USGS
science for a changing world

2006 Minerals Yearbook

TITANIUM

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

April 2008

TITANIUM

By Joseph Gambogi

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

Excluding the United States, world production of titanium dioxide (TiO_2) contained in titanium mineral concentrates increased by 10% compared with that of 2005. The industry continued the development of mine capacity for heavy-mineral sands, with many active projects. U.S. consumption of titanium mineral concentrates increased slightly compared with that in 2005. The United States was heavily reliant on imports of titanium mineral concentrates. Australia, Canada, and South Africa were the leading import sources.

Global production of TiO_2 pigment was estimated to be 4.8 million metric tons (Mt), a slight increase compared with that in 2005 (Mineral Sands Report, 2007b). According to U.S. Geological Survey (USGS) survey data, domestic production of TiO_2 pigment decreased slightly compared with that of 2005.

Consumption of titanium used in titanium metal and steel production continued to increase because of numerous orders for commercial aircraft, military hardware, and industrial equipment. U.S. and foreign titanium sponge producers were increasing production and adding new capacity. In 2006, domestic production of titanium ingot increased by 10% and mill product production increased by 17% compared with production in 2005. Prices for titanium metal products increased significantly.

Legislation and Government Programs

The Defense Advanced Research Projects Agency (DARPA) continued to fund work on its Titanium Initiative whose objective is to develop revolutionary processes for the low-cost extraction of titanium metal from oxide ores. In 2006, DARPA identified two technologies that offered the potential to significantly reduce the cost of titanium (Tether, 2006, p. 31).

Production

Mineral Concentrates.—Titanium mineral concentrates of economic importance include ilmenite, leucoxene, rutile, synthetic rutile, and titaniferous slag. Mining of titanium minerals is usually performed using surface methods. Dredging and dry mining techniques are used for the recovery of heavy minerals. Gravity spirals are used to separate the heavy-mineral suite, while magnetic and high-tension separation circuits are used to separate the heavy-mineral constituents. Ilmenite is often processed to produce a synthetic rutile or titaniferous slag. Although numerous technologies are used to produce synthetic rutile, nearly all are based on either selective leaching or thermal reduction of iron and other impurities in ilmenite. Titaniferous slag with a TiO_2 content of 75% to 95% is produced commercially using pyrometallurgical processes.

U.S. mineral concentrate producers were DuPont Titanium Technologies [a subsidiary of E.I. du Pont de Nemours and Co. (DuPont)] and Iluka Resources, Inc. (a subsidiary of Iluka Resources Ltd.). DuPont's mining operations near Starke, FL, produced a mixed product containing ilmenite, leucoxene, and rutile that was used as a feedstock in DuPont's TiO_2 pigment plants. In 2006, Iluka produced titanium mineral concentrates from its heavy-mineral sand operations at Green Cove Springs, FL; Lulaton, GA; and Stony Creek, VA. By yearend, Iluka had ceased mining in Florida and Georgia. The closures were attributed in part to financial losses from mining small, thin, and disparate low-grade deposits and rising operating costs. Iluka planned to process stockpiled tailings in Florida in 2007. Following the cessation of mining in Florida and Georgia, Iluka sold its Brunswick, GA, landholdings. Iluka's Stony Creek operation produced ilmenite concentrate using dry mining techniques. In 2006, Iluka was conducting a feasibility study for the development of the Brink deposit, which is located near Stony Creek (Iluka Resources Ltd., 2006b).

Metal.—Commercial production of titanium metal involves the chlorination of titanium-containing mineral concentrates to produce titanium tetrachloride ($TiCl_4$), which is reduced with magnesium (Kroll process) or sodium (Hunter process) to form a commercially pure form of titanium metal. As the metal is formed, it has a porous appearance and is referred to as sponge. Titanium ingot is produced by melting titanium sponge or scrap or a combination of both, usually with various other alloying elements, such as aluminum and vanadium. Electron beam (EB), plasma, scull, and vacuum-arc melting (VAR) are the commercial methods used to produce ingot. Titanium mill products are produced from the drawing, forging, and rolling of titanium ingot or slab into products of various sizes and shapes. These mill products include billet, pipe and tube, plate, rod and bar, sheet, strip, and wire. Titanium castings are produced by investment casting and rammed graphite mold casting. Ferrotitanium is usually produced by induction melting of titanium scrap with iron or steel. The two standard grades of ferrotitanium that are normally produced contain 40% and 70% titanium.

U.S. producers of titanium sponge in 2006 were Allegheny Technologies Inc. (ATI), Honeywell Electronic Materials Inc., and Titanium Metals Corp. (Timet). Honeywell Electronic Materials' plant in Salt Lake City, UT, produced titanium sponge using the Hunter process and supported the company's production of electronic-grade titanium. ATI's Albany, OR, plant and Titanium Metals Corp.'s Henderson, NV, plant produced titanium sponge using the Kroll process. Data on domestic production of titanium sponge are withheld to avoid disclosing company proprietary data (table 2).

In 2006, ATI raised sponge capacity at its Albany, OR, plant to 3,630 metric tons per year (t/yr). ATI also announced plans to construct a 10,900-t/yr titanium sponge facility adjacent to

U.S. Magnesium Corp.'s magnesium facility at Rowley, UT. The greenfield sponge plant was designed to use the Kroll process and was scheduled to be completed in 2008 (Allegheny Technologies Inc., 2007, p. 7).

RTI International Metals, Inc. announced plans to significantly increase its ingot, forging, scrap processing, and mill product capacity. The expansions were planned for RTI's Canton, OH; Houston, TX; Niles, OH; and Montreal, Quebec, Canada, operations. Most of the expansions were to be completed in 2007 (RTI International Metals, Inc., 2007, p. 26–27).

Perryman Co. was constructing EB and VAR ingot capacity at its Houston, PA, mill. When completed, the new plant was expected to add 1,360 t/yr of ingot capacity and would enable Perryman to recycle all the scrap it generates. The addition of new ingot capacity followed an expansion in mill product capacity (Titanium News, 2006).

In 2006, Timet's Henderson, NV, sponge facility operated at 102% of its annual practical capacity of 8,600 t/yr. At yearend, Timet was completing a 4,000-t/yr expansion in sponge capacity at Henderson, NV. At Morgantown, PA, Timet planned to commission 8,500 t/yr of new EB capacity in 2008 (Titanium Metals Corp., 2007, p. 35, 36).

In 2006, production of titanium metal products continued to rise but at a slower pace than in 2005. U.S. production of ingot rose to 53,100 metric tons (t), an 11% increase compared with that of 2005. Production of mill products increased by 17% compared with that of 2005 (table 3). U.S. producers of ferrotitanium were Galt Alloys Inc. and Global Titanium Inc. Data on production of ferrotitanium were not available.

