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2006 Minerals Yearbook

THORIUM

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Thorium

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Domestic survey data and table were prepared by James B. Hedrick, mineral commodity specialist, and the world production table was prepared by Glenn J. Wallace, international data coordinator.

Thorium consumption worldwide is relatively small compared with that of most other mineral commodities. There was no domestic production of thorium in 2006. All thorium compounds, metal, and alloys used by the domestic industry were derived from imports, company stocks, or material previously acquired from the U.S. Government stockpile. Domestic imports for consumption of refined thorium products increased by 975% in 2006, according to data collected by the U.S. International Trade Commission (USITC) (table 1). The value of thorium compounds used by the domestic industry in 2006 was estimated to be about $1,560,000, a tenfold increase from $145,000 in 2005. Only minor amounts, less than 10 metric tons (t), of thorium are typically used annually. However, large fluctuations in consumption are caused by intermittent use, especially for catalytic applications that do not require annual replenishment. In 2006, a large shipment of thorium compounds from the United Kingdom was imported for reprocessing, not for consumption. Subtracting this shipment from domestic imports realized an adjusted total of 4.7 t, a decrease from the 4.93 t in 2005.

Thorium and its compounds were produced primarily from the mineral monazite, which was recovered as a byproduct of processing heavy-mineral sands for titanium, zirconium, or tin minerals. Monazite was recovered primarily for its rare-earth content, and only a small fraction of the byproduct thorium produced was consumed. Monazite-producing countries were Brazil, India, and Malaysia.

Problems associated with thorium's natural radioactivity represented a significant cost to those companies involved in its mining, processing, manufacture, and use. The costs to comply with environmental regulations and potential legal liabilities, and the excessive costs to purchase storage and waste disposal space were the principal deterrents to its commercial use. Health concerns associated with thorium's natural radioactivity have not been a significant factor in switching to alternative nonradioactive materials (Ed Loughlin, Grace-Davison division of W.R. Grace & Co., oral commun., 1997; Don Whitesell, The Coleman Company, Inc., oral commun., 2002).

Limited demand for thorium, compared with demand for rare earths produced from thorium-containing minerals, continued to create a worldwide oversupply of thorium compounds and residues. Most major rare-earth processors have switched feed materials to thorium-free intermediate compounds, such as rare-earth chlorides, hydroxides, or nitrates. Excess thorium not designated for commercial use was either disposed of as a low-level radioactive waste or stored for potential use as a nuclear fuel or in other applications. Principal nonenergy uses have shifted from refractory applications to chemical catalysts, lighting, and welding electrodes.

Legislation and Government Programs

No stocks of thorium nitrate remain in the National Defense Stockpile (NDS). Thorium nitrate previously stored at the Defense National Stockpile Center depots at Curtis Bay, MD, and Hammond, IN, were shipped to the low-level radioactive waste disposal area of the Nevada Test Site in Nye County, NV. Shipments to Nevada from both depots were completed by the end of fiscal year 2005.

Production

Domestic mine production data for thorium-bearing minerals were developed by the U.S. Geological Survey from a voluntary canvass of U.S. thorium operations. The one mine to which a canvass form was sent responded. Although thorium was not produced in the United States in 2006, the mine that had previously produced thorium-bearing monazite continued to produce titanium and zirconium minerals and maintained its monazite capacity on standby. Production of monazite in Florida was expected to resume in 2006; Iluka Resources Limited planned to reprocess tailings mainly for the zircon content. Monazite was last produced in the United States in 1994.

Consumption

Statistics on domestic thorium consumption were developed by surveying various processors and manufacturers, evaluating import and export data, and analyzing Government stockpile shipments.

Domestic thorium producers and processors that were surveyed in 2006 reported no consumption of thorium oxide equivalent in 2006. Additional information on domestic consumption was not available. Essentially all thorium alloys and compounds used by the domestic industry were derived from imports, company stocks, or materials previously sold from the National Defense Stockpile. Domestic companies processed or fabricated various forms of thorium for nonenergy uses, such as chemical catalysts, lighting, and welding electrodes.

Novastar Resources Ltd. announced a merger agreement with Thorium Power Inc. on March 17 (Novastar Resources Ltd., 2006). As part of the merger, the company will focus on developing thorium-base nuclear fuels to retrofit existing nuclear plants and for future nuclear plants.

On October 6, Novastar announced the acquisition of Thorium Power Inc., forming a new company under the name Thorium Power Ltd. (Thorium Power, Ltd., 2006§). The company is a leading developer of nonproliferative thorium-base fuels for the nuclear industry. The acquisition provides the new company with patents and technologies specific to thorium power generation. Testing of the thorium fuel technology is ongoing at the Kuchatov Institute in Russia. In addition to providing fuel cycle technologies, Thorium Power has developed proprietary technologies to dispose of weapons grade and reactor grade plutonium as part of the nuclear fuel process.

