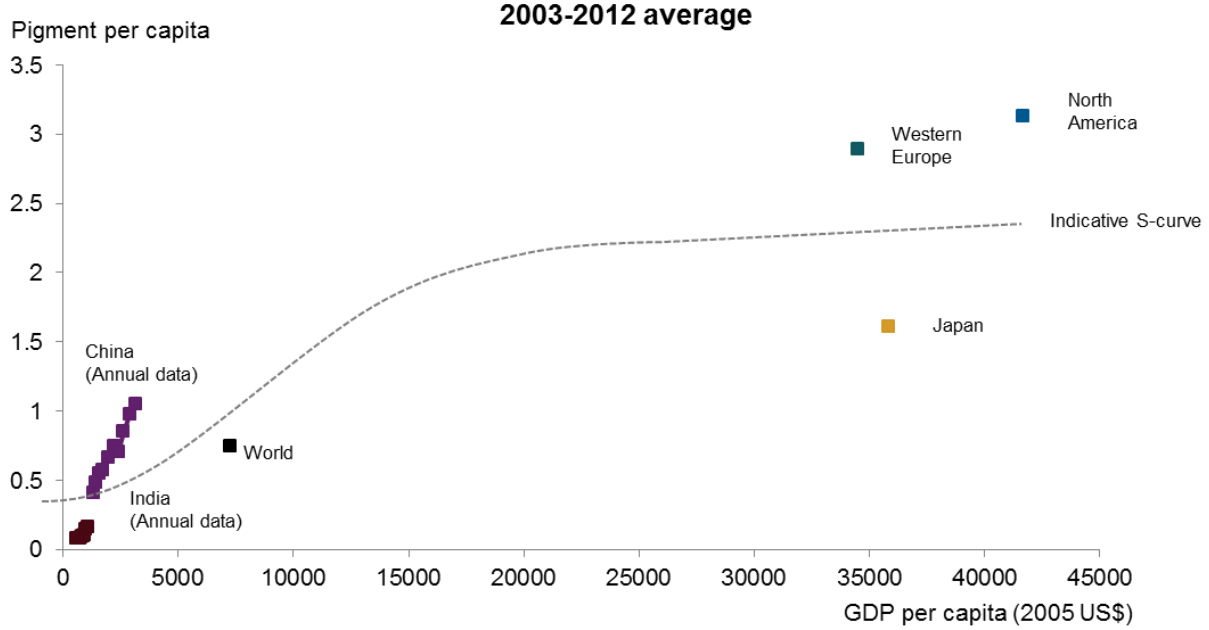
Source: World Bank

The saturation point for pigment per capita varies by region (depending on house size, manufacturing sector size and other factors) but is typically between 2 to 3 kg of pigment per capita.

During 2007-11 average annual China pigment demand grew by 6.1%. On a total pigment demand basis, China is now the largest consumer of pigment globally. Its requirements are met with approximately 80% domestic pigment production, (almost entirely sulphate pigment) and around 20% imports (predominantly chloride pigment).

While China's pigment consumption per capita has grown markedly in recent years, it remains below developed economy levels.

TiO_2 Feedstocks: Intensity of Use
2003-2012 average



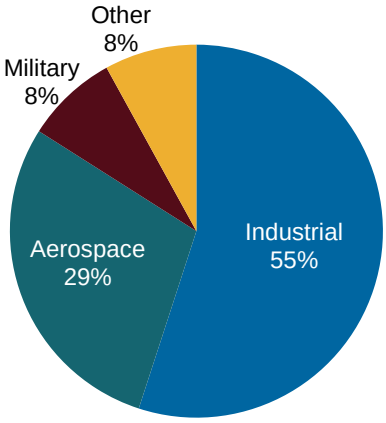
Source: Iluka, TZMI and Global Insight

Titanium Metal

Titanium metal demand has grown strongly in recent years, with a ten year average annual growth of 12% per annum.

Titanium metal has a high strength to weight ratio making it ideal for aerospace (engines and frames) and defence armaments applications. It also has high corrosion resistance, leading to use in industrial chemicals and desalination plants, heat exchanges, industrial and power plant cooling systems and offshore oil and gas drilling components.

