REPORT R63/2007

AN OVERVIEW OF SOUTH AFRICA'S ZIRCON INDUSTRY AND THE ROLE OF BEE

DIRECTORATE: MINERAL ECONOMICS

Zircon sand

mineral resources

Department:
Mineral Resources
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ABSTRACT

South Africa's zircon is produced from extensive beach placer deposits located along the eastern, southern and north-eastern coasts, as well as along the west coast, north of Cape Town. Important zircon mining operations are Richards Bay Minerals and Exxaro's KwaZulu-Natal Sands and Namakwa Sands. Since 1996, South Africa's production has been somewhat of a rollercoaster, fluctuating between 328,6 kt/y and 444 kt/y. Currently, South Africa's heavy minerals mining industry stands favourably within the world market, producing just over 40 percent of the world's zircon output in 2006. However, the country's zircon industry is export orientated due to the small nature of the local market. Some of the exported zircon is used in several value added sectors, including chemical beneficiation. In 2006 Geratech became South Africa's only beneficiator of zircon and their products are also exported overseas, where the demand for zirconium downstream products increases by 8% per annum. There has been a fair amount of activity in the local zircon industry, with some new projects already under way and others in the pipeline. The drive to establish Black Economic Empowerment (BEE) participation in the South African mining industry had notable successes in the zircon industry and looks set to be completed within the timelines prescribed by the Mining Charter. Although South Africa is faced with several challenges, such as increasing zircon exports and initiating research and development across the value chain pertaining to the zircon industry, it will still remain one of the major zircon producers for some years to come. The anticipated increase in local zircon production is likely to have a significant effect on the global market where demand continues to exceed supply.

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ABBREVIATIONS AND SYMBOLS

$	US dollars
%	percent
BEE	Black Economic Empowerment
DME	Department of Minerals and Energy
km	kilometers
kt	kilo tons
kt/y	kilo tons per year
KZN	Kwazulu-Natal
MPRDA	Minerals and Petroleum Resources Development Act
MRC	Mineral Resource Commodities
Mt	million tons
RBIT	Richard's Bay Iron and Titanium
RBM	Richard's Bay Minerals
Zr	zirconium

1. INTRODUCTION

Zirconium (Zr) is the 18th most abundant element on Earth — three times more abundant than copper. It occurs in nature as the free oxide ZrO_2 (baddeleyite), but most commonly as zircon, a compound oxide with silica having the chemical formula $ZrO_2 \cdot SiO_2$ or $ZrSiO_4$ (zirconium silicate). Zirconium in ores is associated with small amounts of the chemically similar element hafnium, with the relative hafnium content being 1–3% (typically 2%).

Zircon occurs naturally as a common accessory mineral in igneous rocks such as granitic pegmatites and syenite, and also in metamorphic rocks such as schists and gneiss. Weathering processes, together with the tendency for zircon to naturally separate from ordinary silica sand due to its high density, have led to the formation of large secondary deposits of zircon sand in river and beach placers. The zircon in these deposits is usually associated with other heavy minerals[1] such as ilmenite and rutile (both of which are titanium bearing minerals), monazite, garnet, staurolite and kyanite.

Since the 1960s, zircon has developed from a low value by-product to an important co-product of the mining and processing of heavy mineral sands for the extraction of the titanium minerals, viz ilmenite and rutile. Heavy mineral sand deposits typically contain 1–10% heavy minerals. These are processed by gravity separation to produce a concentrate containing more than 95% heavy minerals. Zircon, along with other minerals of value such as ilmenite, rutile and monazite, is separated from the complex mineral mix by magnetic and electrostatic separation processes. Most zircon production is exported in bulk from the country of origin in seagoing bulk carriers, unpackaged. A shipment is typically 1kt, but may be as high as 10 kt.

Zircon is used in refractories as foundry sand moulds. It is also used as a corrosion resistant metal in nuclear reactors and chemical processing equipment. Zircon sand applications include glazes in pottery and ceramics. Chromite and olivine can be used as a substitute for some foundry applications, whilst dolomite and spinel refractories

[1] Heavy minerals are defined as minerals with densities exceeding 3000 kg/m^3.

can substitute for zircon in certain high-temperature applications. Niobium, stainless steel, and tantalum also provide limited substitution for zircon .