As the world's consumption of electrical power continues to increase, it is expected that dozens or even hundreds of nuclear plants will be needed in the next few decades to provide power. The two principal problems with uranium as a fuel is that it generates a byproduct, plutonium, which can be used to create nuclear weapons, and that it creates a large volume of spent fuel waste (Hays and Mushakov, 2006). The thorium fuel cycle, however, does not produce weapons-grade material and, in fact, can be used to dispose of plutonium in the breeder reactor, which produces more fissile material than it consumes, by eliminating tons of excess weapons-grade radioisotope plutonium-239 presently stored throughout the world. Thorium's use as a fuel will also reduce waste by 55% by volume and 70% by weight because of its extended in-core fuel time of 9 years compared with 3 to 4 years for conventional uranium fuel.

The members of the American Nuclear Society (ANS) issued a position paper in November supporting thorium as a nuclear fuel. Stating that thorium is 3 to 4 times as abundant as uranium, widely distributed in nature, and readily available in many countries, the ANS endorses thorium fuel for long-term global sustainability (American Nuclear Society, 2006).

Prices

Thorium oxide prices in 2006, as quoted by Rhodia Electronics and Catalysis, Inc.'s U.S. subsidiary Rhodia, Inc., were unchanged from those of the previous year (table 1). At yearend, thorium oxide prices delivered, duty paid, were $82.50 per kilogram for 99.9% purity and $107.25 per kilogram for 99.99% purity. Thorium nitrate prices from Rhodia were $27.00 per kilogram for mantle-grade material.

Foreign Trade

Exports of thorium compounds from the United States were 1,090 kilograms (kg) valued at $424,000, an increase from the 737 kg in 2005 (table 2). Principal destinations, in order of quantity were Singapore, the United Kingdom, Japan, and Australia.

Imports of thorium compounds in 2006 were from the United Kingdom and France and were 48,600 kg valued at $1.56 million, an increase from the 4,930 kg valued at $145,000 in 2005 (table 2). Rhodia Electronics & Catalysis' rare-earth separation plant in La Rochelle, France, remained the principal source of imported thorium compounds for the United States. Most of the thorium is supplied from older stocks that were produced when the plant was processing monazite. The La Rochelle plant currently processes intermediate rare-earth concentrates that have had the thorium removed.

In 2006, 10,000 kg of thorium ores and concentrates valued at $4,800 was imported from Canada. No thorium ores and concentrates were imported in 2005.

World Review

Thorium demand worldwide remained depressed because of concerns over its naturally occurring radioactivity. Industrial consumers expressed concerns about the potential liabilities, the cost of complying with environmental monitoring and regulations, and the cost of disposal at approved waste burial sites.

Outlook

Thorium use in the United States has decreased substantially during the past decade. Domestic consumption is expected to remain at recent depressed levels unless low-cost technology is developed to dispose of thorium residues created as a byproduct during mineral processing or thorium's use as a nonproliferative nuclear fuel gains widespread commercialization. In the long term, high-disposal costs, increasingly stringent regulations, and public concerns related to thorium's natural radioactivity are expected to continue to depress its use in nonenergy applications in the United States as well as worldwide.

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TABLE 1
SALIENT U.S. REFINED THORIUM STATISTICS[1]

(Kilograms and dollars per kilogram)

	2002	2003	2004	2005	2006
Exports, gross weight:					
Thorium ore, including monazite	--	23,000	18,000	--	--
Compounds	880	590	731	737	1,090
Imports, gross weight:					
Thorium ore, including monazite	--	--	--	--	10,000
Compounds	650	4,140	5,320	4,930	48,600
Prices, yearend:					
Nitrate, gross weight[2, 3]	27.00	27.00	27.00	27.00	27.00
Oxide, 99.9% purity[3]	82.50	82.50	82.50	82.50	82.50

-- Zero.

[1]Data are rounded to no more than three significant digits, except prices.

[2]Source: Rhodia Canada, Inc., free on board port of entry, duty paid, thorium oxide basis.

[3]Source: Rhodia Electronics and Catalysis, Inc.

TABLE 2
U.S. FOREIGN TRADE IN THORIUM AND THORIUM-BEARING MATERIALS[1]

	2005		2006		
	Quantity (kilograms)	Value	Quantity (kilograms)	Value	Principal destinations/sources and quantities, 2006
Exports, thorium compounds	737	$281,000	1,090	$424,000	Singapore 411; United Kingdom 287; Japan 201; Australia 104.
Imports:					
Thorium ore, monazite concentrate	--	--	10,000	4,800	Canada 10,000.
Compounds	4,930	145,000	48,600	1,560,000	United Kingdom 43,900; France 4,710.

-- Zero.

[1]Data are rounded to no more than three significant digits.

Source: U.S. Census Bureau.

TABLE 3
MONAZITE CONCENTRATE: ESTIMATED WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons, gross weight)

Country[3]	2002	2003	2004	2005	2006
Brazil	--	--	731 [4]	800	800
India	5,000	5,000	5,000	5,000	5,000
Malaysia	441 [4]	795 [4]	1,683 [4]	320 r	700
Total	5,440	5,800	7,410	6,120 r	6,500

rRevised. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through April 18, 2007.

[3]In addition to the countries listed, China, Indonesia, Nigeria, North Korea, the Republic of Korea, and countries of the Commonwealth of Independent States may produce monazite; available general information is inadequate for formulation of reliable estimates of output levels.

[4]Reported figure.