USGS
science for a changing world

2006 Minerals Yearbook

ZIRCONIUM AND HAFNIUM

U.S. Department of the Interior
U.S. Geological Survey

February 2008

Zirconium and Hafnium

By Joseph Gambogi

Domestic survey data and tables were prepared by Mahbood Mahdavi, statistical assistant, and the world production table was prepared by Linder Roberts, international data coordinator.

World production of zirconium mineral concentrates in 2006, excluding U.S. production, was estimated to be 1.18 million metric tons (Mt) compared with 1.09 Mt in 2005. Because of the closure of mines in Florida and Georgia, domestic production of zircon decreased in 2006 compared with production in 2005. Production of milled zircon and zirconium oxide increased compared with that of 2005. The United States was a net exporter of zirconium ore and concentrates. U.S. imports of zirconium ore and concentrates decreased by 5% compared with those of 2005, and domestic exports of zirconium ore and concentrate decreased by 24%. Prices for zirconium mineral concentrates increased significantly.

The principal economic source of zirconium is the zirconium silicate mineral zircon ($ZrSiO_4$). A relatively small quantity of zirconium is derived from the mineral baddeleyite, a natural form of zirconium oxide or zirconia (ZrO_2). In 2006, zircon was mined at many locations worldwide, primarily Australia, South Africa, and the United States. Baddeleyite was produced from a single source at Kovdor, Russia.

With the exception of prices and referenced data, all survey data in this report have been rounded to no more than three significant digits. Totals and percentages were calculated from unrounded numbers.

Production

Data for zirconium and hafnium manufactured materials are developed by the U.S. Geological Survey from a voluntary survey of domestic operations. Of the 44 operations surveyed, 31 did not respond. Data for nonrespondents were estimated on the basis of prior-year levels.

Data for zircon concentrates are developed by a second voluntary survey of domestic mining operations. Of the two domestic zircon producers, 100% responded. Data on domestic production and consumption of zircon concentrates were withheld to avoid disclosing company proprietary data.

Domestic production of milled zircon and zirconium oxide was 33,500 metric tons (t) and 21,700 t, respectively (table 1). Domestic production of zircon concentrate in 2006 decreased compared with that of 2005.

Zircon is normally produced as a coproduct or byproduct of the mining and processing of heavy-mineral sands. In 2006, U.S. producers of zircon were DuPont Titanium Technologies [a subsidiary of E.I. du Pont de Nemours & Co. (DuPont)] and Iluka Resources, Inc. (a subsidiary of Australian company Iluka Resources Ltd.). DuPont produced zircon from its heavy-mineral sands operation near Starke, FL. Iluka produced zircon from its heavy-mineral sand operations at Green Cove Springs, FL, Lulaton, GA, and Stony Creek, VA.

In 2006, Iluka was shutting down operations in Florida and Georgia. Mining in Florida and Georgia ceased in February and June, respectively. However, the mineral separation plant continued to process tailings rich in zircon. Iluka's production of zircon concentrate in Florida decreased by 48% compared with that in 2005, and in Virginia decreased slightly compared with that in 2005. Iluka began a prefeasibility study of the Brink deposit to support the continued operation of its Stony Creek mining operations. The Brink deposit is about 48 kilometers south of the Stony Creek mining operations (Iluka Resources Ltd., 2007, p. 14, 23.)

U.S. producers of zirconium and hafnium metal were Wah Chang (an Allegheny Technologies, Inc. company), Albany, OR, and Western Zirconium (a subsidiary of Westinghouse Electric Co.), Ogden, UT. Primary zirconium chemicals, those produced directly from zircon, were produced by Wah Chang and Magnesium Elektron Inc., Flemington, NJ. Secondary zirconium chemicals, produced from intermediate zirconium chemicals, were produced by about 10 companies. Zirconia was produced from zircon sand at plants in several States.

In 2006, the multinational company Imerys Group announced a bid for UCM Group PLC, a leading producer of fused zirconia with operations in the United Kingdom and the United States. Universal America Inc. (UAI), Greeneville, TN, is UCM's principal site for the production of monoclinic and stabilized zirconia. UAI has a capacity of more than 10,000 metric tons per year (t/yr). In addition, UCM's Unitec Ceramics, Stafford, United Kingdom, produced fine-sized zirconia for the advanced ceramics market. At yearend, UCM's board of directors unanimously recommended that its shareholders accept the offer (Imerys Group, 2007, p. 17, 19, 158).