Titanium Metal End Use

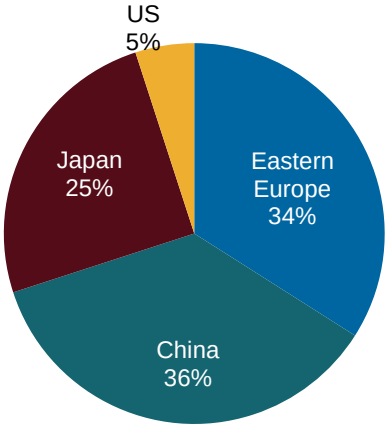


Source: TZMI

Titanium sponge is an intermediate material in the manufacture of titanium metal (with some metal also recovered from scrap). Sponge is predominantly made by a batch process that is high cost (Kroll process). The high cost to produce it has limited titanium metal use. Research and development activities globally are focussed on a more efficient, less expensive process to produce titanium powder and titanium metal.

Production of sponge is mainly in Eastern Europe and Asia. Downstream milling and casting industries are more geographically spread.

Titanium Sponge Production Capacity by Region (2012 – 315kt)



Source: TZMI

Other Titanium Dioxide Uses

There has also been high growth in 'other' titanium dioxide end uses, with a ten year average annual growth rate of 12%.

This segment predominantly includes welding applications. Rutile is used in high-quality welds and in growing (but lower rutile consuming) fluxed core wire applications.

Demand is typically linked to infrastructure and construction activities in developing countries.

Mineral Sands Lead Indicators

Medium to long term industry demand is correlated to GDP (per capita), urbanisation, construction and industrial activity.

A range of leading indicators relevant to zircon and titanium end use markets can be considered as guides to potential shorter term demand trends.

Construction is a key end use sector for both zircon (tiling) and titanium dioxide (paint and pvc pipes and fittings). Lead indicators for demand in the construction sector include:

- interest and mortgage rates;
- mortgage applications / approvals;
- housing and building approvals;
- housing starts;
- floor space under construction;
- house sales; and
- house prices.

Many of the end uses of zircon and titanium dioxide also directly or indirectly relate to manufactured industrial and consumer goods. For these sectors, lead indicators include:

- industrial production;
- new orders and inventory indices;
- consumer confidence or sentiment;
- purchasing managers indices (PMI);
- retail sales; and
- electricity generation/capacity.

Specific industry sales or output indicators are also relevant where zircon or titanium dioxide products are key inputs, such as:

- Automotive new orders and sales;
- ship building;
- aeroplane orders;
- defence spending; and
- nuclear plant construction.

Broad economic lead indicators, such as the OECD lead indicator, which takes into account a raft of individual indicators, are used for macro and country specific growth trends.

Changes to government policies aimed at stimulating or otherwise key markets for mineral sands products can also provide an indication of short term demand changes. For example, Chinese government spending on social housing and incentives to invest in private property, is a case in point.

Import and export data on zircon sand, opacifier and flour (intermediate products used in tile manufacture) and pigment, while not necessarily lead indicators, can provide useful information into the current industry dynamics, potential inventory positions and downstream market activity.

Iluka also monitors company financial results and commentary from downstream sectors, such as pigment, paint, tiles and retail hardware. These provide an insight into end consumer demand, capacity utilisation, inventory levels and product prices.

New Project Inducement

Iluka undertakes inducement analysis of most known mineral sands deposits and projects (where information is publicly available) to estimate an inducement price, or pricing regime, at which a project might theoretically proceed and generate an adequate return (defined as a return above a risk weighted hurdle rate).

The methodology employed by Iluka utilises the following structure.

1. Financial model for each deposit or project, incorporating:

    - deposit characteristics: resource and reserves, grade, assemblage and recoveries;
    - proposed mining rate, and hence project life;
    - proposed mining method;
    - capital cost;
    - operating costs;
    - technical feasibility, including risks, access to technology, implications on nature of deposit on potential recoveries and processing efficiencies;
    - sovereign or jurisdictional risk; and
    - funding availability and costs.

2. Iluka's internal expertise on geology, mine construction and project economics is applied, although the company typically takes at "face value" proponent information on resource base and main parameters, unless they diverge markedly from known industry benchmarks.
3. All projects are ranked on financial criteria based on inducement pricing for titanium and (if applicable) zircon.
4. Forecast supply-demand deficits/surpluses for zircon and titanium markets are then assumed (with a typical conservative view on production depletions from existing major production provinces) to be filled by new projects, after taking into account any expansions from existing producers. The size of any market deficit, and correspondingly the level of new production/new projects required to fill deficit and the associated inducement price for those projects, forms the basis of an indicative inducement price for new supply.