TiO_2 Pigment.—U.S. production of TiO_2 pigment in 2006 was 1.40 Mt, a 7% increase compared with that in 2005 (table 5). U.S. producers of TiO_2 pigment were DuPont, Louisiana Pigment Co. L.P. (a joint venture of NL Industries, Inc. and Huntsman Corp.), Millennium Inorganic Chemicals Inc., and Tronox Inc. (table 4). TOR Minerals International, Inc. produced a TiO_2 pigment from finely ground synthetic rutile.

In 2005, Kerr-McGee Corp. began an initial public offering (IPO) to spin off its chemical business, but retained 56.7% of the common stock in the new company, Tronox Inc. In March 2006, Kerr-McGee disbursed all its remaining interest in Tronox. Based in Oklahoma City, OK, Tronox's global TiO_2 pigment capacity was 642,000 t/yr, with facilities in Australia, Germany, the Netherlands, and the United States (Tronox Inc., 2007, p. 15).

TiO_2 pigment is produced from titanium mineral concentrates by either the chloride route or the sulfate route. In the chloride process, rutile is converted to $TiCl_4$ by chlorination in the presence of petroleum coke. $TiCl_4$ is oxidized with air or oxygen at about 1,000° C, and the resulting TiO_2 is calcined to remove residual chlorine and any hydrochloric acid that may have formed in the reaction. Aluminum chloride is added to the $TiCl_4$ to assure that virtually all the titanium is oxidized into the rutile crystal structure. In the sulfate process, ilmenite or titanium slag is reacted with sulfuric acid. Titanium hydroxide is then precipitated by hydrolysis, filtered, and calcined. Although either process may be used to produce pigment, the decision to use one process instead of the other is based on numerous factors, including raw material availability, freight, and waste disposal costs. In finishing operations, the crude form of the pigment is milled to produce a controlled distribution of particle size and surface treated or coated to improve its functional behavior in different media. Some typical surface treatments include alumina, organic compounds, and silica.

TiO_2 pigment produced by either process is categorized by crystal form as either anatase or rutile. Rutile pigment is less reactive with the binders in paint when exposed to sunlight than is the anatase pigment and is preferred for use in outdoor paints. Anatase pigment has a bluer tone than rutile, is somewhat softer, and is used mainly in indoor paints and in paper manufacturing. Depending on the manner in which it is produced and subsequently finished, TiO_2 pigment can exhibit a range of functional properties, including dispersion, durability, opacity, and tinting.

Consumption

Mineral Concentrates.—On a gross weight basis, 96% of the domestic consumption of titanium mineral concentrates was used to produce TiO_2 pigment. The remaining 4% was used to produce miscellaneous other products, including fluxes, metal, and welding rod coatings. Based on TiO_2 content, domestic consumption of titanium mineral concentrates was 1.42 Mt, a slight increase compared with that of 2005 (table 6). Consumption data for titanium concentrates were developed by the USGS from a voluntary survey of domestic operations. Of the 16 operations canvassed, 4 responded, representing 18% of the consumption data in table 6. Data for nonrespondents were estimated based on prior-year consumption with adjustments for current-year trends.

Metal.—Titanium metal alloys are used for their high strength-to-weight ratio and corrosion resistance. Because of the increased supply of titanium sponge, consumption of titanium sponge increased, while scrap consumption decreased compared with that of 2005 (table 3). Scrap supplied a calculated 47% of ingot feedstock. Because of increased demand from aerospace and industrial markets, domestic shipments of titanium metal mill products increased by 27%. Estimated U.S. mill product usage by application was as follows: aerospace, 73%, and other, 27%. Other uses included those in the consumer goods, marine, medical, oil and gas, pulp and paper, and specialty chemical industries.

A significant quantity of titanium in the form of ferrotitanium, scrap, and sponge is consumed in the steel and nonferrous alloy industries. In the steel industry, titanium is used for deoxidation, grain-size control, and controlling and stabilizing carbon and nitrogen content. Titanium intensive steels include interstitial-free, stainless, and high-strength low-alloy steels. Reported domestic consumption of titanium products in steel and other alloys was 11,300 t, a 3% increase compared with that of 2005 (table 7).

TiO_2 Pigment.—In the United States, apparent consumption of TiO_2 pigment was 1.11 Mt, a slight decrease compared with that of 2005 (table 5). The leading uses of TiO_2 pigment, based on TiO_2 pigment shipments in the United States, were paint and coatings (57%), plastics and rubber (26%), and paper (13%) (table 8). Other uses (4%) included catalysts, ceramics, coated fabrics and textiles, floor coverings, printing ink, and roofing granules.

Insufficient data were available to determine yearend consumer inventories of titanium mineral concentrates and TiO_2 pigment producer stocks. Increased production levels worldwide improved the availability of unwrought products. Stocks of sponge, scrap, and ingot increased significantly. Industry stocks of sponge increased by 90%. Stocks of scrap increased to 8,940 t, and stocks of ingot increased by 32% compared with those of 2005 (table 3).

Prices

Titanium mineral concentrate prices are listed in table 9. Prices for bulk ilmenite and rutile concentrates were unchanged to slightly higher compared with those in 2005. Published prices for titanium slag were not available. Based on U.S. Customs Service data, the yearend unit value of slag imports ranged from $402 to $454 per metric ton in 2006 compared with $390 to $555 per ton in 2005.

The Bureau of Labor Statistics producer price index (PPI) for TiO_2 pigment decreased by 4% to 165 in December 2006 from 172 in December 2005. The PPI reached a peak of 177 in April 2006 (U.S. Department of Labor, Bureau of Labor Statistics, 2007).

Because of a significant increase in demand for commercial aircraft and military hardware, prices of titanium mill products rose considerably. An increased supply of sponge and scrap limited sponge price increases and caused scrap and ferrotitanium prices to decline.

Foreign Trade

Mineral Concentrates.—The United States is heavily reliant on imports of titanium mineral concentrates because domestic demand for titanium minerals greatly exceeds domestic production. In 2006, the TiO_2 content of imports was estimated to be 1.03 Mt. Exports of titanium concentrates were minor relative to imports.

Imports of titanium mineral concentrates include ilmenite, rutile, synthetic rutile, and titaniferous slag. In 2006, the combined value for all forms of titanium concentrate imports increased by 6% to $458 million (table 11). This increase was the result of increased reliance on natural rutile and titaniferous slag.

In 2006, imports of ilmenite were 187,000 t, a 21% increase compared with those of 2005. The import sources of ilmenite were Australia (68%) and Ukraine (32%). Compared with imports in 2005, imports from Ukraine rose by 216% while imports from Australia decreased by 7%.