Consumption

Global consumption of zircon was estimated to have increased to 1.22 Mt in 2006, a 1.7% increase compared with that of 2005. Ceramics (54%), refractories (13%), and foundry (13%) were reported to be the leading consuming sectors. Consumption of zircon in North America was estimated to be about 140,000 t (TZ Mineral International Pty Ltd., 2007).

Zircon is the primary source of hafnium. Zirconium and hafnium are contained in zircon at a ratio of about 50 to 1. Zircon is a coproduct or byproduct of the mining and processing of heavy-mineral sands for the titanium minerals ilmenite and rutile or for tin minerals. The major end uses of zircon are, in descending order of quantity, refractories, foundry sands (including investment casting), and ceramic opacification. Zircon is also marketed as a natural gemstone and is processed to produce cubic zirconia, a diamond and colored gemstone

simulant. Zirconium metal is used in nuclear fuel cladding, chemical piping, pumps, and valves in corrosive environments, heat exchangers, and various specialty alloys. The principal uses of hafnium are in nuclear control rods, nickel-base superalloys, nozzles for plasma arc metal cutting, and high-temperature ceramics.

Stabilized zirconium oxide exhibits high light reflectivity and good thermal stability and is primarily used as an opacifier and pigment in glazes and colors for pottery and other ceramic products. Yttria-stabilized zirconia (YSZ) is used in the manufacture of oxygen sensors that control combustion in furnaces and automobile engines. YSZ is also used in the manufacture of a diverse array of products, including high-temperature, high-strength structural ceramics, heat- and break-resistant shirt buttons, golf shoe spikes, golf putters, fiber optic connector components, refractory coatings for jet engines, and cubic zirconia, a gemstone simulant for diamonds and colored gemstones. YSZ is increasingly used in dental applications as inlays, crowns, and bridges, as it has two to three times the fracture resistance and 1.4 times the strength of similar alumina products.

Zircon, used for facings on foundry molds, increases resistance to metal penetration and gives a uniform finish to castings. Milled or ground zircon is used in refractory paints for coating the surfaces of molds. In the form of refractory bricks and blocks, zircon is used in furnaces and hearths for containing molten metals. Glass tank furnaces use fused-cast and bonded alumina-zirconia-silica-base refractories. Baddeleyite is used principally in the manufacture of alumina-zirconia abrasive and in ceramic colors and refractories.

Ammonium- and potassium-zirconium carbonates are used as paper and board coatings or insolubilizers for high-quality print performance. Zirconium chemicals are also used in inks to promote adhesion to metals and plastics and as crosslinkers in polymers and printing inks.

Because of its low thermal neutron absorption cross section, hafnium-free zirconium metal is used as cladding for nuclear fuel rods. Commercial-grade zirconium, unlike nuclear grade, contains hafnium and is used in the chemical process industries because of its excellent corrosion resistance. Hafnium is used in nuclear control rods because of its high thermal neutron absorption cross section. However, the leading end use for hafnium metal is as an alloy addition in superalloys.

Prices

In 2006, high demand for zircon concentrates resulted in increased prices. The average value of imported ore and concentrates increased to $791 per metric ton in 2006 from $674 per ton in 2005. The average value of zircon ore and concentrates exports increased to $907 per ton in 2006 from $734 per ton in 2005. Yearend published prices for bulk grades of zircon increased significantly. Australian bulk free on board (f.o.b.) zircon prices increased to $700 to $775 per ton at yearend 2006 from $620 to $700 per ton at yearend 2005. U.S. bulk f.o.b. prices for zircon concentrate increased to $785 per ton in 2006 from $570 per ton in 2005 (table 2).

Foreign Trade

The United States was a net exporter of zirconium ore and concentrates in 2006. U.S. exports of zirconium ore and concentrates were 76,300 t, a 24% decrease from those of 2005 (table 3). The United States was a net exporter of zirconium and hafnium metal in 2006. U.S. exports of zirconium metal were 1,880 t, a 5% decrease in quantity from the 2005 level. In 2006, the majority (84%) of zirconium metal was exported in wrought products.

U.S. imports of zirconium ore and concentrates were 36,200 t, a decrease of 5% from the 38,200 t imported in 2005 (table 4). Australia and South Africa supplied 96% of the imports of ores and concentrates.