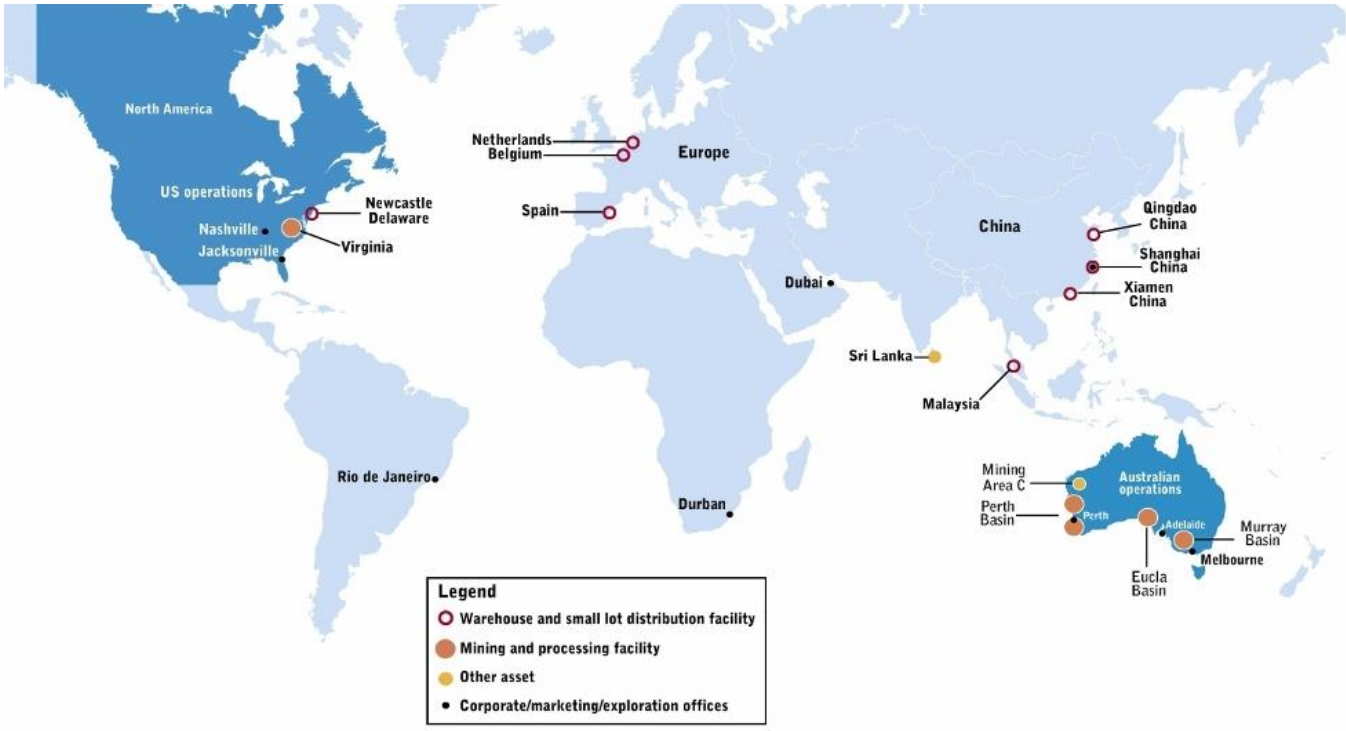
Recent Iluka analysis has estimated a zircon inducement price in the range of US$1,500-1,875 (November 2010) for a market outlook to by 2015 and US$2,000-2,400 (November 2011) for a market outlook to 2016.

The difference between the two estimates is in large part explainable by the different starting points (size of zircon market at time of analysis) and changes in project economic forecasts.

It is likely, in Iluka's estimation, that future supply from new projects may be less than is claimed and/or arrive later. Most deposits or projects are ilmenite dominated, with high grade titanium dioxide products (rutile) and zircon being minor parts of the potential production stream. In addition, recent volatility and lower prevailing product prices than in the 2011-2012 period may also reduce the attractiveness of some projects for investors. Other factors, potentially limiting new supply include:

- technical risk - ~30% of mooted projects are assessed by Iluka as high technical risk; and
- jurisdictional or sovereign risk - ~40% of mooted projects are in countries rated by Iluka with a Significant or High Risk.