Imports of titaniferous slag were 693,000 t, a 4% increase compared with those of 2005. South Africa (74%) and Canada (23%) were the leading import sources of titanium slag. Of the total titaniferous slag imports, 3% may be misclassified because the country of origin did not produce titaniferous slag.

South Africa (44%) and Australia (37%) were the major import sources of natural and synthetic rutile in 2006. Although imports of natural rutile increased compared with those of 2005, imports of synthetic rutile decreased such that the rutile total decreased 3% compared with that of 2005.

Imports of titaniferous iron ore from Canada, classified as ilmenite by the U.S. Census Bureau, decreased by 18% compared with those in 2005. Titaniferous iron ore was used by the steel industry to protect the crucibles of blast furnaces. In this report, imports of titaniferous iron ore from Canada are separated from ilmenite statistics (table 12).

Metal.—Imports of titanium metal are primarily in the form of unwrought titanium and scrap. Kazakhstan (51%), Japan (33%), Ukraine (7%), and Russia (6%) were the leading sources of imported titanium sponge, while Japan (18%), the United Kingdom (17%), Germany (16%), and France (11%) were the leading sources of imported scrap. The leading import sources of titanium ingot were Russia (77%) and Germany (18%). Imports of titanium powder were 152 t, a 21% increase compared with those of 2005. China (65%) was the major source of titanium powder. Imports of other unwrought forms of titanium increased by 14% compared with those of 2005.

Imports of titanium wrought products and castings are primarily in the form of bloom, sheet bar, and slab (30%); bar, rod, profiles, and wire (24%); and plate, sheet, strip, and foil (22%). Russia (71%) and Japan (9%) were the major import sources of wrought products and castings. Imports of wrought products and castings increased by 46% compared with those of 2005, and exports of wrought products and castings increased by 23%.

Imports of ferrotitanium and ferrosilicon titanium, primarily used in the iron and steel industry, were 7,080 t, a 58% decrease compared with those of 2005. Exports of ferrotitanium and ferrosilicon titanium were 2,320 t, a 36% decrease compared with those of 2005.

TiO_2 Pigment.—The United States continued to be a net exporter of TiO_2 pigment. In 2006, exports exceeded imports by a ratio of 2 to 1. Exports of TiO_2 pigment were 581,000 t, an 11% increase compared with those of 2005. About 88% of exports was in the form of finished pigment with more than 80% TiO_2 content.

During 2006, 288,000 t of TiO_2 pigment was imported, a 16% decrease compared with that in 2005 (table 13). The leading import sources of TiO_2 pigment were Canada (33%), China (16%), Germany (9%), France (6%), and Finland (5%). Compared with those of 2005, imports of TiO_2 pigment containing more than 80% TiO_2 decreased by 17% to 206,000 t, other TiO_2 pigment decreased by 18% to 5,420 t, and unfinished TiO_2 (unmixed and not surface treated) decreased by 11% to 76,200 t.

World Review

Australia.—Bemax Resources Ltd. was commissioning its Ginkgo Mine and Broken Hill mineral separation plant in the Murray Basin. Bemax hoped to expand its mining to the nearby Snapper deposit and expand the Broken Hill mineral separation plant by 2009. The Ginkgo and the Snapper Mines were expected to produce 600,000 t/yr of heavy-mineral concentrate during 20 years of mining (Bemax Resources Ltd., 2007, p. 3).

Roche Mining completed construction of Iluka's mineral separation plant (MSP) near Hamilton, Victoria. The MSP was part of Iluka Murray Basin project, which also included its Douglas mining operation and storage and shiploading facilities

at the Port of Portland. By mid-2007, the MSP was expected to reach its full production capacity of 110,000 t/yr of zircon and 70,000 t/yr of rutile (Iluka Resources Ltd., 2006a).

Tronox announced plans to increase TiO_2 pigment capacity at its Tiwest joint venture at Kwinana, Western Australia, by 40,000 t/yr to 50,000 t/yr. The expansion was expected to serve Asian markets and was scheduled to be completed in 2009 (Tronox Corp., 2007, p. 20).

Canada.—Titanium Corp. Inc. continued efforts to commercialize the recovery of heavy minerals from the oil sands tailings of Syncrude Canada Ltd. in Alberta Province. In 2006, Titanium Corp. completed the first phase of its pilot program in Fort McMurray, Alberta, to isolate heavy minerals from fresh oil sands tailings (Titanium Corp. Inc., 2007).

China.—China was a major producer and consumer of titanium mineral concentrates, TiO_2 pigment, and titanium sponge. In 2006, many projects were underway to increase production capacity.

China imported an estimated 709,000 t of titanium concentrates in 2006, a 41% increase compared with imports in 2005. Imports from Vietnam, however, were thought to contain a mix of heavy-mineral concentrates that were shipped to separation plants in China for further processing (Mineral Sands Report, 2007a).

Pangang Group began commissioning 100,000 t/yr of titanium slag capacity at Panzhihua, Sichuan Province. The facility was expected to produce up to 60,000 t/yr of sulfate-grade slag and 40,000 t/yr of chloride-grade slag. Ilmenite used to feed the slag facility was thought to be sourced from Sichuan Province and Yunnan Province (Mineral Sands Report, 2006).

China's leading titanium metal producers were increasing capacity. Fushun Titanium Industry Co. Ltd. completed a sponge expansion project in August. Sponge capacity at Fushun increased to 5,000 t/yr and was expected to increase further to 10,000 t/yr by yearend 2007. Zunyi Titanium Industry Co., Ltd. completed process improvements to its sponge plant, increasing capacity to 10,000 t/yr. China's ingot capacity increased to 40,600 t/yr from 30,000 t/yr in 2005 (Hanchen, 2007).

In June, Aluminum Corp. of China signed a memorandum of understanding with Aricom Plc for the development of a titanium sponge plant in Heilongjiang Province in northeast China. The source ilmenite was expected to be Aricom's Kuranakh Mine in Russia (Aricom Plc, 2007, p. 7).

DuPont was moving forward with plans to construct a chloride TiO_2 pigment facility in Dongying, Shandong Province. In May, DuPont formed an agreement with Huatai Group Co., Ltd. to supply chlorine, caustic soda, hydrochloric acid, and steam (E.I. du Pont de Nemours and Co., 2006).

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 project's entire nonmagnetic concentrate. The agreement also provided Astron with a first right of refusal to purchase all magnetic concentrate. Carnegie was expected 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, 2006, p. 7).

Japan.—Japan's TiO_2 pigment production in 2006 was 239,000 t, an 8% decrease compared with that in 2005 (Roskill's Letters from Japan, 2007a). Production of titanium sponge was 37,800 t, a 23% increase compared with that in 2005 (Roskill's Letters from Japan, 2007b).