Imports of unwrought zirconium were 213 t in 2006, and the leading sources were, in descending order of quantity, France (60%), Germany (31%), China (8%), and Japan (2%). Imports of zirconium waste and scrap were 43 t in 2006, and the leading sources were, in descending order of quantity, France (42%), the United Kingdom (26%), and Canada (21%). Domestic imports of ferrozirconium alloys were 197 t in 2006, a 36% decrease from the 306 t imported in 2005. In 2006, ferrozirconium imports originated primarily from Brazil (95%). U.S. imports of hafnium were about 4 t in 2006, an 8% decrease compared with those of 2005.

World Review

Excluding U.S. production, world production of zirconium mineral concentrates in 2006 was estimated to be 1.18 Mt, a moderate increase compared with the revised 2005 data (table 5). Australia and South Africa supplied about 75% of production outside the United States. World reserves of zircon are estimated to be 38 Mt of zirconium oxide content. During 2006, the heavy-mineral sands industry continued to be active in the exploration and development of mineral deposits on a global basis, particularly in Australia, Mozambique, South Africa, and the United States. Major zircon producers were, in order of decreasing production capacity, Iluka (Australia/United States), Richards Bay Minerals (RBM) (South Africa), Namakwa Sands (Pty.) Ltd. (South Africa), Tiwest Joint Venture (Australia), DuPont (United States), Ticor South Africa (Ticor SA) (South Africa), Consolidated Rutile Ltd. (CRL) (Australia), Vilnohirsk State Mining & Metallurgical (Ukraine), and Bemax Resources NL (Australia.)

Global fused zirconia production was estimated to be in range of 45,000 to 55,000 t/yr, and capacity was estimated to be 65,000 t/yr. China, India, and the Republic of Korea were major growth markets for stabilized zirconia (Industrial Minerals, 2006).

Australia.—Following the commissioning of its Ginkgo Mine and Broken Hill mineral separation plant in the Murray Basin, Bemax Co. Ltd. completed prefeasibility studies and planned to expand its mining to the Snapper deposit and expand the Broken Hill mineral separation plant by 2009. The two mines were expected to produce 600,000 t/yr of heavy-mineral concentrate during 20 years (Bemax Resources NL, 2007, p. 5-6).

In the Northern Territory, Matilda Minerals Ltd. began commercial production of heavy-mineral sands concentrate on the Tiwi Islands. Under an offtake agreement with Astron Advanced Materials Ltd., 3,380 t of zircon-rich heavy-mineral concentrate was stockpiled for shipment to Astron's mineral separation plant on Hainan Island, China. Matilda continued its exploration efforts in the Tiwi Islands (Matilda Minerals Ltd., 2007, p. 1-3).

In 2006, Iluka's Australian operations produced about 363,000 t of zircon concentrate. In the Murray Basin, Iluka commissioned a wet concentration plant at its Douglas heavy-mineral mining operation and produced 173,000 t of heavy-mineral concentrate. In November, Iluka commissioned a mineral separation plant, at Hamilton, Victoria. Production in 2007 was expected to include 110,000 t of zircon. Iluka continued its exploration and development efforts and was conducting prefeasibility studies in New South Wales (Murray Basin), Victoria (Murray Basin), and South Australia (Jacinth–Ambrosia, Eucla Basin) (Iluka Resources Ltd., 2007).

Canada.—Titanium Corp. Inc. continued to pursue the recovery of heavy minerals from the Athabasca oil sands tailings in Alberta. In 2006, Titanium Corp. completed the first phase of its pilot program in Fort McMurray, Alberta, to isolate a heavy-mineral concentrate from fresh oil sands tailings. The company began the final stage of a pilot program to optimize the recovery and separation of zircon minerals at its facility in Regina, Saskatchewan (Titanium Corp. Inc., 2007).

China.—China was a major consumer of zirconium mineral concentrates and was estimated to consume 350,000 t of zircon in 2006. Most of China's consumption was supplied by imports. Zircon-rich heavy-mineral concentrate was shipped to mineral separation plants in China from Indonesia, The Gambia, Nigeria, and Vietnam. In 2006, China imported 352,000 t of zircon sand, flour, and concentrates, a 19% increase compared with imports in 2005 (Mineral Sands Report, 2007b).