Iluka's Operations and Market Presence



Iluka's indicative production capacities are:

- zircon ~500 - 550 ktpa;
- rutile ~200 - 240 ktpa; and
- synthetic rutile ~340 - 550 ktpa (dependent on number of kilns in operation, 2 kilns ~340 ktpa, four kilns ~500 - 550 ktpa).

Zircon and rutile are predominantly sourced from Iluka's Jacinth-Ambrosia operation in South Australia and Murray Basin operation in Victoria.

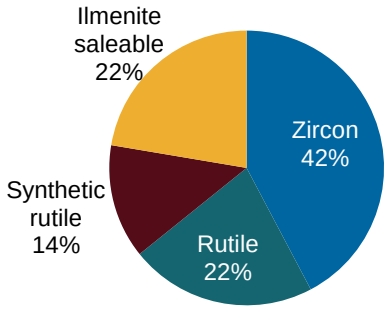
- Jacinth-Ambrosia capacity ~300 ktpa zircon, ~40 ktpa rutile, ~150ktpa ilmenite.
- Murray Basin capacity ~110 ktpa zircon, ~170 ktpa rutile.

Iluka has installed capacity to operate four synthetic rutile kilns (Western Australia). The level of kiln operation is dependent on market conditions and the company has idled kiln capacity where market conditions or financial returns, in Iuka's assessment, have not warranted operation. Kilns are fed with internal ilmenite produced internally supplemented, at times, by external ilmenite purchased from other producers.

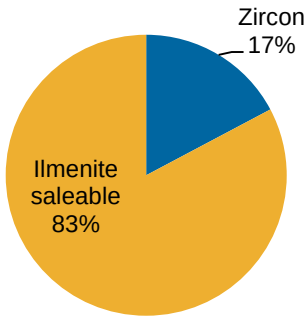
Iluka's Virginia operation in the US produces mainly chloride grade ilmenite that is sold into the US market.

- Virginia capacity ~330 ktpa ilmenite, ~50 ktpa zircon.

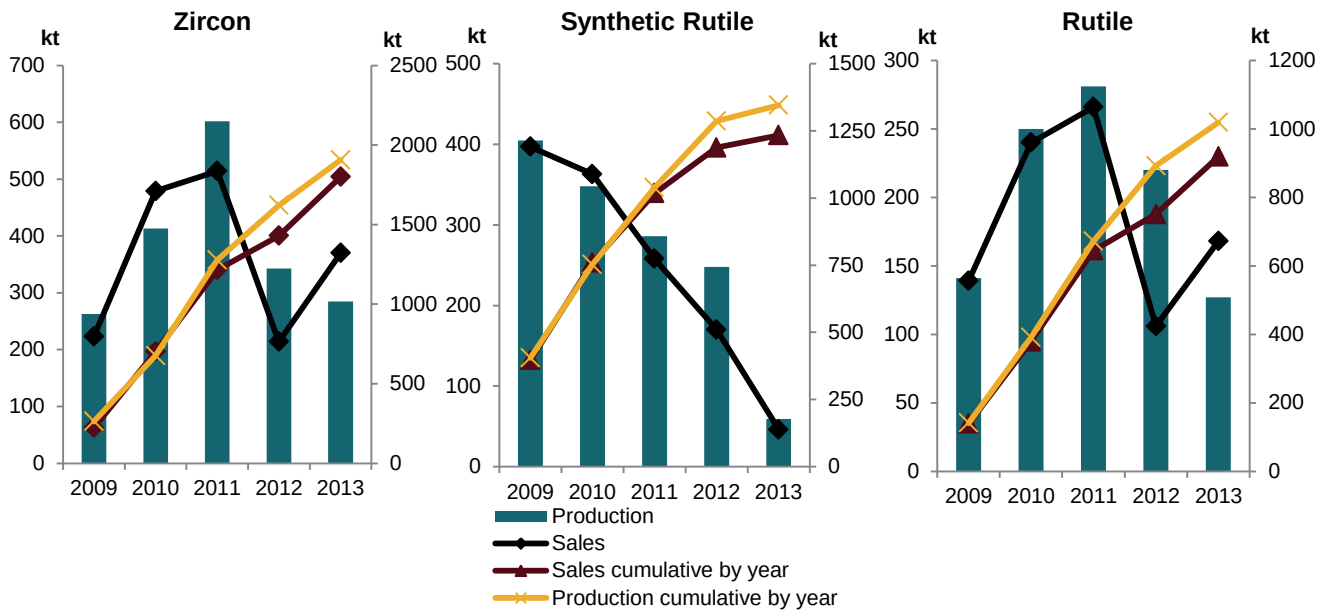
Iluka Australian Production (2013 – 827kt)