Toho Titanium Co., Ltd. was expanding titanium sponge capacity at its Chigasaki plant to 16,000 t/yr from 15,000 t/yr. In addition, Toho planned to construct a 12,000-t/yr sponge plant in the Wakamatsu ward of Kitakyushu City. The Wakamatsu plant was expected to start producing by yearend 2009 and to reach full capacity by 2011. In July 2006, Toho began construction of an EB furnace to increase ingot production capacity at Kitakyushu. The 10,000-t/yr ingot furnace was scheduled to go into operation in April 2008 (Toho Titanium Co., Ltd, 2007, p. 2).

Sumitomo Titanium Corp. (STC) increased capacity at its Amagasaki plant to 24,000 t/yr from 18,000 t/yr. Based on strong demand for titanium mill products, STC planned to increase its sponge capacity to 34,000 t/yr by July 2009 (Osaka Titanium technologies Co., Ltd., 2006).

Kenya.—Tiomin Resources Inc. experienced legal and bureaucratic delays in the development of its 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 330,000 t/yr of ilmenite, 75,000 t/yr of rutile, and 40,000 t/yr of zircon from the Kwale project (Tiomin Resources Inc., 2007, p. 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 a capacity of 700,000 t/yr of ilmenite and 33,000 t/yr of zircon with a 40-year mine life. QMM was a joint venture between Rio Tinto plc and the Government of Madagascar. Production was scheduled to commence in 2008, and Rio Tinto planned to export the 60% grade ilmenite to 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).

Netherlands.—Because of rising TiO_2 pigment demand in Europe, Tronox was expanding capacity at its Botlek TiO_2 pigment facility near Rotterdam. Chloride-route capacity at the Botlek facility was expected to increase to 90,000 t/yr from 72,000 t/yr (Tronox Inc., 2007, p. 5).

Russia.—VSMPO-AVISMA Corp. planned to increase its sponge capacity to 44,000 t/yr by 2010 with a further goal of 56,000 t/yr by 2012. The expansion included facilities for sponge production and development of infrastructure to ensure regular power supplies. In 2006, VSMPO-AVISMA planned to produce 32,000 t of sponge (Russia Newswire, 2007).

Aricom was developing ilmenite and titanomagnetite deposits in eastern Russia. Preliminary mine construction was underway in 2006 at the Kuranakh ilmenite and titanomagnetite deposit.

Production was scheduled to begin by yearend 2007. When completed, the project was expected to produce 900,000 t of titanomagnetite and 290,000 t/yr of ilmenite (Aricom Plc, 2007, p. 2).

Sierra Leone.—Sierra Rutile Ltd. was working to increase rutile production at its mine at Moyamba that reopened in 2005. In 2006, a second dredge was under construction and was scheduled to be commissioned by yearend 2007. The addition of the second dredge was expected to double mine capacity to 200,000 t/yr. The company also planned to add a third dredge and increase the capacity of its separation plant to bring capacity to 270,000 t/yr (Titanium Resources Group Ltd., 2007, p. 8).

South Africa.—KZN Sands (formerly Ticor South Africa) temporarily shut down one of its two TiO_2 slag furnaces in the second half of 2006 for maintenance. KZN's furnaces, which had a capacity of 250,000 t/yr of slag, were commissioned in 2003 and were still being brought to full production level. KZN's capacity also included low-manganese pig iron (145,000 t/yr), rutile (25,000 t/yr), ilmenite (550,000 t/yr), and zircon (50,000 t/yr) (Exxaro Resources Ltd., 2007, p. 30).

United Kingdom.—Huntsman Corp. was expanding TiO_2 pigment capacity at its Greatham site by 50% to 150,000 t/yr. The chloride-route expansion was expected to be completed in 2008 (Huntsman Corp., 2006).

Outlook

Global demand growth for TiO_2 is expected to increase at historical rates of about 3% annually. Higher than average growth is expected in the Asia region. An abundance of new chloride-grade mineral feedstock projects may delay the development of some mining projects. China's significant expansion in sulfate-route TiO_2 production capacity could stimulate mineral exploration and development of sulfate-grade mineral feedstock in China and throughout the world.

Growth in aerospace, defense, and industrial uses is expected to drive demand for titanium metal for the foreseeable future. In the near term, titanium metal producers from around the globe are likely to increase titanium sponge capacity significantly through the expansion of existing facilities in China, Japan, and Russia and the addition of new operations in China and the United States. Based on announced capacity expansion plans, by 2010, domestic and global sponge capacities are expected to reach 43,000 t/yr and 280,000 t/yr, respectively. Numerous government and private industry programs are working to commercialize lower cost methods of producing titanium metal. At least one of these methods is expected to reach commercialization during the next 2 years.

References Cited

Allegheny Technologies Inc., 2007, Annual report 2006: Pittsburgh, PA, Allegheny Technologies Inc., 112 p. (Accessed May 4, 2007, at http://www.investquest.com/iq/a/ati/fin/annual/06/ati06ar.pdf.)

Aricom Plc, 2007, Aricom Plc annual review 2006: London, United Kingdom, Aricom Plc, 16 p. (Accessed November 6, 2007, at http://www.aricom.plc.uk/aricom/uploads/press/ARICOMFINALANNREP.pdf.)

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

Carnegie Minerals Plc, 2006, Emerging zircon production—Exploration potential: London, United Kingdom, Carnegie Minerals Plc, 26 p. (Accessed November 6, 2007, at http://www.carnegiemins.com/media/presentations/2006/Carnegie Minerals 22-06-06 final.ppt.)

E.I. du Pont de Nemours and Co., 2006, DuPont marks milestone toward new titanium dioxide plant in China: Wilmington, DE, E.I. du Pont de Nemours and Co., May 12. (Accessed January 8, 2008, at http://www2.dupont.com/Media_Center/en_BR/daily_news/may/article20060512.html.)

Exxaro Resources Ltd., 2007, Exarro annual report 2006: Pretoria, South Africa, Exxaro Resources Ltd., 215 p. (Accessed April 24, 2007, at http://www.exxaro.com/financials/annualreport2006/pdf/exxaro_annualreport2006.pdf.)

Hanchen, 2007, Development report of titanium industry in China in 2006: Broomfield, CO, International Titanium Association, October 8, 16 p.

Huntsman Corp., 2006, Huntsman announces major pigments production increase: Billingham, United Kingdom, Huntsman Corp. news release, August 16, 1 p. (Accessed November 20, 2006, at http://www.huntsman.com/Index.cfm?PageID=1159&News_ID=1553&style=40&PrintPage=1&Showtitle=1.)

Iluka Resources Ltd., 2006a, Murray Basin mineral separation plant practical completion: Perth, Australia, Iluka Resources Ltd. news release, November 27, 1 p. (Accessed October 31, 2007, at http://www.iluka.com/Default.aspx?page=130&did=43.)