Gambia, The.—Carnegie Minerals Plc. began production of heavy-mineral concentrate at its mining operations near Batukunku and Sanyang. Under an offtake agreement, Astron Ltd. could acquire The Gambia project's entire nonmagnetic concentrate containing zircon and rutile. The agreement also provided Astron with a first right of refusal to purchase all magnetic concentrate containing ilmenite. Carnegie hoped to produce 15,000 t of nonmagnetic concentrate in 2007. The production capacity target during the first 5 years of operation was 20,000 t/yr of nonmagnetic concentrate (Carnegie Minerals Plc, 2006a, p. 4-7).

Indonesia.—Olympia Resources Ltd. announced plans to construct a mineral separation plant at Banjarmasin to produce zircon concentrate from small mining operations in Kalimantan. When completed, the plant was expected to produce 23,500 t/yr of zircon concentrate. Olympia planned to export zircon, rutile, and gold to China (Olympia Resources Ltd., 2006).

Kenya.—Tiomin Resources Inc. experienced legal and bureaucratic delays in its development of the Kwale mineral sands project. In December, Tiomin Kenya declared force majeure because of its inability to obtain unrestricted access to the mining lease to initiate construction activities. Tiomin had planned to produce 40,000 t/yr of zircon from the Kwale project (Tiomin Resources Inc., 2007, p. 3-4).

Madagascar.—Construction of the QIT Madagascar Minerals SA (QMM) mineral sands project was underway. In 2006, basic construction of infrastructure began, and a contract to develop a deep-sea port at Ehoala near the town of Fort-Dauphin was awarded. When completed, the project was expected to have output of 700,000 t/yr of ilmenite and 33,000 t/yr of zircon with a 40-year mine life. QMM is a joint venture between Rio Tinto Plc. and the Madagascar Government. Production was scheduled to commence in 2008, and Rio Tinto planned to smelt the 60%-grade ilmenite at its slag operation at Sorel, Quebec, Canada (Rio Tinto Plc., 2007, p. 4).

Mozambique.—At yearend, construction at Kenmare Resources Plc's Moma heavy-mineral project neared completion. Mining and mineral separation were scheduled to begin in 2007. The operation was expected to support a 20-year mine life with production of 800,000 t/yr of ilmenite, 56,000 t/yr of zircon, and 21,000 t/yr of rutile (Kenmare Resources Plc., 2006).

Russia.—Production of baddeleyite byproduct from Kovdorsky GOK's apatite and magnetite mine on the Kola Peninsula was 7,500 t, a record level. The company planned to increase production by improving recovery and reprocessing tailings (Mineral Sands Report, 2007a).

Senegal.—Carnegie Minerals Plc. was considering expanding its newly commissioned mining operations in The Gambia to the coast of Senegal. Following airborne magnetic and radiometric studies, a drilling program was completed near Niafarang. Additional drilling in the Casamance Province was scheduled to begin in 2007 (Carnegie Minerals Plc., 2006b).

Mineral Deposits Ltd. completed an environmental impact study for the Grande Côte zircon project, and a feasibility study to produce 85,000 t/yr of zircon concentrate was submitted to the Senegalese Government. At yearend, the company was waiting to commence negotiations for a mine lease (Mineral Deposits Ltd., 2006, p. 6).

South Africa.—In Johannesburg, Geratech Zirconium Beneficiation Ltd. began commercial production of zirconium chemicals and oxides. Geratech's technology was based on an alkali-fusion process, followed by precipitation, filtration, and calcination (Engineering News, 2006).

Outlook

Tremendous industrial growth in China is expected to increase global consumption of zircon particularly in the form of ceramics and zircon chemicals. The rising popularity of flat-panel displays will significantly decrease demand for zircon by TV glass producers, but this is not expected to significantly affect overall consumption of zircon. Global growth in the consumption of zirconium concentrates is expected to be 3% to 5% per year through the next decade. New mine production should ensure adequate supply for several years. Additional expansions in supply were expected in Australia, Madagascar, Mozambique, and South Africa.

References Cited

Bemax Resources NL, 2007, Annual report 2006: Brisbane, Australia, Bemax Resources NL, April 27, 99 p. (Accessed May 22, 2007, at http://www.bemax.com.au/annual/2006Annual%20Report.pdf.)

Carnegie Minerals Plc, 2006a, Emerging zircon production: London, United Kingdom, Carnegie Minerals Ltd., September 7, 26 p. (Accessed November 6, 2007, at http://www.carnegiemins.com/media/presentations/2006/Carnegie%20Minerals%2022-06-06%20final.ppt.)