2. STRUCTURE OF SOUTH AFRICA'S ZIRCON INDUSTRY

2.1 Main Producers

In South Africa, zircon is produced from the extensive beach placer deposits located along the eastern, southern and north-eastern coasts. Smaller deposits are located along the west coast, north of Cape Town. Generally, South Africa contribute almost 40 percent towards the 1 Mt zircon output globally. Important mining operations in zircon production are Richards Bay Minerals and Exxaro's KwaZulu-Natal Sands and Namakwa Sands.

Richards Bay Minerals (RBM), the largest zircon producer in South Africa, has enormous reserves along the KwaZulu-Natal coastlines situated along the eastern coast of South Africa. Richards Bay Minerals is the trading name for two registered companies, Tisand (Pty) Ltd and Richards Bay Iron and Titanium (Pty) Ltd (RBIT). Tisand undertakes the dune mining and mineral separation operations, while the smelting and beneficiation processes are carried out at RBIT. The company is jointly owned by Rio Tinto plc and BHP Billiton, and is one of the largest standalone mining operations in South Africa.

After acquiring Namakwa Sands from Anglo American, Exxaro Sands is strategically placed as one of the world's top three suppliers of zircon. In addition, Exxaro Sands currently comprises KZN Sands (formerly known as Ticor SA), which houses the South African operations, and Australia Sands, which houses the Australian operations.

Namakwa Sands' mining operations are located at Brand-se-Baai, approximately 60 km west of Koekenaap on the west coast of South Africa. Its major assets are:

- a mineral sands mine at Brand-se-Baai, consisting of a mine, primary concentrator plants and a secondary concentrating plant

- a mineral separation plant, 7 km west of Koekenaap, used to separate ilmenite, rutile and zircon products
- a smelter near Saldanha Bay where ilmenite is smelted to produce titanium dioxide slag and low manganese pig iron.

KZN Sands is focused on the exploration, mining and treatment of mineral sands deposits in KwaZulu-Natal, and exploration in Limpopo and Eastern Cape provinces in South Africa. The operation currently produces ilmenite, zircon and rutile through hydraulic mining from Hillendale mine, 20 km south-west of Richards Bay, to produce slurry for the mine's primary wet plant. Further processing, including smelting ilmenite to produce titanium dioxide slag, takes place at the central processing complex in Empangeni, 20 km west of Richards Bay.

2.2 Production, Consumption and Markets

Since 1996, South Africa has accumulatively produced a total of 4,3 Mt of zirconium mineral concentrates. The production has been somewhat of a rollercoaster, fluctuating between 328,6 kt/y and 444 kt/y (Figure 2). Generally, the production has increased from 363,5 kt/y in 1996 to 435 kt/y in 2006. Currently, South Africa's heavy minerals mining industry stands favourably within the world market, producing just over 40 percent of the world's zircon output in 2006. Global mine production of zircon concentrates increased to 1,05 Mt in 2006, a significant increase of 8,2 percent when compared with that of 2005 (Figure 2). Major producers were Australia (0,48 Mt) and South Africa (0, 43 Mt), who collectively represent 87,4 percent of world total production. World reserves base for zircon concentrates remained unchanged at 72 Mt in 2006, with Australia (30,0 Mt) and South Africa (14,0 Mt), together accounting for 61,1 percent of the world total reserve base.

Of particular interest is the fact that since 1999, South Africa has annually exported more than it has produced (Figure 1), although there has been some local sales as well. The additional zircon exported may be from the stock build-up that was accumulated when the global demand for zircon was less than the supply. However, the gradually decreasing difference observed between production and export sales

since 2004 suggests the likelihood of the situation to change in the near future, a result of the prevailing demand that currently exceeds supply.

