



Union of Independent Experts in the Field of Mineral Resources, Metallurgy
and Chemical Industry

Zirconium Resources Market Research in the CIS

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Annotation

The present report is devoted to research of current conditions of the market of zirconium raw materials in Russia and the CIS countries and to the forecast of its development. The report consists of five parts, contains 82 pages, including 19 drawings, 27 tables and 3 supplements. This work is a desk research. As information sources the data of Rosstat, the State committee of statistics for CIS countries, Federal customs service of the Russian Federation, the branch official statistics of rail transportation of the Russian Federation, the branch and regional press, annual and quarterly accounts of emitters of securities, and also Internet sites of the enterprises-manufacturers were used. Because cargo transportation by motor transport is not subject to obligatory statistical account in Russia, in the present report the data about the transportations, which are carried out by rail, and the data of some enterprises is cited only.

The Report Chapter 1 gives data on mineral raw-material base of zirconium and extraction of zirconium bearing ores abroad. There is data on world production of mineral concentrates. The Chapter contains information on the major world producers; the standards on zirconium concentrates are mentioned too. We highlighted the basic fields of zirconium concentrates use, and cited the world prices for this kind of mineral raw materials.

The Second Chapter of the Report is devoted to the analysis of mineral raw-material base and extraction zirconium bearing ores in Russia and the CIS. The Chapter contains data on the largest manufacturers of zirconium concentrates in Ukraine and Russia. There is data on process technology and the applied equipment, assortment and quality of production, volumes of output and plans for development of the enterprises.

The Third Chapter is devoted the analysis of foreign trade operations in Russia and Ukraine with zirconium concentrates in 2001-2007. We give dynamics of export from Russia of baddeleyite concentrate and import to Russia of zirconium concentrate, volumes and avenues of its deliveries.

In the Fourth Chapter consumption zirconium and baddeleyite concentrates in Russia is discussed. It describes the calculation of consumption of zirconium bearing concentrates, gives the structure of their application, explains the basic areas of consumption and cites enterprises-consumers.

In final, the Fifth Chapter of the Report there is a forecast of development of the Russian market of zirconium raw materials until 2018. The outlook for its manufacture and consumption in Russia is presented in two variants – at optimistic and pessimistic succession of events in the market of described production.

Introduction

Zirconium belongs to a group of rare metals; though in earth crust it surpasses many nonferrous metals in prevalence (copper, zinc, tin, etc.).

Some 20 zirconium and zirconium bearing minerals are known, however only two of them have industrial value: zirconium silicate – zircon $ZrSiO_4$ (contains 60-67% of ZrO_2) and natural zirconium oxide – baddeleyite ZrO_2 (contains 95-97% of ZrO_2). The share of the former stands at least 97% of the overall manufacture of zirconium raw materials. Possibilities of industrial application of one more widespread zirconium mineral – eudialyte – composite silicate of zirconium and rare earths of yttrium subgroup, containing 10-16% of ZrO_2 - are being investigated.

Zirconium and baddeleyite are accumulated in crust by weathering, and products of their resedimentation – deposits of neighboring driftage, closely associated with primary ore bodies, and in deposits of distant driftage – lacking direct connection with ore bodies. The latter includes modern and ancient deposits of coastal-maritime type (beach, shelf, dune, etc.) with which zircon major fields (together with rutile, ilmenite, monzite and other minerals) are associated.

Practically zirconium does not form large and rich deposits of its own, as it is being contained in solid ore deposits and alluvial deposits together with titanium, iron, copper, tantalum, niobium, rare earths where it is one of the major or associated commercial minerals. Extraction of zirconium from bowels is always closely connected with extraction of titanium and is valued in relation to it as 1:5.

World production of zirconium bearing concentrates has exceeded 1,4 million tons. Zirconium products include both natural mineral concentrates (zirconium and baddeleyite), and products of their processing – all of them enjoy great demand in the world.

The overwhelming part of zirconium concentrates (85-90%) finds application in mineral form as raw materials at manufacturing of high-quality ceramics, glaze, enamels, at manufacturing of fusion-cast refractory for foundry, glass making and other manufactures. Only 10-15% of concentrates goes for processing into metal, its alloys, as well as into hafnium. Metal zirconium, being an absolute "transmitter" of neutrons, is widely used as envelope of fuel elements and as a constructional material for nuclear reactors in load-bearing structures of an active zone. Zirconium is also used as alloying additive to manufacture of special steels, in chemical mechanical engineering, as constructional material in devices working in aggressive media, and in other areas of mechanics. Various

zirconium compounds are used for manufacture of various refractory materials, ceramics, glaze, in specialized glasses, for skin curing, impregnation of fabrics, etc.