Carnegie Minerals Plc., 2006b, Senegal geophysical surveying and infill drilling update: London, United Kingdom, Carnegie Minerals Plc., December 12, 2 p. (Accessed April 24, 2007, at http://www.carnegiemins.com/news/news/2006/Survey%20and%20Drilling%2012-12-06.pdf.)

Engineering News, 2006, Pioneering value addition: Garden View, South Africa, Creamer Media Plc. Ltd., July 7. (Accessed December 11, 2007, at http://www.engineeringnews.co.za/article.php?a_id=88370.)

Industrial Minerals, 2006, Fused zirconia—Growth with stability: Industrial Minerals, no. 460, January, p. 20-28.

Iluka Resources Ltd., 2007, Concise annual report 2006: Perth, Australia, Iluka Resources Ltd., March 27, 81 p. (Accessed May 22, 2007, via http://www.iluka.com/Default.aspx?page=130&did=142.

Imerys Group, 2007, Annual report 2006: Paris, France, Imerys Group, March 29, 276 p. (Accessed December 18, 2007, via http://www.imerys.com/scopi/group/imeryscom/imeryscom.nsf/pagesref/SCMM-6ZYGA4?opendocument&lang=en.)

Kenmare Resource Plc., 2006, Construction in the home straight: Dublin, Ireland, Kenmare Resource Plc., October 27, 2 p. (Accessed December 17, 2007, at http://www.kenmareresources.com/investors/documents/Vol7_Eng_271006.pdf.)

Matilda Minerals Ltd., 2007, Quarterly report for the period ended 31 December 2006: West Perth, Australia, Matilda Minerals Ltd., January 21, 16 p. (Accessed May 7, 2007, at URL http://www.matildaminerals.com/pdfs/420736.pdf.)

Mineral Deposits Ltd., 2006, Annual report 2006: Melbourne, Australia, Mineral Deposits Ltd., October 27, 72 p. (Accessed September 6, 2007, at http://www.mineraldeposits.com.au/user/files/Annual%20Reports/MDL_2006_Annual_Report.pdf.)

Mineral Sands Report, 2007a, Baddeleyite production up at Kovdor: Mineral Sands Report, no. 136, February, p. 4.

Mineral Sands Report, 2007b, Chinese zircon: Mineral Sands Report, no. 136, February, p. 18-19.

Olympia Resources Ltd., 2006, Olympia Resources Ltd board approves Kalimantan zircon processing plant: Herdsman, Australia, Olympia Resources Ltd., October 25, 4 p. (Accessed December 1, 2007, at http://www.olympiaresources.com.au/images/documents/OLYKalimantanProcessingPlant.pdf.)

Rio Tinto Plc., 2007, Rio Tinto annual report 2006: London, United Kingdom, Rio Tinto Plc., March 1, 66 p. (Accessed April 24, 2007, at http://www.riotinto.com/documents/FinancialResults/riotinto_2006_annual_review.pdf.)

Titanium Corp. Inc., 2007, Quarterly update: Toronto, Ontario, Canada, Titanium Corp. Inc., January 24. (Accessed November 14, 2006, at http://www.titaniumcorporation.com/s/NewsReleases.asp?ReportID=167668&_Type=News-Releases&_Title=Titanium-Corporation-Inc.-Quarterly-Update.)

Tiomin Resources Inc., 2007, Consolidated financial statements December 31, 2006: Toronto, Canada, Tiomin Resources Inc., March 28, 30 p. (Accessed December 17, 2007, at http://www.tiomin.com/i/pdf/2006Q4.pdf.)

TZ Mineral International Pty. Ltd, 2007, Mineral sands annual review: Perth, Australia, TZ Mineral International Pty. Ltd., June, p. 85.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Zirconium. Ch. in Metal Prices in the United States Through 1998, 1999.

Zirconium. Ch. in United States Mineral Resources, Professional Paper 820, 1973.

Zirconium. International Strategic Minerals Inventory Summary Report, Circular 930-L, 1992.

Zirconium and Hafnium. Ch. in Mineral Commodity Summaries, annual.

Other

American Metal Market, daily.

Chemical Engineering, biweekly.

Chemical Week, weekly.

Engineering and Mining Journal, monthly.

Industrial Minerals, monthly.

International Titanium Association.

Metal Bulletin, weekly and monthly.