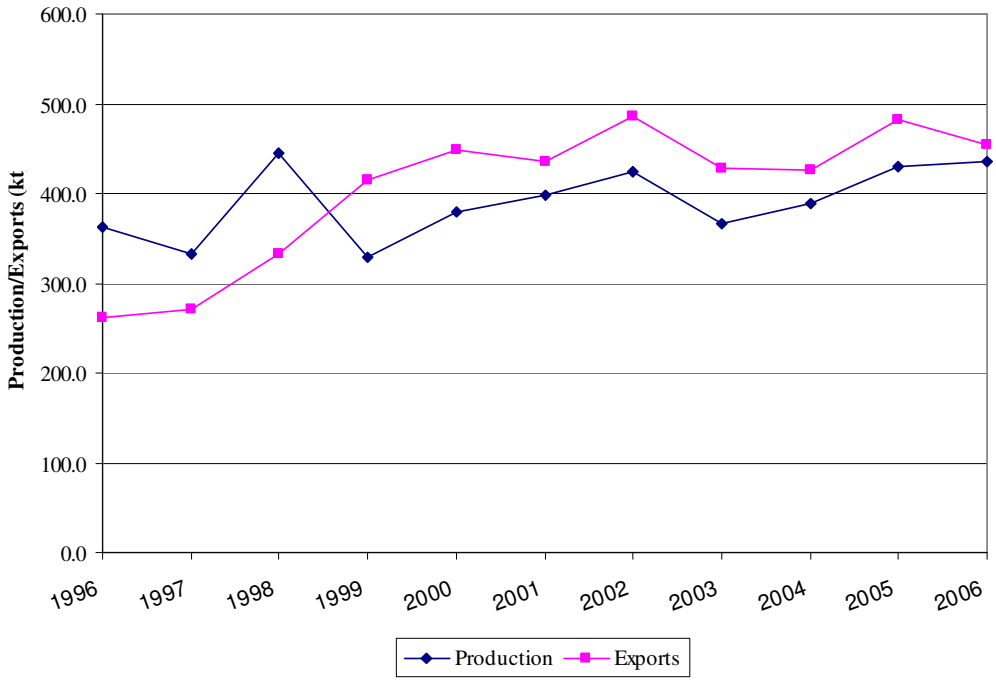

Figure 1: South Africa's zircon production and export sales since 1996.

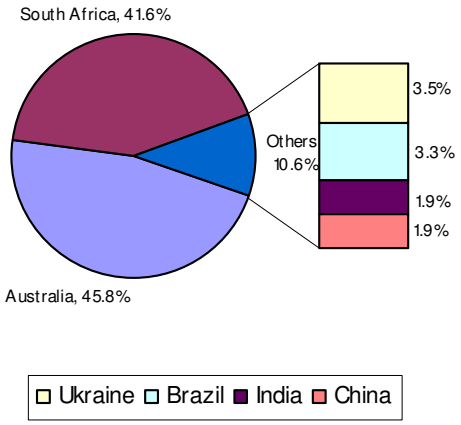

Figure 2: Percentage contribution of different countries to the 1,05 Mt zircon world output.

The small nature of the local zircon market is the reason why the local industry is export orientated. The bulk of South African zircon exports is used in a wide range of applications including ceramics, chemicals and TV glass. The global consumption of zircon in 2006 was approximately 1,2 Mt, with percentage distribution dominated by ceramics (51 percent), refractory (15 percent) and foundry (15 percent), (Figure 3).

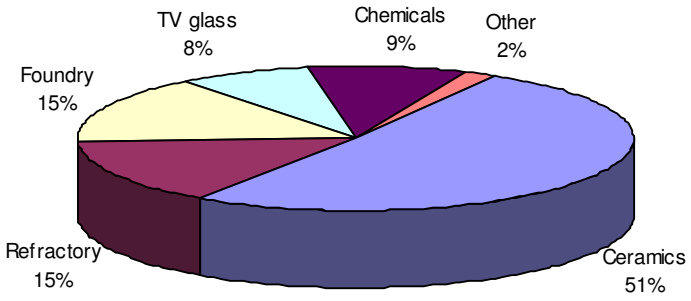

Figure 3: Global consumption of zircon, 2006.