Iluka Resources Ltd., 2006b, Sale of land holdings—Georgia: Perth, Australia, Iluka Resources Ltd., December 6, 1 p. (Accessed December 10, 2007, at http://www.iluka.com/Default.aspx?page=130&did=41.)

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

Mineral Sands Report, 2006, Pangang Titanium to commission chloride slag: Victoria Park, Australia, TZ Minerals International Pty. Ltd., July, p. 4.

Mineral Sands Report, 2007a, Chinese import statistics: Victoria Park, Australia, TZ Minerals International Pty. Ltd., February, p. 25.

Mineral Sands Report, 2007b, Quarterly supply/demand update: Victoria Park, Australia, TZ Minerals International Pty. Ltd., May, p. 18.

Osaka Titanium technologies Co., Ltd., 2006, Sumitomo Titanium Corp is to carry out production capacity enhancement: Amagasaki, Japan, Osaka Titanium technologies Co., Ltd., October 27, 2 p. (Accessed December 10, 2007, at http://www.osaka-ti.co.jp/e/e_annu/pdf/34000plant_expansion.pdf.)

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

Roskill's Letters from Japan, 2007a, Titanium dioxide—Japanese market in January to June 2007: London, United Kingdom, Roskill Information Services Ltd., September, no. 373, p. 15, 16.

Roskill's Letters from Japan, 2007b, Titanium metal—Recovery in shipments in first half of the year: London, United Kingdom, Roskill Information Services Ltd., September, no. 373, p. 12.

Russia Newswire, 2007, Vladislav Tetyukhin, General director of VSMPO–AVISMA Corporation, announces the company's development program through 2012: Russia Newswire, October 31, 1 p. (Accessed January 10, 2008, at http://www.russianewswire.com/releases_headlines_details.php?id=5965.)

RTI International Metals, Inc., 2007, Form 10-K 2006: Niles, OH, RTI International Metals, Inc., March, 99 p. (Accessed May 4. 2007, at http://www.rti-intl.com/pdf/200610K.pdf.)

Tether, T., 2006, Statement by Dr. Tony Tether: Arlington, VA, Defense Advanced Research Projects Agency, March 29, 35 p. (Accessed October 3, 2006, at http://www.darpa.mil/body/news/2006/DARPAHASC32906final.pdf.)

Titanium Corp. Inc., 2007, Quarterly update: Toronto, Ontario, Canada, Titanium Corp. Inc. January 24 (Accessed November 14, 2007, 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, Ontario, Canada, Tiomin Resources Inc., March 28, 30 p. (Accessed December 17, 2007, at http://www.tiomin.com/i/pdf/2006Q4.pdf.)

Titanium Metals Corp., 2007, Form 10-K 2006: Dallas, TX, Titanium Metals Corp. March 24, 106 p. (Accessed December 10, 2007, at http://www.timet.com/pdfs/06annual.pdf.)

Titanium News, 2006, Construction underway on Perryman Company's new titanium melting facility: Hartford, CT, Metal Management, Inc., v. 37, no. 2, p. 1, 8.

Titanium Resources Group Ltd., 2007, Annual report: Tortola, British Virgin Islands, Titanium Resources Group Ltd., 56 p. (Accessed December 12, 2007, at http://www.titaniumresources.com/downloads/v2/TRGAnnualReport2006.pdf.)
Toho Titanium Co., Ltd, 2007, Business report: Chigasaki, Japan, Toho Titanium Co., Ltd., 15 p. (Accessed December 10, 2007, at http://www.toho-titanium.co.jp/en/ir/pdf/business_report_2007.pdf.)
Tronox Inc., 2007, Form 10-K 2006: Oklahoma City, OK, Tronox Inc., March 16, 146 p. (Accessed December 10, 2007, at http://www.tronox.com/html/annualreport/2006/pdf/tronox_2006.pdf.)
U.S. Department of Labor, Bureau of Labor Statistics, 2007, Producer price index—Commodities: U.S. Department of Labor, Bureau of Labor Statistics. (Accessed July 25, 2007, via http://data.bls.gov/.)

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Recycling—Metals. Ch. in Minerals Yearbook, annual.
Titanium and Titanium Dioxide. Ch. in Mineral Commodity Summaries, annual.
Titanium Mineral Concentrates. Ch. in Mineral Commodity Summaries, annual.
Titanium Mineral Resources of the United States—Definitions and Documentation—Contributions to the Geology of Mineral Deposits. Bulletin 1558–B, 1984.
Titanium. Ch. in Metal Prices in the United States through 1998, 1999.
Titanium. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
Titanium. International Strategic Minerals Inventory Summary Report, Circular 930–G, 1988.
Titanium. Mineral Industry Surveys, quarterly.

Other

American Metal Market, daily.
Economics of Titanium Metal, The (4th ed.). Roskill Information Services Ltd., 2007.
Economics of Titanium Minerals and Pigments, The (4th ed.). Roskill Information Services Ltd., 2006.
Geology of Titanium-Mineral Deposits. Geological Society of America Special Paper 259, 1991.
Industrial Minerals, monthly.
Japan Titanium Society.
Metal Bulletin, weekly.
Mining Journal, monthly and weekly.
Mining Magazine, monthly and weekly.
Platts Metals Week, weekly.
Titanium. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Titanium Newsletter. International Titanium Association, quarterly.

TABLE 1
SALIENT TITANIUM STATISTICS[1]

		2002	2003	2004	2005	2006
United States:						
Mineral concentrate:						
Imports for consumption	metric tons	1,230,000	1,230,000	1,060,000	1,190,000	1,230,000
Consumption[2]	do.	1,780,000	1,790,000	1,920,000	1,720,000	1,870,000
Sponge metal:						
Imports for consumption	do.	10,700	9,590	11,900	15,800	24,400
Consumption	do.	17,300	17,100	21,200	26,100	28,400
Price, yearend[3]	dollars per pound	3.64	2.72-3.95	3.55-6.44	3.46-12.22	5.87-12.84
Titanium dioxide pigment:						
Production	metric tons	1,410,000	1,420,000	1,540,000	1,310,000	1,400,000
Imports for consumption	do.	231,000	240,000	264,000	341,000	288,000
Consumption, apparent	do.	1,110,000 [4]	1,070,000 [4]	1,170,000 [5]	1,130,000 [5]	1,110,000 [5]
Producer price index, yearend (1982=100):[6]		146	144	158	172	165
World, production:						
Ilmenite concentrate[7]	metric tons	5,400,000 [r]	5,780,000 [r]	5,940,000 [r]	6,090,000 [r]	6,700,000
Rutile concentrate, natural[8]	do.	446,000	361,000	353,000 [r]	373,000 [r]	511,000
Titaniferous slag[e]	do.	1,870,000	1,880,000	1,880,000	1,880,000	2,160,000

[e]Estimated. [r]Revised.
[1]Data are rounded to no more than three significant digits, except prices.
[2]Excludes consumption used to produce synthetic rutile.
[3]Landed duty-paid unit based on U.S. imports for consumption.
[4]Production plus imports minus exports plus stock decrease or minus stock increase.
[5]Production plus imports minus exports. Excludes stock changes.
[6]Source: U.S. Department of Labor, Bureau of Labor Statistics.
[7]Includes U.S. production of ilmenite, leucoxene, and rutile rounded to one significant digit to avoid disclosing company proprietary data.
[8]U.S. production of rutile included with ilmenite to avoid disclosing company proprietary data.