Mineral Sands Report, bimonthly and monthly.

Mining Engineering, monthly.

Mining Magazine and Mining Journal, monthly and weekly.

Roskill Information Services Ltd.

U.S. Census Bureau trade statistics, monthly.

Zirconium and Hafnium. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.

TABLE 1
SALIENT U.S. ZIRCONIUM STATISTICS[1]

(Metric tons)

	2002	2003	2004	2005	2006
Zircon:					
Production:					
Concentrates	W	W	W	W	W
Milled zircon	37,000	35,200	31,400	31,400	33,500
Exports	47,100	74,300 r	71,400 r	101,000	76,300
Imports for consumption[2]	36,000 r	38,100 r	36,200 r	38,200	36,200
Consumption, apparent[2, 3]	W	W	W	W	W
Stocks, December 31, dealers and consumers[4]	21,600	27,900	16,700	16,100	17,600
Zirconium oxide:					
Production[5]	17,600	20,400	21,300	19,900	21,700
Exports[6]	1,950	1,520	1,600	2,260	3,340
Imports for consumption[6]	2,900	2,350	3,960	3,160	2,820
Consumption, apparent[3]	21,100 r	20,700	23,700	21,000	24,200
Stocks, December 31, producers[5]	2,490	2,030	2,070	2,210	1,560
Zirconium; unwrought powder, waste and scrap, other:					
Exports	1,640	1,700	1,700	1,970	1,880
Imports	556	542	796	1,020	728
Ferrozirconium:					
Exports	868	1,930	913	65	491
Imports	167	154	165	306	197
Hafnium, unwrought powder, waste and scrap, other, imports	5	5	4	4	4

rRevised. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits.
[2]Includes insignificant amounts of baddeleyite.
[3]Defined as production plus imports for consumption minus exports plus or minus government shipments
[4]Excludes foundries.
[5]Excludes intermediate oxides associated with metal production.
[6]Includes germanium oxides and zirconium dioxides.

TABLE 2
PUBLISHED YEAREND PRICES OF ZIRCONIUM AND HAFNIUM MATERIALS

Specification of material		2005	2006
Zircon:			
Domestic, standard-grade, bulk[1]	dollars per metric ton	570 r	785
Imported sand, free on board, bulk[2]	do.	620-700	700-775
Baddeleyite, contract price, cost, insurance, and freight main European port:[2]			
Refractories/abrasive grade	do.	2,200-2,600	2,200-2,600
Ceramic grade (98% zirconium oxide and hafnium oxide)	do.	2,800-3,200	2,800-3,200
Zirconium oxide[3]	dollars per kilogram	20.10-24.10	20.10-24.10

rRevised.
[1]Domestic average price.
[2]Source: Industrial Minerals.
[3]Source: Stanford Materials Corp.

TABLE 3
U.S. EXPORTS OF ZIRCONIUM, BY CLASS AND COUNTRY[1]

Class and country	HTS[2]	2005 Quantity (metric tons)	2005 Value (thousands)	2006 Quantity (metric tons)	2006 Value (thousands)
Ore and concentrates:	2615.10.0000				
Belgium		2,330	$1,690	3,940	$2,710
Brazil		2,380	2,220	2,460	3,020
Canada		12,500	7,390	12,900	11,400
Colombia		2,600	2,790	2,330	2,930
Germany		622	563	1,910	1,350
Italy		25,600	16,600	8,850	6,980
Mexico		19,400	11,500	12,400	8,680
Netherlands		23,000	13,700	19,800	13,700
Spain		368	282	1,680	1,430
United Kingdom		2,180	3,970	3,140	6,370
Other		9,920	13,400	6,860	10,600
Total		101,000	74,000	76,300	69,200
Ferrozirconium:	7202.99.1000				
Argentina		--	--	39	56
Costa Rica		--	--	79	104
Guatemala		--	--	120	158
Mexico		24	51	178	365
Japan		27	27	--	--
United Kingdom		--	--	43	117
Other		14	22	32	53
Total		65	100	491	853
Unwrought zirconium, powders:	8109.20.0000				
France		4	235	15	606
Hungary		12	407	10	451
Japan		24	649	9	384
Mexico		3	124	41	1,300
United Kingdom		97	1,390	111	1,930
Other		35	814	16	634
Total		175	3,620	202	5,310
Zirconium waste and scrap:	8109.30.0000				
Austria		19	277	--	--
Belgium		19	83	--	--
Canada		28	1,410	36	1,920
France		10	106	6	69
Germany		23	249	--	--
Japan		24	422	9	177
United Kingdom		16	419	9	315
Other		7	116	9	139
Total		146	3,080	69	2,620
Other zirconium:	8109.90.0000				
Canada		268	17,500	413	30,100
China		164	11,700	360	25,100
France		80	4,450	120	6,240
Japan		683	15,000	333	17,300
Korea, Republic of		179	18,400	162	19,200
Spain		50	7,240	70	9,000
United Kingdom		52	4,490	38	2,790
Other		173	8,520	111	8,000
Total		1,650	87,200	1,610	118,000