The zircon market performed strongly in 2006, displaying a tight supply-demand dynamics, with the 1,05 Mt zircon supply at 150 kt below demand. This resulted in 20 percent increase in annual zircon price. Such market conditions, coupled with demand from the pigment industry, led to the current state of buoyancy for the heavy minerals, particularly zircon industry. However, the industry could face a quieter period in the immediate future due to the possible influx of new entrants into the industry and expansion projects (see section 2.4), resulting in the softening of prices until markets are able to catch up with new supply.

2.3 Adding Value to Zircon

The bulk of South Africa's zircon is exported abroad and is used in several value added sectors, including chemical beneficiation. In 2006 Geratech became South Africa's only beneficiator of zircon. This was the company's first year of commercial production of significance, when it produced between 4,5 kt and 5 kt of value added zircon chemicals and oxides. Before Geratech developed the technology in South Africa, zircon beneficiation was limited mainly to China.

Zircon chemicals and oxides are used in a wide range of environment-friendly applications, as it provides a safe alternative to the use of dangerous chemicals, such as formaldehyde resins in the paper industry, chrome in the leather industry and lead in the paint industry. There are at least 50 industries that use beneficiated zircon in their products, one of which is the manufacturing of antiperspirants. The mineral finds its main applications in the opacifier market, where it is used to provide white brilliance to products such as ceramics.

Geratech's products are mainly exported overseas, where the demand for zirconium downstream products increases by 8% per annum. While zircon is sold for US$600/t to US$800/t, beneficiated zirconium products sell for between US$1 600/t and US$300 000/t. This certainly augurs well for the Minerals and Petroleum Resources Development Act (MPRDA), and thus presents the need to promote local zircon beneficiation, in order to positively contribute to the growth of the local economy. Geratech's medium-term plans are to capture about 5% of the market for zircon chemicals and oxides and the company is focusing on producing zirconium tetrachloride, a process that will use significant quantities of chlorine gas.

2.4 Recent and Future Developments

2.4.1 Southern Mining Corporation Projects

Southern Mining Corporation has the mining rights to the Bothaville heavy mineral occurrence, with 90 Mt estimated reserves. The total inferred resource is estimated in excess of 185 Mt, and in situ heavy mineral reserves in excess of 50 Mt, based on an estimated heavy mineral grade of 30 percent. Additionally, an estimated 40Mt

comprises the in situ valuable heavy minerals which, at a 75 percent recovery, should yield 30 Mt of valuable heavy minerals. The composition of heavy minerals reserves is estimated to be ilmenite (68 percent), zircon (9 percent), other titaniferous minerals (23 percent) and Monazite (<1 percent).

2.4.2 Exxaro Heavy Minerals Projects

Grinaker-LTA M&E's newly formed metals and minerals division in 2006 secured the contract for all the multidisciplinary construction work on 'Project 1000' at Exxaro's Namakwa Sands on the West Coast of South Africa. A US$43-million expansion is under way to increase the output of zircon and rutile products by 25%, and use the full capacity of the mineral separation plant. The project was commissioned in the first half of 2007 and will extend the economic life of the operation by approximately 10 years.

Exxaro's proposed Fairbreeze mine is 45 km south-west of Richards Bay and designed to supplement mining output produced by Hillendale to enable KZN Sands' mineral separation plant to operate at design capacity of 105 tonnes per hour. A feasibility study was completed in June 2005, while environmental and water licence approvals were obtained during the second half of 2006. Subject to anticipated mining license approval, construction of the Fairbreeze mine will start, with commissioning planned for July 2008. Fairbreeze will be a hydraulic mining operation, requiring estimated capital expenditure of R645 million, with an approximate life of mine of 10 years.