TABLE 2
U.S. TITANIUM METAL PRODUCTION CAPACITY IN 2006[1, 2]

(Metric tons per year)

Company	Plant location	Yearend capacity[e]	
		Sponge	Ingot[3]
Alcoa Howmet	Whitehall, MI	--	3,200
Allegheny Technologies Inc.	Albany, OR	3,630	10,900
Do.	Monroe, NC	--	14,100
Do.	Richland, WA	--	10,000
Alloy Works LLC	Greensboro, NC	--	1,800
Honeywell Electronic Materials Inc.	Salt Lake City, UT	340	--
RTI International Metals, Inc.	Niles, OH	--	13,600
Titanium Metals Corp.	Henderson, NV	8,600	12,300
Do.	Morgantown, PA	--	20,000
Do.	Vallejo, CA	--	800
Total		12,600	86,700

[e]Estimated. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Estimated operating capacity based on 7-day-per-week full production.
[3]Includes electron-beam, plasma, and vacuum-arc-remelting capacity.

TABLE 3
COMPONENTS OF U.S. TITANIUM METAL SUPPLY AND DEMAND[1]

(Metric tons)

Component	2005	2006
Production:		
Ingot	48,100	53,100
Mill products	30,900	36,100
Exports:		
Waste and scrap	20,600	10,800
Sponge	1,910	1,380
Other unwrought	2,540	3,030
Wrought products and castings	10,800	11,600
Total	35,800	26,800
Imports:		
Waste and scrap	12,400	12,800
Sponge	15,800	24,400
Other unwrought	3,910	4,810
Wrought products and castings	3,660	5,360
Total	35,800	47,400
Stocks, industry, yearend:		
Sponge	4,330	8,240
Scrap	6,900	8,940
Ingot	3,270	4,330
Consumption, reported:		
Sponge	26,100	28,400
Scrap	25,700	25,000
Ingot	40,100	45,100
Shipments:		
Ingot	16,000 [r]	16,900
Mill products (net shipments):		
Forging and extrusion billet	8,110	11,800
Plate, sheet, strip	9,970	12,200
Rod, bar, fastener stock, wire	5,160	5,650
Other[2]	587	629
Total	23,800	30,200

See footnotes at end of table.

TABLE 3—Continued
COMPONENTS OF U.S. TITANIUM METAL SUPPLY AND DEMAND[1]

(Metric tons)

Component	2005	2006
Shipmants—Continued:		
Castings (shipments)	W	744
Receipts, scrap:		
Home	5,490	13,500
Purchased	15,200	19,400

[r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Data are rounded to no more than three significant digits; may not add to totals shown
[2]Data for pipe, tube, and other have been combined to avoid disclosing company proprietary data.

TABLE 4
U.S. PRODUCERS OF TITANIUM DIOXIDE PIGMENT[1, 2, 3]

(Metric tons per year)

Company	Plant location	Yearend capacity[4]
Du Pont Titanium Technologies	De Lisle, MS	340,000
Do.	Edgemoor, DE	154,000
Do.	New Johnsonville, TN	380,000
Louisiana Pigment Co. L.P.	Lake Charles, LA	146,000
Millennium Inorganic Chemicals Inc.	Ashtabula, OH	220,000
Do.	Baltimore, MD	50,000
Tronox Inc.[5]	Hamilton, MS	225,000
Do.	Savannah, GA	110,000
Total		1,630,000

[1]Estimated operating capacity based on 7-day-per-week full production.
[2]Table does not include TOR Minerals International Inc.'s Corpus Christi, TX, production capacity of about 26,400 metric tons per year of buff that is produced by refining and fine grinding of synthetic rutile.
[3]Data are rounded to no more than three significant digits; may not add to totals shown.
[4]All plants use the chloride process to manufacture TiO_2 pigment.
[5]Correction posted April 8, 2008.

TABLE 5
COMPONENTS OF U.S. TITANIUM DIOXIDE PIGMENT SUPPLY AND DEMAND[1]

		2005		2006	
		Gross weight	TiO_2 content	Gross weight	TiO_2 content
Production[2]	metric tons	1,310,000	1,220,000 [e]	1,400,000	1,320,000 [e]
Shipments:[3]					
Quantity	do.	1,420,000	1,220,000 [e]	1,400,000	1,320,000 [e]
Value	thousands	$3,110,000	XX	$3,020,000	XX
Exports	metric tons	524,000	493,000 [e]	581,000	546,000 [e]
Imports for consumption	do.	341,000	321,000 [e]	288,000	271,000 [e]
Consumption, apparent[e, 4]	do.	1,130,000	1,050,000	1,110,000	1,040,000

[e]Estimated. XX Not applicable.
[1]Data are rounded to no more than three significant digits.
[2]Excludes production of buff pigment.
[3]Includes interplant transfers.
[4]Production plus imports minus exports. Excludes stock changes.

Sources: U.S. Census Bureau and U.S. Geological Survey.

TABLE 6
ESTIMATED U.S. CONSUMPTION OF TITANIUM CONCENTRATE[1, 2]

(Metric tons)

	2005		2006	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content
Concentrate:				
Pigment	1,650,000	NA	1,800,000	NA
Miscellaneous[3]	64,000	NA	72,000	NA
Total	1,720,000	1,390,000	1,870,000	1,420,000

NA Not available.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes a mixed product containing altered ilmenite, leucoxene, and rutile.

[3]Includes alloys, carbide, ceramics, chemicals, glass fibers, titanium metal, and welding-rod coatings and fluxes.

TABLE 7
U.S. CONSUMPTION OF TITANIUM IN STEEL AND OTHER ALLOYS[1, 2]

(Metric tons)

	2005	2006
Steel:		
Carbon steel	4,300	4,480
Stainless and heat-resisting steel	3,370	3,270
Other alloy steel[3]	472	568
Total steel	4,130	8,310
Superalloys	1,310	1,300
Alloys, other than above	1,460	1,600
Miscellaneous and unspecified	54	47
Grand total	11,000	11,300

[1]Includes ferrotitanium, scrap, sponge, and other titanium additives.

[2]Data are rounded to no more than three significant digits; may not add to totals shown.