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States.

Source: U.S. Census Bureau.

TABLE 4
U.S. IMPORTS FOR CONSUMPTION OF ZIRCONIUM AND HAFNIUM, BY CLASS AND COUNTRY[1]

Class and country	HTS[2]	2005 Quantity (metric tons)	2005 Value (thousands)	2006 Quantity (metric tons)	2006 Value (thousands)
Zirconium ore and concentrates:	2615.10.0000				
Australia		20,500	$11,200	21,000	$15,200
South Africa		15,000	9,160	13,900	10,700
Other		2,630	5,370	1,360	2,790
Total		38,200	25,700	36,200	28,600
Ferrozirconium:	7202.99.1000				
Brazil		304	662	187	490
Other		2	13	10	16
Total		306	675	197	506
Unwrought zirconium, powder:	8109.20.0000				
France		230	4,300	128	2,540
Germany		28	1,680	66	2,260
Other		11	24	20	186
Total		269	6,000	213	4,990
Zirconium waste and scrap:	8109.30.0000				
Canada		2	6	9	78
France		--	--	18	106
Germany		4	74	--	--
Japan		8	70	4	35
United Kingdom		(3)	10	11	84
Other		(3)	4	(3)	6
Total		14	164	43	309
Other zirconium:	8109.90.0000				
Belgium		13	290	23	411
Canada		63	3,790	67	4,160
France		588	51,600	352	34,500
Germany		43	7,600	20	5,330
Other		34	1,360	29	1,000
Total		741	64,700	492	45,400
Unwrought hafnium including powders:	8112.92.2000				
Canada		(3)	14	2	256
China		(3)	4	(3)	14
France		4	827	2	386
Germany		(3)	44	(3)	34
United Kingdom		--	--	(3)	9
Other		(3)	42	(3)	2
Total		4	931	4	701

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Harmonized Tariff Schedule of the United States.
[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 5
ZIRCONIUM MINERAL CONCENTRATES: ESTIMATED WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country[3]	2002	2003	2004	2005	2006
Australia	412,000 [4]	462,000 [4]	441,000 [4]	427,000 [r, 4]	491,000
Brazil[5]	20,000	27,198 [r, 4]	25,263 [r, 4]	25,657 [4]	25,700
China	35,000 [r]	50,000 [r]	140,000 [r]	160,000 [r]	170,000
India	19,000	20,000	20,000	20,000	21,000
Indonesia	250	250	200	200	200
Malaysia	5,293 [4]	3,456 [4]	6,886 [4]	4,954 [r, 4]	4,000
Russia[6]	6,900 [r]	6,600 [r]	5,500 [r]	6,700 [r]	7,500
South Africa[7]	429,000 [r]	404,000 [r]	368,000 [r]	376,000 [r]	398,000
Ukraine	34,300	35,000	35,000	35,000	35,000
United States	W	W	W	W	W
Vietnam	11,000	21,000 [r]	39,000 [r]	33,000 [r]	26,000
Total[8]	973,000 [r]	1,030,000 [r]	1,080,000 [r]	1,090,000 [r]	1,180,000

[p]Preliminary. [r]Revised. W Withheld to avoid disclosing company proprietary data; not included in total.
[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes data available through May 9, 2007.
[3]Small amounts of zirconium concentrates were procuded in various countries; however, information is not sufficent to estimate output.
[4]Reported figure.
[5]Includes production of baddeleyite-caldasite.
[6]Production of baddeleyite concentrate averaging 98% ZrO_2.
[7]Includes production of byproduct zircon from titanium sands mining from Palabora Mining Co. Ltd.
[8]Does not include U.S. data, which are withheld to avoid disclosing company proprietary data.