Iluka US Production (2011 – 229kt)



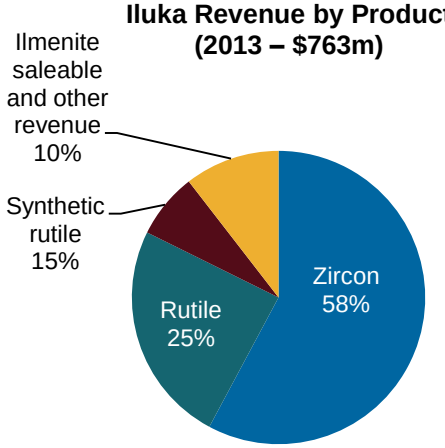
Iluka Sales and Production



Iluka's asset base is flexible with production levels able to be adjusted to some degree to reflect sales and market conditions. This has been demonstrated in recent years when Iluka has both reduced production (for example during the 2009 global financial crisis and in late 2012-2013) and reactivated operations or increased capacity (for example, 2011) when economic and demand conditions have warranted.

Iluka has a focus on higher margin products, namely zircon, rutile and synthetic rutile. Iluka generally prioritises its ilmenite for use as feed for synthetic rutile kilns. However, the company is now commercialising part of its ilmenite reserves from its Murray Basin operations, which includes sulphate ilmenite able to be sold into the China pigment market.

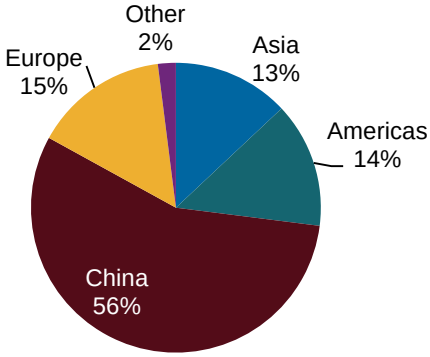
Iluka Revenue by Product (2013 – $763m)



Reflecting a global mineral sands industry, Iluka's sales are distributed around the world.

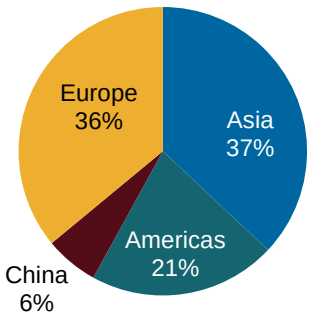
A large proportion of zircon sales are to China (45%) with strong demand for ceramics and zircon chemicals.

Iluka Zircon Sales by Region (2011 – 370 kt)



High grade titanium sales are weighted to North America and Europe, and to a lesser extent Asia, and are linked to the locations of major pigment plants and welding customers.

Iluka High Grade Titanium Sales by Region (2013 – 214kt)