Zirconium concentrates are a unique source of hafnium, which contains in them at volumes of 0.5-2.0% of HfO₂.

The overwhelming volume of output of zirconium concentrates in the CIS falls within Ukraine. Level of development of mineral raw-material base of zirconium in Russia is extremely low: now only Kovdorsky deposit of baddeleyite ore is being under development. There is practically no manufacture of zirconium concentrates in the Russian Federation, though here are considerable stocks of deposits in the pipeline.

1. Zirconium mineral raw material base and zirconium ores mining abroad

1.1. Reserves and deposits of zirconium

According to estimates by USA Geological service (USGS), the total reserves of zirconium (in terms ZrO_2) in the world make about 34 million tons (excluding Russia and CIS countries). Zirconium in ores and alluvial deposits is mainly represented by zircon, baddeleyite, eudialyte.

Deposits of ores and alluvial deposits bearing zirconium, were discovered in Australia, the USA, the Republic of South Africa, Brazil, India, China and other countries, their reserves are presented in Table 1.

Explored reserves of zirconium in the world are distributed as follows (%): Australia – 45%, the Republic of South Africa – 21%, Brazil – 7%, the USA – 8%, China – 5,6% and India-5,7%.

Table 26. World Reserves of Zirconium According to Estimate of USA Geological Service (excluding Russia and CIS countries)

Country	Total reserves, mt of ZrO_2	Discovered resources (including reserves), mt of ZrO_2	Median content of ZrO_2 , %
USA	3.4	5.3	0.2-0.3
Australia	9.1	30.0	0.2-1.7
Brazil	2.2	4.6	0.3-4.7
China	0.5*	3.7	0.2-0.3
India	3.4	3.8	0.06-0.6
South Africa	14.0	14.0**	0.3-0.4
Other countries	0.9	4.1	-
Total	34	66	-

*Other sources say PRC boasts discovered resources of zirconium at over 2.1 mt.

** Including baddeleyite deposits from primary mine at Palabora.

Source: USGS

Distinctive feature of structure of world's reserves is the prevailing share of titan-zirconium alluvial deposits. The basic industrial world's reserves of zirconium (over 95%) are contained in coastal-marine alluvial (CMA), where zirconium sits together with titanite (ilmenite, rutile) and rare-earth minerals. Average grade of zircon in sands of CMA varies largely – from the 100-th portion of percent to three percent (seldom reaching 8%). Reserves and resources of zircon of coastal-marine alluvial are characterized by vast scales – up to several millions of ton of zirconium dioxide in certain deposits.

Baddeleyite bearing ores account for about 5 % of world industrial reserves of zirconium. Its reserves are counted in several hundreds of thousands tons.

Security of the countries-manufacturers with measured reserves of zirconium raw materials, calculated on the level of operating capacities at extraction, as a whole exceeds 80 years.

Australia

Australia until now remains the world leader at manufacturing of zirconium concentrate, possessing the largest alluvial deposits, which amass along lengthways of its western and eastern coasts, as well as in the south of Australia in Murray River basin.

Alluvial deposits of Australia are being intensively mined at annual extraction volume of zirconium up to 500,000 ton a year. Its overall reserves in this country provide the enterprises 55 years of operation. Titan-zirconium alluvial deposits at the western coast of Australia provide 25% of zirconium concentrate production in the world. Despite large established reserves of heavy minerals in Australia, prospecting works for the purpose of exploration of new deposits are intensively underway.

Republic of South Africa

According to Geological service of the USA, zirconium reserves in the Republic of South Africa are estimated at 14 million tons (including all available data from inventory of world strategic resources).

The largest alluvial deposit been explored since 1977 – Richards-Bay in northern part of Natal province at eastern coast of Republic of South Africa. Zircon reserves there are estimated almost at 7 million tons with zirconium grade at 6-8 kg/m³. In result of prospecting works, the reserves in Natal province have been increased.

United States of America

Ilmenite-rutile-zirconium alluvial deposits were discovered in Florida, Georgia, Virginia and Tennessee states of the USA.

The confirmed reserves of sands in state of Florida are assumed at 20 million tons of heavy minerals, of which zircon makes 1 %, rutile – 11 % and ilmenite – 40 %. Reserves of being mined deposit in Virginia account for 5 million ton of heavy minerals, of which 19% account for zirconium. Reserves of heavy minerals in Tennessee are assumed at 17.6 million tons.

China

Chinese alluvial deposits both coastal-marine and continental usually contain small reserves of heavy minerals (tens and several hundreds thousand ton of zirconium). In addition, just in alluvial deposits at Guangdong province, the zircon reserves are assumed at 1.07 million tons of the mineral and endowment it stands for 30 years.