[3]Includes high-strength low-alloy and tool steel.

TABLE 8
U.S. DISTRIBUTION OF TITANIUM PIGMENT SHIPMENTS, TITANIUM DIOXIDE CONTENT, BY INDUSTRY[1]

(Percent)

Industry	2005	2006
Paint, varnish, lacquer	62.7	57.1
Paper	12.1	12.6
Plastics and rubber	24.4	26.3
Other[2]	0.8	4.0
Total	100.0	100.0

[1]Excludes exports.

[2]Includes agricultural, building materials, ceramics, coated fabrics and textiles, cosmetics, food, paper, and printing ink. Also includes shipments to distributors.

TABLE 9
YEAREND PRICES OF TITANIUM PRODUCTS

		2005	2006
Concentrate:			
Ilmenite, free on board (f.o.b.) Australian ports[1]	dollars per metric ton	75-85	75-85
Rutile, bagged, f.o.b. Australian ports[1]	do.	550-650	570-700
Rutile, bulk, f.o.b. Australian ports[1]	do.	460-480	450-500
Titaniferous slag, import, 80% to 95% TiO_2[2]	do.	390-555	402-454
Metal:			
Sponge import[2]	dollars per pound	3.46-12.22	5.87-12.84
Scrap, turnings, unproccessed[3]	do.	4.85-5.15	4.00-4.40
Ferrotitanium, 70% Ti[3]	do.	8.50-9.50	6.79-7.00
Mill products[4]	producer price index	218	300
Titanium dioxide pigment[4]	do.	172	165

[1]Source: Industral Minerals.
[2]Landed duty-paid unit value based on U.S. imports for consumption.
[3]Source: Platts Metals Week.
[4]1982=100. Source: U.S. Department of Labor, Bureau of Labor Statistics.

TABLE 10
U.S. EXPORTS OF TITANIUM BY CLASS[1]

		2005		2006	
Class	HTS[2]	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Metal:					
Scrap	8108.30.0000	20,600	$91,400	10,800	$110,000
Unwrought:					
Sponge	8108.20.0010	1,910	19,800	1,380	15,600
Ingot	8108.20.0030	1,720	32,600	2,070	41,300
Other	8108.20.0090	820	17,200	956	22,300
Wrought:					
Billet	8108.90.6010	392	18,900	1,200	64,500
Bloom, sheet bar, slab	8108.90.6020	613	14,300	532	13,400
Bar, rod, profile, wire	8108.90.6031	3,460	174,000	3,670	237,000
Other	8108.90.8000	6,350	288,000	7,900	528,000
Total		35,800	656,000	28,500	1,030,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	3,630	21,300	2,320	12,100
Ores and concentrates	2614.00.0000	20,900	8,930	32,800	11,800
Pigment:					
80% or more titanium dioxide pigment	3206.11.0000	486,000	955,000	513,000	911,000
Other titanium dioxide pigment	3206.19.0000	24,000	75,900	57,100	147,000
Unfinished titanium dioxide[3]	2823.00.0000	14,500	30,600	10,800	24,700
Total		524,000	1,060,000	581,000	1,080,000

[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]Unmixed and not surface treated.

Source: U.S. Census Bureau.

TABLE 11

U.S. IMPORTS FOR CONSUMPTION OF TITANIUM CONCENTRATE, BY COUNTRY[1]

Concentrate and country	HTS[2]	2005 Quantity (metric tons)	2005 Value (thousands)	2006 Quantity (metric tons)	2006 Value (thousands)
Ilmenite:	2614.00.6020				
Australia		135,000	$18,700	127,000	$14,200
Ukraine		19,000	1,670	60,100	5,890
Total		154,000	20,400	187,000	20,100
Titaniferous slag:	2620.99.5000				
Canada		168,000	65,400	159,000	68,200
South Africa		472,000	178,000	512,000	199,000
Other		27,000 [3]	10,500 [3]	22,000 [3]	8,990 [3]
Total		667,000	254,000	693,000	276,000
Rutile, natural:	2614.00.6040				
Australia		35,400	14,600	60,100	28,100
South Africa		137,000	63,200	136,000	61,400
Ukraine		5,440	2,510	5,530	2,610
Other		5,970	3,580	49,300 [3]	22,400 [3]
Total		184,000	83,800	251,000	114,000
Rutile, synthetic:	2614.00.3000				
Australia		158,000	64,100	73,000	33,400
Malaysia		14,300	6,190	9,060	4,300
Other		9,170 [3]	3,890 [3]	22,300 [3]	10,000 [3]
Total		182,000	74,200	104,000	47,800
Titaniferous iron ore, Canada[4]	2614.00.6020	61,100	3,560	49,800	3,240

[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]All or part of these data have been referred to the U.S. Census Bureau for verification.

[4]Includes materials consumed for purposes other than production of titanium commodities, principally heavy aggregate and steel-furnace flux. Titaniferous iron ore from Canada is classified as ilmenite under the HTS.

Source: U.S. Census Bureau. Data adjusted by the U.S. Geological Survey.

TABLE 12

U.S. IMPORTS FOR CONSUMPTION OF TITANIUM METAL, BY CLASS AND COUNTRY[1]

Class and country	HTS[2]	2005 Quantity (metric tons)	2005 Value (thousands)	2006 Quantity (metric tons)	2006 Value (thousands)
Waste and scrap:	8108.30.0000				
Canada		905	$7,980	664	$6,380
France		2,080	33,800	1,350	21,300
Germany		1,640	29,300	2,070	41,500
Israel		341	4,670	325	6,450
Japan		3,010	33,900	2,320	33,400
Taiwan		637	10,500	657	11,900
United Kingdom		2,060	19,700	2,160	24,100
Other		1,690 r	21,900 r	3,270	55,000
Total		12,400	162,000	12,800	200,000
Unwrought:					
Sponge:	8108.20.0010				
Japan		6,200	54,900	8,070	86,800
Kazakhstan e		8,390	51,400	12,400	83,700
Russia		977	7,140	1,570	27,800
Ukraine		239	5,640	1,650	40,100
Other		47	648	697	13,300
Total		15,800	120,000	24,400	252,000
Ingot:	8108.20.0030				
France		112	4,010	39	1,520
Germany		332	6,720	555	19,400
Russia		1,920	26,500	2,430	34,200
Other		83	1,490	120	3,650
Total		2,450	38,700	3,140	58,800
Powder:	8108.20.0015				
China		86	1,830	99	3,030
Japan		20	1,490	14	1,470
Other		20 r	746 r	39	666
Total		126	4,060	152	5,170
Other:	8108.20.0091				
France		238	4,080	367	6,410
Japan		752	12,600	479	12,600
United Kingdom		180	4,330	338	10,600
Other		164	1,920	334	6,100
Total		1,330	22,900	1,520	35,600
Wrought products and castings:[3]	8108.90.3030, 8108.90.3060, 8108.90.6010, 8108.90.6020, 8108.90.6031, 8108.90.6045, 8108.90.6060, 8108.90.6075				
Canada		87	4,750	181	9,470
China		215	8,480	304	15,900
Italy		94	3,890	51	3,720
Japan		390	14,700	487	22,500
Russia		2,300	47,100	3,820	91,500
Sweden		71	2,260	54	2,180
United Kingdom		241	12,200	184	11,400
Other		264	18,100	280	24,200
Total		3,660	111,000	5,360	181,000
Ferrotitanium and ferrosilicon titanium	7202.91.0000	16,900	76,200	7,080	63,400

eEstimated. rRevised.