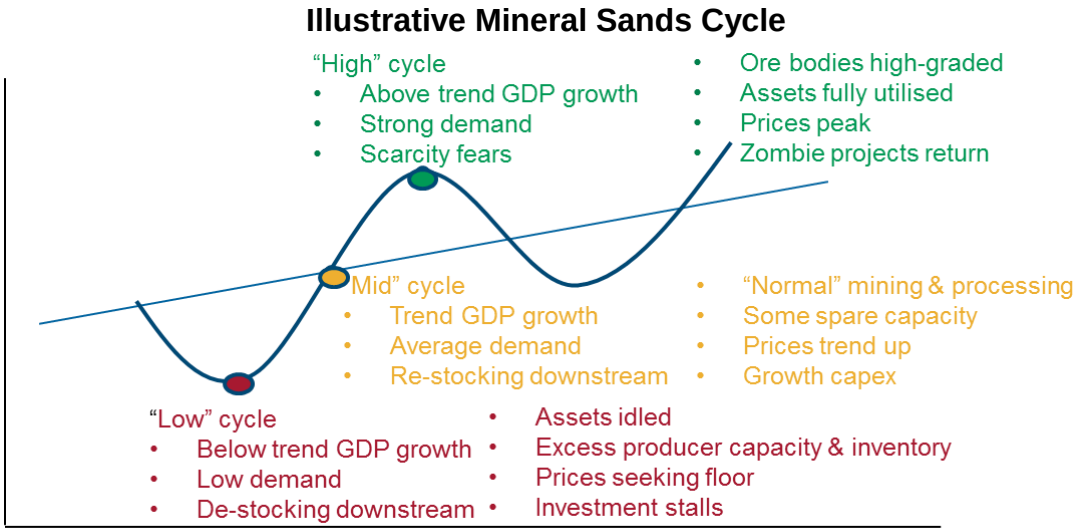


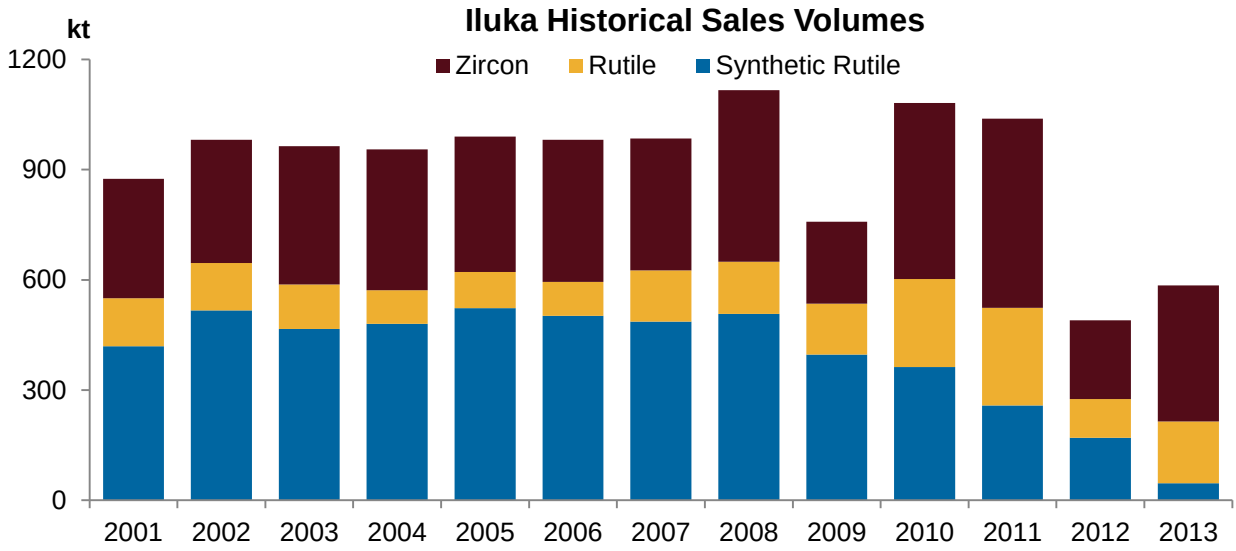
Mineral Sands Cycle Characteristics

The mineral sands industry, as with other sectors, can experience significant volatility in physical sales volumes and financial characteristics over the course of the business cycle. Recent global economic growth volatility and inventory stocking and destocking in the mineral sands chain, have magnified this volatility.

As illustrated in the chart displaying Iluka's historical sales, 2008 and 2010-2011 reflect "high" cycle characteristics with strong end use demand and re-stocking. Before 2008 sales displayed relatively little variation, reflecting the smoothing effect of long term contracts (since lapsed for Iluka).

Demand in 2009 and 2012-13 represents "low" cycle characteristics, including below-trend global growth and de-stocking at some levels of the overall value chain. Sales in 2012 were impacted by coincident low demand for both zircon and high grade titanium dioxide feedstocks. Zircon sales recovered in 2013 though demand for high grade titanium sales remained low.





Iluka's production response measures (which in 2012 included a preparedness to build inventory and in 2013 a material reduction in production) are designed to protect margins during low cycle periods, even if this entails ceding market share, such that a recovery in demand and sales volumes is associated with healthy margin structures.

As evident from Iluka's recent zircon sales and production profile, below, production closes matches sales volumes over time.

It is Iluka's view that the medium term fundamentals for zircon and high grade titanium dioxide products are favourable, based on demand for mineral sands products being linked to:

- urbanisation;
- consumption based growth in developing economies; and
- increasing array of applications.

In addition to the above, Iluka's view is that all unfunded projects will face difficulties in securing funding and offtake for the foreseeable future given the spare capacity held by existing producers. In any respect, there is typically a significant lead time for new production to occur.

Further information on mineral sands cycle characteristics can be found in the Iluka Briefing Paper – Mineral Sands Cycle Characteristics, April 2013.

Iluka Zircon Sales and Production Volumes