Other countries

Brazil and India play subordinate role by reserves and extraction of zirconium while certain deposits there are noted for high grade of heavy metals (India and Sri-Lanka – up to 80%), including zirconium. High radioactivity is one of characteristics of Asian zirconium.

Total reserves of zirconium at Mozambique (Moma mine) are 7.8 million tons. Alluvial deposits overlie the surface of soil.

Ore region - Grand-Cot in Senegal - stretching along the coastline over 50 km was discovered in this country in 1990-s. Indicated resources of leucogene-zirconium-ilmenite sands account for 800 million tons, containing 1.0 million tons of zirconium.

Significant zirconium resources are associated with eudialyte ores. Eudialyte is a composite mineral. Formerly it was considered exclusively as the source of zirconium extraction (13.7% of zirconium oxide). Eudialyte bears 0.3% of hafnium oxide; 0.8% of columbium pentoxide; 0.75 of tantal and 2.3% - sum of rare earths. In this connection, there was sharp increase of interest to commercial evaluation of eudialyte ores in Greenland and the USA.

Shared resources of zirconium raw material exceed measured and prospective reserves manifold. Strong demand for zirconium product in the world promotes geological prospecting work aimed at identification of new zirconium-bearing alluvial deposits.

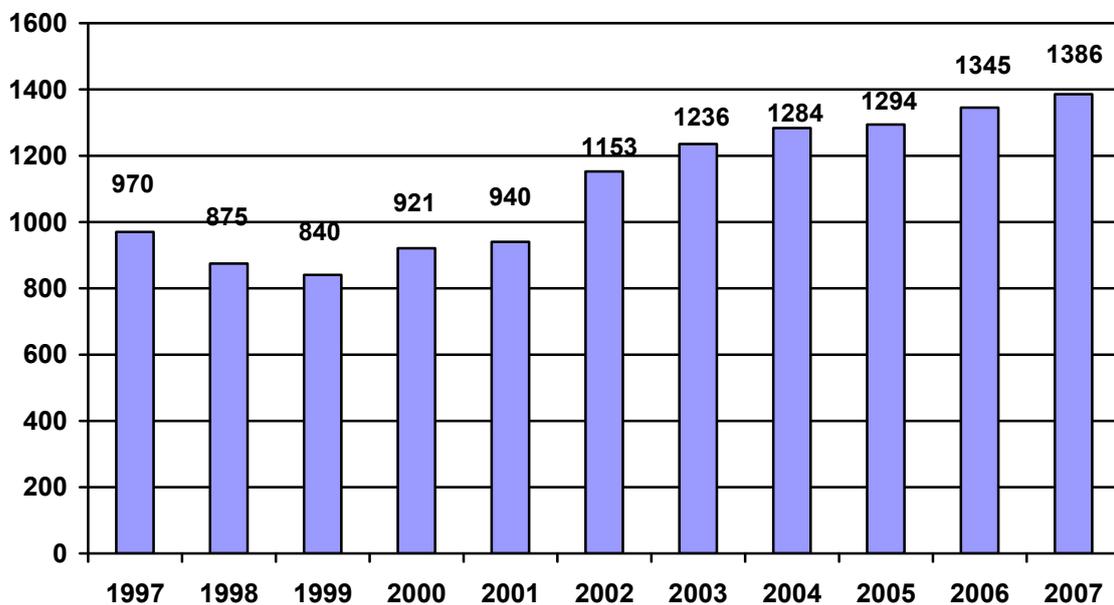
1.2. World Production of Mineral Concentrates (1997-2007). Major Companies-producers of Zirconium Raw Materials

Zirconium and baddeleyite concentrates are key types of zirconium raw materials. Zirconium concentrate accounts for over 97% share in the world zirconium raw materials production, baddeleyite concentrate – near 3%.

Zirconium is produced predominantly in the course of development of ilmenite-rutile-zirconium alluvial deposits. None of deposits in the world produces exclusively zirconium. Mass ratio of zirconium concentrate in value of tradable product at most titan-zirconium mines stands at 15-20%. Production of zirconium concentrate in the world grows further and under Infomine assumptions accounted for 1.4 million tons as of the end of 2007. During the last decade, production of zirconium concentrate grew steadily (excluding 1998 when demand for this raw material dropped due to crisis). Rising prices and great need for zirconium concentrate stimulated search and prospecting for new deposits, their development as well as revision of earlier discovered mines.

Figure 1 demonstrates dynamics of the world production of zirconium concentrates.

Figure 20. Dynamics of the world production of zirconium concentrate in 1997-2007, 000 tpa



Source: assessment by Infomine of USGS data

Table 2 presents production of zirconium concentrate by countries for the last four years.