[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]Includes bar, billet, bloom, castings, foil, pipe, plate, profile, rod, sheet, sheet bar, slab, strip, tube, wire, and other.

Source: U.S. Census Bureau.

TABLE 13

U.S. IMPORTS FOR CONSUMPTION OF TITANIUM PIGMENT, BY COUNTRY[1]

Country	HTS[2]	2005 Quantity (metric tons)	2005 Value (thousands)	2006 Quantity (metric tons)	2006 Value (thousands)
80% or more titanium dioxide pigment:	3206.11.0000				
Australia		3,620	$6,380	7,730	$14,800
Belgium		9,990	18,000	9,060	17,200
Canada		73,000	141,000	76,200	157,000
China		29,800	39,600	26,900	37,600
Finland		14,000	27,400	15,100	30,100
France		7,060	11,100	2,770	4,990
Germany		17,600	35,200	17,700	38,100
Italy		9,460	14,700	6,880	10,900
Japan		6,190	15,800	4,240	12,100
Korea, Republic of		7,360	8,860	1,040	1,400
Mexico		13,800	23,700	3,650	6,200
Netherlands		5,310	11,300	5,110	10,900
Norway		4,010	6,840	3,570	6,990
Singapore		2,030	3,820	1,830	3,580
Slovenia		3,020	4,780	1,920	3,550
Spain		8,800	13,900	12,200	19,600
United Kingdom		27,400	47,100	6,420	11,500
Other		6,130	8,700	4,100	6,880
Total		249,000	438,000	206,000	393,000
Other titanium dioxide:	3206.19.0000				
Canada		2,680	11,100	1,870	7,610
China		795	2,120	1,270	2,490
Finland		274	2,820	269	2,730
Germany		1,220	3,800	762	2,270
India		491	1,490	208	452
Japan		390	5,830	284	4,260
United Kingdom		113	2,270	111	1,820
Other		644	2,230	650	1,830
Total		6,600	31,600	5,420	23,500
Unfinished titanium dioxide:[3]	2823.00.0000				
Belgium		1,560	3,080	424	1,280
Brazil		2,030	2,590	2,370	3,050
Canada		28,600	14,300	16,200	8,520
China		15,700	21,000	17,800	24,700
Czech Republic		7,810	13,100	3,610	6,420
France		17,100	25,700	13,300	25,300
Germany		5,910	13,000	6,110	12,500
Korea, Republic of		1,680	2,320	6,360	8,550
Poland		752	1,250	322	605
Other		4,720	11,300	9,730	18,700
Total		85,800	108,000	76,200	110,000
Grand total		341,000	578,000	288,000	526,000

[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]Unmixed and not surface treated.

Source: U.S. Census Bureau.

TABLE 14
TITANIUM: WORLD PRODUCTION OF MINERAL CONCENTRATES, BY COUNTRY[1, 2]

(Metric tons)

Concentrate type and country	2002	2003	2004	2005	2006
Ilmenite and leucoxene:[3, 4]					
Australia	1,956,000	2,063,000	1,965,000 [r]	2,080,000 [r]	2,367,000
Brazil[5]	177,027	120,160	133,000	127,142 [r]	130,000 [p]
China[e]	750,000	800,000	840,000	900,000	1,000,000
Egypt[e]	125,000	125,000	125,000	125,000	125,000
India[e]	460,000	500,000	520,000	550,000	580,000
Kazakhstan[e]	-- [r]	9,300 [r]	11,670 [r]	10,000 [r]	25,000
Malaysia	106,046	95,148	61,471	38,196 [r]	35,000 [e]
Norway[e]	750,000	840,000	860,000	860,000	850,000
Sierra Leone	--	--	--	--	13,819
Ukraine	512,400	420,500	370,000 [e]	375,000 [r, e]	470,000
United States[e, 6]	400,000	500,000	500,000	500,000	500,000
Vietnam[e, 7]	170,000 [r]	310,000 [r]	550,000 [r]	520,000 [r]	600,000
Total[8]	5,400,000 [r]	5,780,000 [r]	5,940,000 [r]	6,090,000 [r]	6,700,000
Rutile:[4]					
Australia	218,000	173,000	162,000	177,000	233,000
Brazil[5]	1,878	2,303 [r]	2,117 [r]	2,069 [r]	2,100 [p]
India[e]	18,000	18,000	19,000	19,000	19,000
Sierra Leone	--	--	--	--	73,802
South Africa[e]	138,000	108,000	110,000	115,000 [r]	123,000
Ukraine[e]	70,000	60,000	60,000	60,000	60,000
United States	(9)	(9)	(9)	(9)	(9)
Total	446,000	361,000	353,000 [r]	373,000 [r]	511,000
Titaniferous slag:[e, 10]					
Canada	900,000	873,000	863,000	860,000	930,000
South Africa	973,000	1,010,000	1,020,000	1,020,000	1,230,000
Total	1,870,000	1,880,000	1,880,000	1,880,000	2,160,000

[e]Estimated. [p]Preliminary. [r]Revised. -- Zero.

[1]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 July 10, 2007.

[3]Ilmenite is also produced in Canada and South Africa, but this output is not included here because most of it is duplicative of output reported under "Titaniferous slag," and the rest is used for purposes other than production of titanium commodities, principally steel furnace flux and heavy aggregate.

[4]Small amounts of titanium minerals were reportedly produced in various countries; information, however, is inadequate to make reliable estimates of output levels.

[5]Excludes production of unbeneficiated anatase ore.

[6]Includes rutile to avoid disclosing company proprietary data. Rounded to one significant digit.

[7]Estimate based on import statistics from trading partners (primarily China and Japan).

[8]Includes U.S. production, rounded to one significant digit, of ilmenite, leucoxene, and rutile to avoid disclosing company proprietary data.

[9]Included with ilmenite to avoid disclosing company proprietary data.

[10]Slag is also produced in Norway, Kazakhstan, and Russia, but this output is not included under "Titaniferous slag" to avoid duplicative reporting.