Several mineral sands exploration projects by Exxaro are in various stages of investigation. These include:

- Letsitele – Limpopo province
- Gravelotte – Mpumalanga province
- Port Durnford – KwaZulu-Natal province
- Fairbreeze Project Blocks A, B and D – KwaZulu-Natal province
- Centane – Eastern Cape province

2.4.3 Australian Mineral Resource Commodities Project

An Australian mining company, Mineral Resource Commodities (MRC), has applied for the mining rights of the R11 billion titanium and zircon deposits of Xolobeni Mineral Sands Project on the Pondoland coast in the Eastern Cape. Feasibility studies demonstrated that the Xolobeni Mineral Sands Project has 22 year mine life and expected to produce 250 kt/y and 19 kt/y of ilmenite and rutile, respectively. The mine is also expected to produce 15 kt/y each of zircon and leucoxene. However, plans to develop the mine faces stiff opposition from environmentalists on the basis of possible eco-tourism potential destruction of the region with few long-term benefits. As stipulated by the Department of Minerals and Energy (DME), granting of the mining rights will be judged according to a number of social and environmental criteria.

3. THE ROLE OF BEE

The drive to establish Black Economic Empowerment (BEE) participation in the South African mining industry had notable successes, including the zircon industry. The South African government requires mining companies investing in the country to sell 15 percent of their equity to black investors by 2009, and 26 percent by 2014, to accelerate black participation in the economy. The process of finding equity partners within the zircon industry is at an advanced stage and looks set to be completed within the timelines prescribed by the Mining Charter.

Richards Bay Minerals (RBM) intend to allocate 24 percent to a BEE consortium and 2 percent to its employees. The consortium would include host communities, as well as consortiums representing a KwaZulu-Natal-based women's group, and a national partner. RBM intends to finalise the transaction by the end of this year, depending partly on how quickly the financing arrangements, due diligence, and regulatory approval could be finalised.

Both Namakwa Sands and KwaZulu-Natal Sands belong to Exxaro, South Africa's largest black-controlled diversified mining company. The former used to belong to Anglo American, while the latter was known as Ticor SA (51 percent owned by Kumba Resources), before it was acquired by Exxaro to be known as KwaZulu Natal

Sands. Exxaro was formed from a R16-billion transaction between Kumba Resources, BEE company Eyesizwe Coal and Anglo American, in which Kumba's assets were merged with Eyesizwe Coal. The deal also included options, which have since been exercised, for Exxaro to acquire Anglo American's Namakwa Sands minerals sands operation.

Mineral Resource Commodities of Australia entered into a BEE agreement with the community-based Xolobeni Empowerment Company (Xolco), which will pay approximately R126 million for a 26 percent ownership. The Xolobeni Mineral Sands Project is the tenth largest mineral deposit in the world and believed to contain more than 9 Mt of ilmenite and the associated zircon.

4. RESEARCH AND DEVELOPMENT

South Africa has witnessed very little research and development across the value-chain pertaining to the zircon industry. Currently, notable research and development is carried out by Geratech, in collaboration with tertiary institutions and organisations such as the University of Pretoria, Technikon of Pretoria, NECSA (South African Nuclear Energy Corporation), Sasol Technologies, Zircoa USA and the South African Government's Research Foundation. Emerging markets are at the centre of the company's research and development efforts. Developments for this market segment include a range of stabilised oxides for the solid oxide fuel cell industry, zirconium isotopes, hafnium free atomic grades oxides and zircon metal.

5. CHALLENGES AND BARRIERS TO DEVELOPMENTS

Soaring Chinese demand for minerals and metals, in general, as well as heavy-minerals mined and processed in South Africa and the rest of the continent is necessitating a supply-side scale-up. Traditionally, South Africa is faced with the challenge of increasing mineral exports through responding with projects to raise output in order to meet this demand.

The heavy minerals mining industry requires a high level of skill from its employees as it tends to be technologically oriented. At present, a high demand for education and skills development within the heavy minerals mining industry, due to the heavy emphasis on technological development, and the current skills shortage is therefore

causing extreme difficulties for the industry. There are plans being implemented to change the current status quo, with industry stakeholders engaging students at many educational establishments and universities taking students on plant tours.

6. OUTLOOK

South Africa will remain one of the major zircon producers for some years to come. Local zircon production is set to increase in future, partly due to the influx of new entrants into the industry and the expansion projects, such as that of the Namakwa Sands. Furthermore, with several mineral sands exploration projects by Exxaro in various stages of development, one can forecast a significant increase in zircon supply from South Africa in the not-so-distant future. This is likely to have a significant effect on the global market where demand continues to exceed supply.

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